Knowledge, understanding, and attitudes towards antibiotic use, prescription advice and antibiotic resistance among parents in Greater Manchester.

Cynthia Poolay Mootien

University of Salford

School of Health and Society

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Declaration

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List of Abbreviations

ABR	Antibiotic Resistance
AMR	Antimicrobial Resistance
ARC	Antimicrobial Resistance Collaborators
BSAC	British Society for Antibiotic Chemotherapy
BSI	Blood Steam Infection
CDC	Centre for Disease Control and Prevention
CDRC	Consumer Data Research Centre
DCP	Day-Care Providers
DDD	Defined Daily Doses
DKE	Dunning-Kruger Effect
DoHSC	Department of Health and Social Care
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
EEA	European Economic Area
EU	European Union
GM	Greater Manchester
GMCA	Greater Manchester Combined Authority
GP	General Practitioner
IBD	Inflammatory Bowel Disease
IBS	Irritable Bowel Syndrome
ICS	Integrated Care System
IMD	Index of Multiple Deprivation
JISC	Joint Information Systems Committee
LE	Life Expectancy
MDG	Millennium Development Goals
MDR-TB	Multi-Drug Resistant Tuberculosis
MRSA	Methicillin-Resistant Staphylococcus Aureus
NHS	National Health System
NHSBSA	NHS Business Services Authority

NICE	National Institute for Health and Care excellence
NIHR	National Institute for Health and Care Research
NW	North West
OECD	Organisation for Economic Cooperation and Development
OHID	Office for Health Improvement and Disparities
ONS	Office for National Statistics
OW	Online Workshop
PHE	Public Health England
POCT	Point of Care Testing
RCT	Randomised Controlled Trial
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus
SDG	Sustainable Development Goals
SES	Socioeconomic Status
SPSS	Statistical Package for the Social Sciences
STI	Sexually Transmitted Infection
TB	Tuberculosis
TDF	Theoretical Domains Framework
UKHSA	UK Health Security Agency
URTI	Upper Respiratory Tract Infection
UTI	Urinary Tract Infection
WHO	World Health Organisation
XDR-TB	Extensively Drug-Resistant Tuberculosis

Abstract

Background:

Antibiotic resistance (ABR) is an important global public health issue. Understanding how much the public knows and understands about ABR is imperative to enable the development of more efficient ways to improve antibiotic stewardship (the collective effort to improve how antibiotics are prescribed by healthcare providers and used by patients). This study aimed to obtain an in-depth understanding of the current knowledge, attitudes, and practices of parents living in GM, regarding antibiotic use, prescription advice, and antibiotic resistance.

Methods:

A mixed-methods explanatory study was conducted with parents of children aged between 3 months and 6 years. Phase 1 involved a cross-sectional survey (n=120), followed by telephone interviews (n=12) in phase 2. Phase 3 involved online creative workshops with parents (n=4), and the final phase (phase 4) involved further interviews with parents from deprived areas, to augment the findings from phase 2.

Results:

Findings from all 4 phases show that parents have certain misconceptions, particularly regarding the consequences of misusing antibiotics.

Phase 1: Participants were unaware that the improper use of these drugs can lead to worsening of an illness (36%); 33% were not aware that taking antibiotics can often have side-effects; 21.7% wrongly believed that bacteria cause the common cold; and 15.0% reported they would request antibiotics for recurrent respiratory infection.

Phase 2: Mistrust in GPs was reported by many parents, who felt uninformed and unheard after medical consultations. Behavioural inconsistencies and emotional disengagement were observed among parents who considered themselves as being responsible antibiotic users.

Phase 3: Parents wanted an intervention that empowered them to discuss treatment options with their GPs. Participants also wanted to see more positive messaging and relatable information in an intervention that might aim to improve antibiotic stewardship among parents.

Phase 4: Participants, from a generally non-UK born sample were unaware of ABR and misunderstandings were present regarding the responsible use of antibiotics. Findings from this phase confirmed that some of the findings obtained from phase 2.

Conclusion:

There is significant scope to improve parents' knowledge, understanding, and attitudes towards antibiotic use and ABR. The lack of understanding and awareness vis-à-vis certain aspects of ABR and antibiotic use, has the potential to translate into misinformation passed onto the next generation of antibiotic stewards (children). Parents perceive that GP consultations involving antibiotic prescribing could be improved. Understanding parents' expectations, perspectives, and misconceptions is key to improving knowledge and raising awareness on antibiotics, as well as changing practice around antibiotic use. These findings could inform local and national policies and future research. They could also aid in future training for GPs, regarding precautionary prescribing and improving communication with parents about antibiotic practice.

COVID-19 Impact Statement

Data collection for this study was conducted from April 2020 to July 2023. The first three phases of this study were affected by the COVID-19 pandemic in terms of data collection and participant recruitment. Due to governmental regulations on public gatherings and social distancing enforced during this study, phases 1 – 3 were conducted remotely; to ensure researcher and participant safety and comply with government social distancing guidelines. All ensuing changes to the methodology, were approved by the University's Ethics Board, prior to the start of each phase. A flowchart detailing the timeline and process of this study is provided in section 1.1 (Aim & Objectives).

Phase 1 (the survey) was conducted between April and August 2020. The original design of the study intended to make use of online and paper questionnaires, to ensure that a more reflective sample of parents in GM was obtained, including participants with less digital engagement. Non-NHS day-care centres and community centres in various boroughs in GM would have been targeted for questionnaire distribution, to include boroughs of various deprivation levels. However, due to COVID-19 restrictions online surveys were the only feasible method of data collection at the time. Social media was used to share the online survey (via parental Facebook pages), as this was an effective and feasible method of recruiting parents from various online communities in GM. However, this resulted in limitations, particularly in accessing groups with low levels of digital literacy or poor English. It is important to note that some of the third parties contacted (i.e. gatekeepers of social media platforms) were apprehensive of sharing the survey, as they wished to restrict the information on their social media pages to the pandemic.

Phase 2 (interviews with parents) was conducted between August 2020 and January 2021. In-person focus groups were originally planned for this phase of the study, which were intended to be undertaken in the same selected boroughs as the paper questionnaires would have been distributed. This was planned to capture socio-economic differences in responses. However, telephone interviews were the only method that was feasible when this phase was conducted.

Phase 3 (online creative workshops) also began during the pandemic and were conducted between November 2021 and May 2022. Due to social distancing restrictions, online creative workshops were chosen for their practicality, and to ensure COVID-19 guidance was followed for the safety of the participants and the researcher. However, as the sample for the online workshops was drawn from those who took part in Phases 1 and 2, they were unable to capture the diversity of the population of GM.

Due to the disruption caused by COVID-19 some aspects of this study were impacted, particularly with regards to the population sample obtained, which affected both the representativeness of the sample and generalisability of the findings. Therefore, further interviews were carried out between June and July 2023 (Phase 4), to capture a more diverse group of parents with children, i.e. parents of children aged 3 months to 6 years old, living in areas of deprivation in GM. For this phase parents were recruited face-to-face, given that COVID-19 restrictions were terminated.

Chapter 1 Introduction

This thesis begins with an introductory chapter, providing the rationale for this study exploring knowledge (defined as the information and skills, that a person may possess or accumulates through experience of education), understanding and attitudes towards antibiotic use, prescription advice (i.e., the instruction and guidance given by healthcare providers when antibiotics are prescribed) and antibiotic resistance (ABR) among parents in Greater Manchester (GM), and its significance as a global public health issue. This is followed by a critical review of the literature on ABR, including the drivers and challenges of ABR, as well as the global, national, and regional trends in antibiotic prescribing and usage (Chapter 2). The methodology (Chapter 3) provides a detailed description and critical discussion of the data collection and analysis phases of this study. This is followed by the results chapter (Chapter 4) which presents the findings from the different study phases, and the discussion chapter (Chapter 5), which critically discusses how the findings from this study relate and add to the current body of literature. The thesis concludes by providing recommendations for future research to inform interventions in respect of ABR.

The focus of this research is mainly on antibiotics and ABR, which relates specifically to bacterial resistance to antibiotic drugs (Centre for Disease Control and Prevention [CDC], 2018; National Institute for Health and Care excellence [NICE], 2018; World Health Organisation [WHO], 2021) (discussed in more detail in Chapter 2). The study focuses on parents of children aged between 3 months and 6 years: an age group prone to contracting infections from their surroundings, and experiencing drug toxicity, adverse side-effects, and disruptions to their developing microbiota, when prescribed antibiotics (Sultan et al., 2019; Allwell-Brown et al., 2020; Eck et al., 2020; Romadini et al., 2021).

In the UK, 3.6 million antibiotic prescription items were dispensed for children aged 0 to 14 years in the 2019/2020 financial year, which accounts for 12% of the total antibiotic prescriptions (30 million) dispensed in the same period (NHS Business Services Authority [NHSBSA, 2021). Of these, 48% were prescribed for children aged between 0 and 4 years (NHSBSA, 2021). It is critical to improve antibiotic prescribing and use among children, given that children often have multiple episodes of illness, which could potentially lead to multiple antibiotic courses (van Hecke et al., 2019). Therefore, as even low antibiotic use has short-term health implications for children, increasing parental awareness of the importance of protecting a child's microbiome, as well as the potential damage that the unnecessary use of antibiotics could have on individuals, the community, and society, could not only reduce pressure on GPs to prescribe antibiotics, but could potentially enable parents to hold healthcare providers accountable when unwarranted antibiotics are prescribed (as seen with parents in this study, see Chapter 4, section 4.2).

There is consensus that human action has been, and still is, a key driving factor in propagation of ABR (Shallcross & Davies, 2014; Vaudrey et al., 2016; Machowska & Lundborg, 2018; Larsson & Flach, 2021), due to the irresponsible use of antibiotics (Dolk et al., 2018; Machowska & Lundborg, 2018; Larsson & Flach, 2021; WHO, 2021a) (discussed further in Chapter 2, section 2.5). ABR has grown and spread exponentially over the past years (WHO, 2021). A recent study on the global burden of ABR, published in The Lancet (discussed more fully in section 2.3.1), estimated that 1.27 million deaths were attributable to ABR in 2019 (Antimicrobial Resistance Collaborators [ARC], 2022).

Antibiotics are estimated to prevent millions of deaths yearly around the world and are also used as preventative treatment in healthcare settings (NICE, 2018; CDC, 2018; WHO, 2021). They have a crucial role to play in prophylaxis before and after certain surgical interventions, (e.g., hip replacement, pacemaker surgery, and caesarean sections); they are also vital in the prevention and management of infections for people following chemotherapy, immunocompromised patients, and patients with chronic diseases, such as end-stage renal disease (Currie et al., 2014; NICE, 2018; WHO, 2021). However, antibiotic resistant infections, particularly multidrug-resistant infections, are very often more expensive, complex, and difficult to treat than those caused by non-resistant pathogens, as the antibiotics usually used to treat them become less effective (Lee, Cho et al., 2013; Shallcross & Davies, 2014; Baym et al., 2016; O'Neill, 2016; Exner et al., 2017; Pourmand et al., 2017; Hay et al., 2018; Machowska & Lundborg, 2018; NICE, 2018; WHO, 2021).

The Organisation for Economic Cooperation and Development (OECD) and WHO estimate that approximately 2,120 deaths are likely to occur yearly due to resistant infections, a trend forecast to continue, up to 2050 (OECD-WHO, 2022). In 2021, more than 100,000 cases of extensively drug-resistant tuberculosis (XDR-TB) was recorded in 81 countries, and multi-drug resistant gonorrhoea has been confirmed in 10 countries, including the UK (WHO, 2022b) (discussed further in section 2.3.1). In the UK, antibiotic resistant infections affect 1 in 5 people (UKHSA, 2023a; UKHSA, 2023b). An estimated 58,224 people in England had an antibiotic resistant infection in 2022, a 4% increase since 2021 (55,792 infections); deaths caused by severe antibiotic resistant infections increased from 2,110 deaths in 2021 to 2202 in 2022 (UKHSA, 2023b). The North West (NW) has one of the highest ABR burden rates in England (UKHSA, 2023) (see section 2.4.2). Furthermore, the number of antibiotic resistant blood stream infections (BSIs) are higher in the 20% most deprived areas of England (which includes GM) compared to the 20% least deprived areas (UKHSA, 2023).

The control and prevention of various infections are being jeopardised by the rise in ABR, causing increased mortality rates, prolonged illnesses and hospital stays, and greater costs to patients and hospitals (O'Neil, 2016; CDC, 2018; Machowska & Lundborg, 2018; NICE, 2018; WHO, 2021; UKHSA, 2023). It is projected that treating antibiotic resistant infections will exert even more pressure on the healthcare system, costing millions to G7 countries (including the UK), and resulting in loss of productivity and increased demand for resources for the prevention and control of these resistant infections (Dadgostar et al., 2019; Naylor et al., 2019; Zhen et al., 2019; OECD-WHO, 2022). Therefore, it is imperative to tackle the increasing trends in ABR (O'Neill, 2016; CDC, 2018; WHO, 2021; ARC, 2022; WHO, 2022; UKHSA, 2023).

The NHS is already in crisis and under immense strain (Wise, 2022; Cooksley et al., 2023; Spooner et al., 2023; Williams & Pagel, 2023). Primary care pressure has been at unsustainable levels, which has been further exacerbated by the COVID-19 pandemic and industrial action, putting the system in a hazardous position (British Medical Association [BMA], 2022; BMA, 2023; NHS Confederation, 2023; The Health Foundation, 2023; BMA, 2024; NHS, 2024b). With declining GP numbers, rising demand, and staff shortages, the growing strain on GP practices will keep worsening, and will keep having a substantial impact on patient care (BMA, 2023; NHS Confederation, 2023; BMA, 2024; NHS, 2024b). In November 2023, GP appointment bookings reached 31.9 million; and mounting evidence shows that with approximately 7.8 (headcount) GPs per 10,000 in England, the present workload is unsustainable for GPs and unsafe for patients (BMA, 2022; Wise, 2022; BMA, 2023; Cooksley et al., 2023; NHS Confederation, 2023; The Health Foundation, 2023; Spooner et al., 2023; Williams & Pagel, 2023; BMA, 2024; NHS, 2024b). Although this pressure on primary care impacts everyone, the crisis is not an equal crisis as people from deprived communities generally have poorer health outcomes and therefore require more access to health care services (Cooksley et al., 2023; Spooner et al., 2023; Williams & Pagel, 2023).

ABR is a global public health crisis, which will exacerbate UK's already struggling health system. This highlights urgent need for better antibiotic stewardship, which is the collective effort to improve how antibiotics are prescribed by healthcare providers and used by patients (Ewers, et al., 2017; CDC, 2023b; Shrestha et al., 2024; WHO, 2023; NICE, 2024). One of the drivers of ABR is the irresponsible use of antibiotics in primary care, which not only increases ABR, but also increases pressure on a system that is already in crisis (UKHSA, 2023b; 2023; NICE, 2024). Therefore, with a system that cannot deal with demand capacity, reducing GP pressure by encouraging patients to be better antibiotic stewards, could help alleviate a some of the pressure on GPs (UKHSA, 2023b; NICE, 2024).

However, there is a substantial gap in the public's knowledge and understanding of ABR and its consequences, particularly regarding the responsible use of antibiotics, ABR, and its consequences (Mason et al., 2018; McNulty et al., 2019; Anderson et al., 2020; Sobeck et al., 2021; Hawkins et al., 2022). What should be known by the general public with regards to antibiotic use and ABR is discussed in Chapter 2 (see section 2.5.1.2, Table 6). The gap in the public's knowledge and awareness of ABR, as well as misunderstandings about antibiotic use, could add to the growing challenge of reducing ABR (McNulty et al., 2019; Anderson et al., 2020; Sobeck et al., 2021; Hawkins et al., 2022) (discussed further in Chapter 2, section 2.5.1.2). These knowledge gaps and misunderstandings could lead to the inappropriate use of antibiotics, which accelerates the generation and spread of ABR (Salm et al., 2018; Bianco et al., 2020; Mallah et al., 2020). These misconceptions can also lead to patients pressuring GPs to prescribe antibiotics even when unnecessary (Gaarslev et al., 2016; Fletcher-Lartey et al., 2016; Anderson et al., 2018).

Various international and national studies report that parents believe that getting an antibiotic prescription (even if unwarranted) would shorten the duration of their child's infection, improve the child's health outcome, reduce the likelihood of needing a re-consultation, and reduce the potential financial impact if additional time off work was needed (Kotwani et al., 2010; Rooshenas et al., 2014; Fletcher-Lartey et al., 2016; Gaarslev et al., 2016;

Horwood et al., 2016; Bosley et al., 2018; O'Connor et al., 2018; Bosley et al., 2021; Hardman et al., 2021) (discussed further in section 2.4.5). In a UK qualitative study, it was found that antibiotics were requested by mothers for self-limiting infections and some mothers were anxious when antibiotics were not prescribed and would therefore request them for their child, trusting these drugs to be safe and effective in reducing symptom duration and speeding up recovery (Bosley et al., 2022). Parents have a critical role as carers for their children, representing frontline of antibiotic stewardship (followed by GPs), given that they seek treatment/and or guidance regarding the management of their child's illness and are usually the ones to administer antibiotics. Therefore, understanding parents' knowledge, attitudes, and perceptions about antibiotic use and ABR, is imperative to better support them in understanding the risks of antibiotic use, as well as to improve awareness on antibiotic stewardship (McNulty et al., 2007; Price et al., 2018; Goggin et al., 2021; Marsh et al., 2023).

In the UK, GPs have often been found to overprescribe antibiotics for young children, particularly for Upper Respiratory Tract Infections (URTIs) and acute otitis media, despite evidence and guidance that antibiotics are not needed for these infections (Pouwels et al., 2018; Hay et al., 2019; Akhtar et al., 2021; NHSBSA, 2021). More than 82% of children in the UK, presenting with acute otitis media, receive an antibiotic prescription (Pouwels et al., 2018; Hay et al., 2019; van Hecke et al., 2019; Akhtar et al., 2021). There are various factors that may influence antibiotic prescribing for children. For example, children's susceptibility to infections, often due to exposure to viruses in communal settings (e.g., nurseries and day-care) (Rooshenas et al., 2014; Allwell-Brown et al., 2020; Romadini et al., 2021). These infections result in parental consultations to seek treatment, advice, and medical reassurance concerning their child's illness (Bosley et al., 2018; Biezen et al., 2019; Edwards et al., 2021). Due to diagnostic uncertainty, the lack of quick diagnostic tests, fear of complications, fear of litigation, time pressure, and parental pressure and expectation for antibiotics, GPs often resort to precautionary antibiotic prescribing (Cabral et al., 2015; Horwood et al., 2016; O'Doherty et al., 2019; Borek et al., 2020; Rose et al., 2021; Allen et al., 2022; Miller et al., 2022).

Antibiotics can negatively affect the gut, skin, oral, respiratory, and genitourinary microbiomes and can have long-term effects on health, particularly in children (Gough et al., 2014; Sultan et al., 2019; Eck et al., 2020). Microbial colonisation evolves from birth, is crucial for infant health, and influences adult health later in life (Langdon et al., 2016; Hong et al., 2017), which is why focusing on children aged between 3 months and 6 years of age is important in this study. Early events in a child's life, such as chronic exposure to antibiotics and infections, can disrupt a child's optimal microbial development (Mueller et al., 2015; Cully, 2019; Furlong et al., 2019; Reyman et al., 2022). This may lead to lifelong and intergenerational problems in growth and development, and potentially the development of autoimmune conditions, metabolic diseases (e.g., obesity and diabetes), allergies, cardiovascular diseases, irritable bowel syndrome, inflammatory bowel disease, and even cancer (Langdon et al., 2016; Hong et al., 2017; Cully, 2019; Zhong et al., 2019; Reyman et al., 2022) (see section 2.3.1). Unnecessary antibiotic prescribing and use can also lead to adverse side-effects, and drug toxicity (Baddhour et al., 2019; Lovegrove et al., 2019; Rebecca et al., 2021). Therefore, improving the responsible use of antibiotics is crucial, given its effects on the child's developing body (Gough et al., 2014; Reyman et al., 2022).

Due to the strong interaction that antibiotics have on the human microbiota, particularly in children, it is crucial that parents and antibiotic prescribers understand the importance of responsible antibiotic use when needed (Gough et al., 2014; Reyman et al., 2022). Improving awareness on the importance of using antibiotics only as a last resort and raising awareness of the possible long-term side-effects of these drugs could help parents understand that, whilst antibiotics are useful when needed, they must be used with caution particularly with their children, which could in turn increase antibiotic stewardship among this group (Hong et al., 2017; Cully, 2019; Zhong et al., 2019). Some researchers suggest that as children are future antibiotic users and prescribers, antibiotic stewardship behaviours and attitudes may be passed from parents to their children; therefore, there is a need to use familial social influence to change intergenerational behaviours and reinforce antibiotic stewardship behaviours (McNulty et al., 2007; Leck et al., 2014; Price et al., 2018).

Many studies that describe antibiotic expectation and pressure, explore this from the perspective of the prescriber (Horwood et al., 2016; O'Doherty et al., 2019; Van der Zande et al., 2019; Borek et al., 2020). However, there is a dissonance in what GPs believe parents want from a medical consultation, and what they actually want, which is reported to be reassurance and advice (Bosley et al., 2018; Bosley et al., 2021). Patient welfare has been reported to be a priority for some GPs, overriding the need for antibiotic stewardship, which tends to be a minor factor considered by prescribers during diagnosis and antibiotic prescribing (Krockow et al., 2019; Tarrant et al., 2020). In Ashiru-Oredope et al.'s (2022) study (n=2404), only 64% of healthcare workers participating in the study felt that they had a key role in controlling ABR. Given that GPs and other prescribers may feel that their prescribing behaviours have no effect on the spread of ABR, they may be laxer in their prescribing behaviours, interpreting the need for further information and reassurance, as pressure to prescribe antibiotics. Findings from both Allen et al.'s (2020) and Miller et al.'s (2022) studies suggest that rates of broad-spectrum antibiotics are higher in areas that have increased pressure on GP surgeries, which is alarming given the current strain GPs are under. These studies have also reported increased prescribing in areas that have more deprivation and ethnic minority communities; therefore, given GM's ethnic profile, levels of deprivation, and health inequalities, it is feasible that broad-spectrum antibiotics would be prescribed unnecessarily in certain areas of GM.

The continued rise in ABR is threatening the control of life-threatening infections and the performance of high-risk surgeries. Tackling this rise, while targeting a reduction in antibiotic prescribing, is a complex public health challenge, requiring a multi-level approach involving individuals, families, communities, healthcare facilities, national and global stakeholders (Tomson & Vlad, 2014; NICE, 2016; Barber & Swaden-Lewis, 2017; WHO, 2021). Understanding the determinants of ABR along with local and national dynamics is very important (Mölter et al., 2018; Thomson et al., 2020; Devine et al., 2022). Containment, prevention, and awareness interventions for ABR, should target both consumers and healthcare providers, to ensure the sustainable use of antibiotic drugs in both low and high-income settings (Price et al., 2018; DoHSC, 2019b; Majumder et al., 2020; NICE, 2024); which further highlights the need to encourage antibiotic stewardship among all individuals in society, including parents.

With their 5-year national action plan (Department of Health and Social Care [DoHSC], 2019a), the UK government has recognised that ABR is not a crisis of the future, but rather one of the greatest public health challenges today; therefore, the critical importance of tackling ABR nationally has been reported in their 20-year visions for AMR (DoHSC, 2019b; UKHSA, 2023b). The UK DoHSC advocates for working with partners across all sectors and levels, including across communities and with patients (DoHSC, 2019a; DoHSC, 2019b). They have identified key research themes that need to be prioritised with AMR research, including understanding real world interactions and investigating the impact of behaviour of the public, professionals and organisations on AMR (DoHSC, 2019b). Additionally, one of the nine ambitions proposed for the control and containment of AMR is engaging the public on this issue (DoHSC, 2019b). Through public engagement, and to develop societal advocacy against AMR, there is need to identify effective communication channels to engage the public on all aspects of AMR (DoHSC, 2019b). This is considered critical to ensure that people in the UK understand AMR, to enable them to have ownership of the issue and solutions, alongside healthcare practitioners, and other stakeholders (DoHSC, 2019b).

Moreover, learning from the experience of others, is considered crucial for better engagement of various communities (DoHSC, 2019b). This action plan by the UK government, confirms the need to better understand the knowledge, understanding, attitudes, and perceptions of parents nationally and in GM, to inform future interventions that may be used to improve awareness among other parents in a setting like GM. Parents are better placed to explain their needs in terms of intervention on antibiotics use and ABR, and medical consultations for self-limiting infections. Additionally, including parents' views and experiences on ABR and antibiotic use in any future intervention that may relate to other parents or children, could greatly aid engagement with these interventions, particularly as ABR is an invisible problem that may not be easy to understand (Mitchell et al., 2022).

Empowering parents from local communities to be more engaged with ABR using a bottom-up approach, could be more efficient in improving awareness, compared to top-down professional-led interventions (NHS, 2020; Charles, 2022). Involving parents in the development of interventions that directly affect or target them, especially with regards to improving antibiotic stewardship, is a potential way of achieving this. Charles (2022) highlights the importance of fostering collaboration with communities, to empower locals to be central to strategies developed and implemented to improve health and wellbeing. Additionally, enabling the views and experiences of the underrepresented to be taken into consideration, when interventions and policies to improve antibiotic stewardship are being developed, is critical for health improvement, health promotion, and health protection. Insights into challenges that patients may face while using GP services, could inform future local and national strategies developed to encourage quality and sustainability of local services in GM, particularly given the current pressure on the healthcare system in the aftermath of the COVID-19 pandemic.

This PhD study aimed to explore parents' current understanding, knowledge, attitudes, and practice towards antibiotic use, antibiotic prescription advice and ABR. As parents will have different levels of awareness on ABR, comprehending how much parents in GM know and understand about ABR and antibiotic use is important to allow for the development of more efficient ways to encourage this group to be more responsible antibiotic users, raise awareness of this global public health problem, and improve antibiotic stewardship. It is also important to understand this demographic profile, so that the future design and development of interventions can be more focused on the target group (PHE, 2015a, McNulty et al., 2022). Understanding what parents in GM expect when they consult a GP for their sick child, could also shed some light on the drivers of increased antibiotic prescribing in a socio-economically diverse area such as GM, having high levels of deprivation, low health literacy levels, and a large population of ethnic minority groups (OHID, 2021) (see Appendix 2 & 3).

The setting of this study is GM, a socio-economically diverse area. With a population of 2.8 million people, GM is the second most populous urban area in England (population 67,026,300) (ONS, 2024). GM comprises ten local authorities or boroughs, namely: Bolton, Bury, Oldham, Rochdale, Stockport, Tameside, Trafford, Wigan, the City of Manchester, and the City of Salford (Codling & Allen, 2020). A mixture of cultures, ethnicities, and communities can be seen in GM, with various inter-generational and inter-area differences (Greater Manchester Combined Authority [GMCA], 2018; Boyle et al., 2022). The context of GM as setting is important to discuss, particularly the health inequalities observed in this urban area.

According to the 2021 census, an estimated 821,801 GM residents were from ethnic minority groups, which equated to 28.7% of the GM population, and is slightly above the England average of 26.5% (GMCA, 2023). In 2021, almost half of the ethnic minority population in GM comprised Asians (47.4% which is 389,283 people), followed by White people, who were not White British (114,887), Black people (134,113), and those of mixed ethnicity (86,520) (GMCA, 2023). Manchester is the most ethnically diverse borough in GM, with 51.3% (283,366 people) of its residents being from an ethnic minority group (GMCA, 2023). In 2021, Oldham (34.8%) and Bolton (31.2%) were the next most ethnically diverse boroughs, and Wigan (8.2%) was the least (GMCA, 2023). Manchester is the only borough in GM that has an ethnic minority population that accounts for more than half of its population (GMCS, 2023); other urban areas in England where this trend is observed include Leicester (66.6% of population is from an ethnic minority), London (63.2%), and Birmingham (57.1%) (GMCA, 2023).

GM is an area of multiple deprivation levels and has large areas of deprivation compared to the rest of the England (GMCA, 2018). For example, based on the 2019 Index of Multiple Deprivation (IMD), Manchester ranks 6 out of 326 local authorities in England, where 1 is the most deprived (Manchester City Council, 2022). The IMD is used to classify relative deprivation (inequality in poverty compared to others in society) and is calculated by combining seven specific indicators of deprivation: income, employment, health deprivation and disability, education and skills training, crime, barriers to housing and services, and living environment (Ministry of Housing, Communities & Local Government [MoHCLG, 2015; MoHCLG, 2019). Therefore, the IMD is an overall measure of multiple deprivation experienced by people living in an area. IMD is calculated for every small areas/neighbourhoods (also called Lower-layer Super Output Areas [LSOAs]) in England (MoHCLG, 2015; MoHCLG, 2019). These areas are then ranked, from 1 (most deprived) to 32,844 (least deprived), according to their level of deprivation relative to the deprivation of other areas MoHCLG, 2019). However, it is important to note that a single deprivation score, such as the IMD, may not accurately measure levels of deprivation across a larger area, and in some areas, deprivation may not be evenly spread, but rather observed in concentrated pockets of deprivation (MoHCLG, 2019) (discussed further in Chapter 2, section 2.9)

There exist disparities among communities and areas in GM which reflect the legacies of the post-industrial era and the patterns of migration since (Rubery et al., 2017; Raleigh, 2018) (see Appendix 2). GM is below the national benchmark for health, income, standard of living, life expectancy at birth, and mortality rates for the elderly (PHE, 2017; GMCA, 2018; Marmot et al., 2021). This gap between GM and England can be seen across all stages of life (Davies, 2018; GMCA, 2018; Marmot et al., 2021). Disparity in the average healthy life expectancy at birth and wider inequalities can also be seen within the boroughs of GM (Davies, 2012; PHE, 2017; PHE, 2020b).

The prevalence of infectious diseases tends to be increased in communities with lower socioeconomic status (SES), alongside poorer health outcomes (Davies, 2012; Hughes & Gorton, 2015; Furegato et al., 2016; Vaudrey et al., 2016; Davies 2018; Nguipdop-Djomo et al., 2020). As a result, deprivation has been found to be associated with increased antibiotic use (Covvey et al., 2013; Mölter et al., 2018; Thomson et al., 2020; Devine et al., 2022). People in deprived communities have also been found to be more likely to have an infection caused by a drug-resistant strain of the pathogen and least likely to complete their treatments (Davies, 2011; Tosas et al., 2016; See et al., 2017; Devine et al., 2022).

The antibiotic resistance burden has been found to affect different populations differently (UKHSA, 2023). For example, in 2022 Asian ethnic groups had almost double the proportion of antibiotic resistant infections (34.6%) compared to White ethnic group (18.7%) (UKHSA, 2023a; UKHSA, 2023b). In the NW, resistance to rifampicin and multi-drug resistance to TB medication is on the rise (UKHSA, 201b). In the NW, 15.2% of TB cases were reported to be resistant to one or more antibiotics used in TB treatment (UKHSA, 2021b). Considering GM's demographic profile, drug-resistant TB and antibiotic resistant BSIs are on the rise post-pandemic (see section 2.4.2). Additionally, with annual TB rates higher in GM compared to the English average (MCC, 2023; OHID, 2023), and with the health inequalities seen in GM, drug resistance could be a serious public health concern for GM.

Secure employment and a steady income are important determinants of health outcomes (Krieger, 2001; Ferguson et al., 2007; Hofrichter, 2010). For example, low income and financial insecurity will often affect various aspects of life and have been found to lead to poorer health outcomes (Krieger, 2001; Ferguson et al., 2007; Hofrichter, 2010; van der Heide et al., 2013; Zimmerman, Wool & Haley, 2015). Inequalities between GM and the rest of England can also be seen in rates of employment; GM has an employment rate of 72.4%, and unemployment rate (5%) is higher than the English average (3.7%) (Fitzmaurice et al., 2023). In GM people from ethnic minorities are less likely to be employed (Codling & Allen, 2020) with only 52% of people who identify as Pakistani or Bangladeshi employed, compared to 74% of white people (Boyle et al., 2022). Job insecurity and low paid employment adds to the disparity between GM and the rest of the country (Rubery et al., 2017; Raleigh, 2018; Marmot et al., 2021).

In 2020, 118.6 million days were lost due to illness or injury in the UK, which corresponds to 3.6 days lost per worker (ONS, 2020b). In their 2020 report on sickness absence in the labour market, the ONS have shown that "minor illnesses" (e.g., colds, flu, coughs, nausea, and diarrhoea) were the main reason for sickness absence over the past decade, accounting for over a quarter (26.1%) of all occurrences in 2020 (ONS, 2020b). Moreover, with poor employment rates and job insecurity, people tend to ask for antibiotics to treat self-limiting conditions with the hopes of avoiding taking days off that could jeopardise their jobs (Cole, 2014; Fletcher-Lartey et al., 2016; Gaarslev et al., 2016; Davies 2018). This could be an interesting indicator for the increased use of antibiotics in GM over the past years (see section 2.5.1.3), as GM has poor employment rates and high job insecurity, particularly since the COVID-19 pandemic (GMCA, 2020; Marmot et al., 2021). When considering the trends in antibiotic prescribing, it's important to take into account the underlying correlation between levels of deprivation (measured by IMD) and high rates of antibiotic prescribing (see section 2.6.2) (Covvey et al., 2013; Mölter et al., 2018; Thomson et al., 2020; Devine et al., 2022; McCloskey et al., 2023). Therefore, understanding the drivers of antibiotic prescribing within GM could provide a clearer picture of the link between deprivation levels and other socio-demographic factors and how antibiotics are used and prescribed (Covvey et al., 2013; Mölter et al., 2018; Thomson et al., 2020; Devine et al., 2022), which vary widely between high and low-income areas in GM compared to other regions in England (UKHSA, 2021a).

GM has similar characteristics (e.g. unemployment mix, health status, ethnic make-up) to post-industrial large cities such as Birmingham, Leicester, Liverpool, Leeds, and Newcastle upon Tyne. While the available data on demographic profiles of cities in the UK lacks standardisation and consensus regarding the definitions and characteristics of cities, city regions, urban areas, and metropolitan counties, by using comparable data provided by the ONS (2023), GM can be compared to other big cities in England, showing certain similarities in demographic characteristics, such as ethnicity, education levels, self-reported health status, median age of population, and unemployment rates (see Appendix 3).

For example, looking at unemployment rates, Manchester has similar rates (4.0%) to Birmingham (4.7%) and Leicester (3.6%). Self-reported health status was also similar between Manchester (6.6% reporting bad health) and Liverpool (6.9% reporting bad health) (ONS, 2023; UKHSA Fingertips, 2023). Although ethnicity make-up varies between these cities, they show similar trends; for example, in Manchester the majority of the population were of White ethnicity (56.8%), followed by Asian ethnicity (20.9%), which was similar in Birmingham and Leicester (ONS, 2023; UKHSA Fingertips, 2023). Looking at deprivation (measured by IMD 2019), Manchester, Liverpool, and Birmingham are quite similar in terms of deprivation levels being higher than the other areas in England (ONS, 2023; UKHSA Fingertips, 2023). Regarding the total number of prescribed antibiotic items per 1000 resident individuals, Manchester prescribed 12.4 items per 1000 residents, and a similar trend was observed in Liverpool (125.8 items per 1000 residents), and Newcastle (121.8 items per 1000 residents) (ONS, 2023; UKHSA Fingertips, 2023) (see Appendix 3). Looking at antibiotic resistance, specifically MRSA (Methicillin-resistant *Staphylococcus aureus*) bacteraemia, in 2021-2022, Manchester had 1.6 cases per 100,000, which is the same as Liverpool (1.6 cases) while Birmingham has 1.9 cases per 100,000 (ONS, 2023; UKHSA Fingertips, 2023). Therefore, findings from this study could potentially be used in other research, and/or to inform interventions in areas comparable to GM.

This study was undertaken during the COVID-19 pandemic, which has impacted various aspects discussed in this study, e.g., antibiotic use, prescribing practice and rates of infection. It was anticipated, by the WHO, that worldwide antibiotic prescribing and use would increase significantly during the pandemic (WHO, 2020). Researchers in the UK also anticipated changes in antibiotic prescribing (Andrews et al., 2021; Rezel-Potts et al., 2021), as the clinical features of severe respiratory tract infection (fever and cough, progressing to pneumonia and respiratory failure) caused by SARS-CoV-2 mirror bacterial respiratory tract infections (Andrews et al., 2021). This initial uncertainty in the management of patients presenting with pneumonia symptoms prompted the dissemination of various guidelines during the first wave of the pandemic to prevent unnecessary antibiotic prescribing and encourage antibiotic stewardship (the coordinated effort to improve how antibiotics are prescribed and used) (NICE, 2020; WHO, 2020). It was also expected that the shift from face-to-face general GP consultations to telehealth (the delivery of healthcare services with remote support from healthcare professionals) would lead to an increase in antibiotic prescription rates (van de Pol et al., 2021; Gillies et al., 2022).

As predicted, the first wave of the pandemic (February to September 2020) saw an increase in antibiotic prescribing in both primary and secondary care, in the UK (Andrews et al., 2021;

Rezel-Potts et al., 2021; Tang et al., 2023; Zhong et al., 2023). With interrupted time-series analysis using electronic health records to evaluate antibiotic prescribing, Rezel-Potts et al. (2021) found that this occurred for the elderly, females, and children aged 0-4 years. Both Andrews et al. (2021) and Zhong et al. (2023), also using interrupted time-series, reported an increase in broad-spectrum antibiotics as an immediate impact of the pandemic. The most significant increase in broad-spectrum antibiotics was for lower respiratory tract infections (OR 2.33; 95% CI 2.1–2.50) and otitis media (OR 1.96; 95% CI 1.80–2.13) (Zhong et al., 2023). However, both primary and secondary care saw decreasing trends for antibiotic prescribing over the whole pandemic period (see section 2.5.1.1) (UKHSA, 2023) with the exception of antibiotic prescribing among dentists, due to the suspension of routine dental care (Sanderson, 2020; Bissett, 2021; Duncan et al., 2021; British Dental Association, 2022).

It is challenging to identify a causal link between changes in antibiotic prescribing and the COVID-19 pandemic, as the pandemic resulted in changes in healthcare delivery and accessibility, clinical guidelines, and mortality and health levels, which could have influenced antibiotic prescribing patterns. However, the rapid decrease in antibiotic prescribing coincided with the enforcement of national lockdown restrictions, suggesting the reduction in prescribing could be due to decrease primary care attendance (Andrews et al., 2021; Rezel-Potts et al., 2021; UKHSA, 2023; Yang et al., 2023). Additionally, the reduction could also be due to the decrease in the spreading of infectious diseases brought about by increased infection prevention and control (with increased handwashing, hand sanitising, and wearing masks) (Iacobucci, 2020; UKHSA, 2023a). Furthermore, the reduction could also be due to guidance issued on the appropriate management of patients presenting with pneumonia community settings (NICE, 2020).

1.1 Aim and objectives of the study

Aim:

To obtain an in-depth understanding of the current knowledge, attitudes, and practices of parents living in GM, regarding antibiotic use, prescription advice, and antibiotic resistance, based on a mixed methods explanatory study.

Objectives:

- To investigate parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance, in GM.

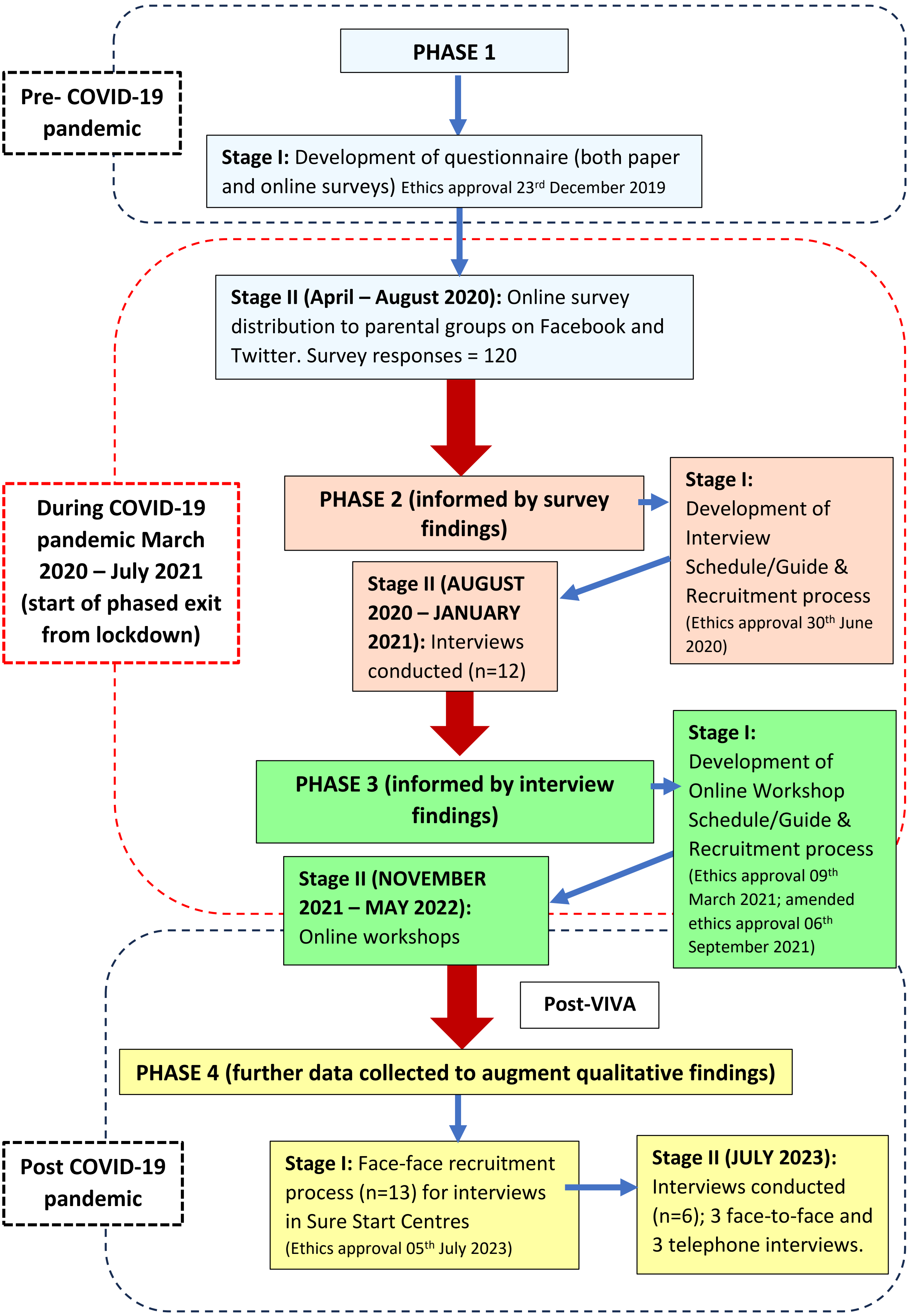
- To explore the factors that influence parents' perceptions, experiences, and practices, in the context of their young child being prescribed antibiotics.

- To provide recommendations for future research and interventions aimed at improving antibiotic awareness among parents.

This mixed-methods explanatory study was conducted in 4 phases, where the findings from each phase informed the next. Phase 1 (involving objective 1) investigated parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and ABR. Phase 2 (involving objective 2), explored parents' perceptions, experiences, practices and behaviour towards antibiotic use for their child. Findings from both phases informed phase 3 (involving objective 3), which explored what parents wanted to see in future interventions aimed at improving parents' ABR awareness and antibiotic stewardship. Due to the type of sample (in terms of socio-demographic characteristics) obtained from phases 2 and 3, phase 4 was added to collect further data, to include the perceptions, experiences, and practices of parents recruited from a deprived area in GM, regarding antibiotic use for their child.

Figure 1 below, illustrates the research timeline and flowchart showing the 4 phases of this PhD study.

Figure 1: Research timeline and flowchart



Chapter 2: Literature review

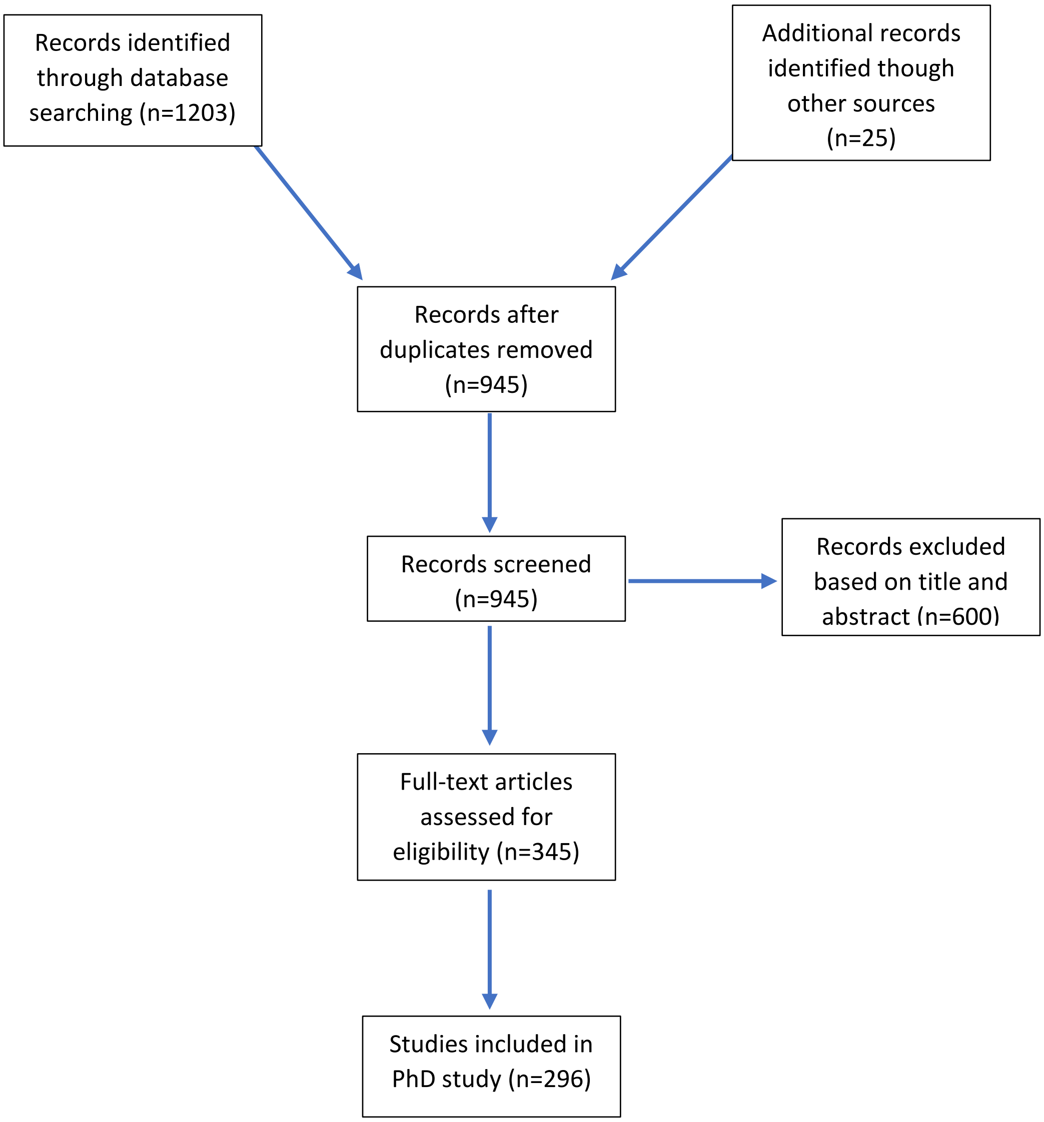
This chapter explores and critically discusses the current literature on ABR in more detail. The first subsection explains what bacteria are, followed by a detailed explanation of what antibiotics are, how they work, and their benefits for public health. Subsection two will discuss the mechanisms of antibiotic resistance. The drivers and consequences of antibiotic resistance will be discussed in the third and fourth subsections, including knowledge and understanding of antibiotics and ABR, and GP perceived pressures. The national trends in antibiotic prescribing and antibiotic use will be discussed in subsection five, and health inequalities in subsection six. Current interventions to improve ABR knowledge, awareness, and behaviours among parents are discussed in subsection seven, followed by a critical discussion about the link between knowledge and behaviour change. The final subsection will discuss gaps in the literature.

CINAHL (from 1990 to present), Ovid via Medline (1996 to present), Web of science (1990 to present), PubMed, and Google Scholar were searched for this review. These databases were used as they provide access to peer-reviewed and scholarly information on health sciences, nursing, medicine, and the health care system, among others. Although researchers still debate on the approved number of databases to search, there is consensus that searching multiple databases could eliminate bias (e.g., publication bias) that could occur when only using one or two databases (Bramer et al., 2017; Frandsen et al., 2019; Bethel et al., 2021; Heath et al., 2022).

A primary search was conducted using specific key words, such as “antibiotics use” OR “antimicrobial use” OR “antibiotic prescribing” OR “antimicrobial prescribing” OR “antibiotic resistance” OR “antimicrobial resistance” OR “antimicrobials” OR “antibiotics” AND “parent”. Boolean operators such as “AND”, “OR”, and “NOT” were also included with these key words, to define the search. Additional key words were later included such as perceptions, knowledge, understanding, attitudes, and misconceptions, and interventions.

Figure 2 below illustrates how studies were identified and selected to include in this PhD thesis.

Figure 2: Study identification and selection



As shown in Figure 2, pertinent articles found using this search strategy were screened, and duplicates removed. The abstracts of these articles were reviewed based on the key words and main concepts. The inclusion criteria for the studies to be critically appraised were:

- Research study (published, peer-reviewed, and evidence-based)
- Published date after 1990
- Articles published in English

Critical appraisal of these studies was done by reviewing the study design, methodology, sample size, main findings, implications of findings, and strengths and limitations of the study.

Articles that comprised of only an abstract were reviewed for their relevance to this PhD study and were acquired through inter-library loans or by contacting the authors. Further methods to select relevant studies included citation tracking and reference checking, to increase likelihood of finding more relevant studies (Harari et al., 2020; Bethel et al., 2021; Heath et al., 2022). These methods could also reveal parallel topics of interest relating to this PhD study, which may not have been identified by a usual keyword search (Harari et al., 2020; Bethel et al., 2021; Heath et al., 2022).

The articles included in the literature review were selected according to the following criteria: studies that included parents as participants or included both GPs and parents, that investigated parents' expectations during GP consultations, that investigated GP pressure and views on antibiotic prescribing, and parents' knowledge and understanding of antibiotic use and ABR. Daily alerts were set up on the databases to keep up to date with any relevant studies that could inform the literature review further.

Regarding the other sections of the literature review, such as those aiming to give an overview of antibiotic resistance, drivers of antibiotic resistance, and the trends in antibiotic prescribing globally and nationally etc., a tailored search strategy was used to find relevant articles and information on these topics.

Grey literature, such as government reports and documents, policy literature, and working papers, were also included in the literature review. Grey literature includes information that can be found outside of traditional channels such as databases and is used to provide a wider range of information (Chaabna et al., 2020; Herari et al., 2020). Therefore, relevant grey literature from organisations such as the WHO, CDC, PHE, UKHSA, and other UK governmental agencies, were also added to the literature review.

It is important to note, that systematic reviews were included in various sections of this PhD thesis, as they are regarded as the highest quality of evidence (Wallace et al., 2022; Uttley et al., 2023). Systematic reviews involve the systematic identification, evaluation, and synthesis of all available relevant evidence, to answer a focused research question and highlight research gaps (Patole et al., 2021; Prill et al., 2021; Uttley et al., 2023). This type of research is a key tool in evidence-based medicine, as is also often used to by decision-makers to inform policy, guidelines, patient care, and future research (Owen, 2021; Haddaway & Mbuagbaw, 2023; Uttley et al., 2023). It is important to mention potential limitations of systematic reviews, such as risks of bias (e.g., selection bias and publication bias), errors in conducting the review which could influence its internal validity (e.g., data extraction errors), and poor reporting quality that may affect reproducibility of the systematic review (e.g., missing search strategy) (Owens, 2021; Uttley et al., 2023). Nevertheless, when conducted rigorously, systematic reviews are considered to be the gold standard for the synthesis of evidence in research (Cumpston et al., 2022; Wallace et al 2022; Uttley et al., 2023).

2.1 Bacteria

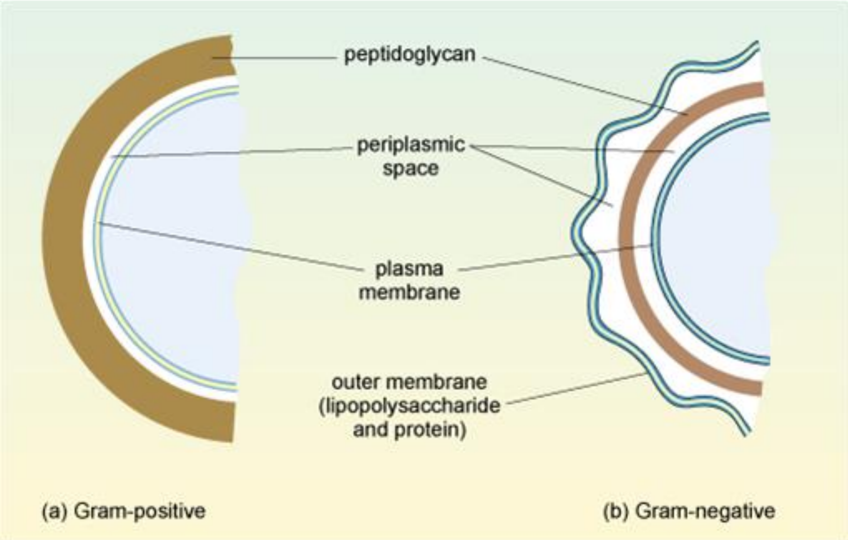
Bacteria are the oldest and most dispersed form of cellular life (Gillings, 2013; Bebell & Muiru, 2014). Bacteria are single-celled microorganisms that are highly adaptable and can be found everywhere in the biosphere and are central to the functioning of all ecosystems on Earth (Cox & Wright, 2013; Culyba et al., 2015; CDC, 2018).

2.1.1 Gram-positive and Gram-negative bacteria

There are many pathogenic bacteria that cause serious illnesses, such as TB, cholera, and gonorrhoea (Wright, 2010; Nesme & Simonet, 2015). Examples of pathogenic bacteria include *Acinetobacter baumannii*, *Enterobacteriaceae*, *Staphylococcus aureus*, *Helicobacter pylori*, *Salmonellae*, *Neisseria gonorrhoeae*, *Streptococcus pneumoniae*, Haemophilus influenzae, among others (WHO, 2017). However, these bacteria are a relatively tiny fraction compared to bacteria as a whole (Wright, 2010; Nesme & Simonet, 2015). Bacteria have an interdependent relationship with the environment surrounding them and form an intrinsic part of the global food web (Bulgarelli et al., 2013; Nesme & Simonet, 2015). They are beneficial and sometimes even essential to other organisms such as plants, insects, fish, and animals, including humans (Bulgarelli et al., 2013; Nesme & Simonet, 2015). Bacteria, alongside fungi and viruses, not only subsist in the whole planet, but are also found in large numbers on the human body (Nesme & Simonet, 2015; Bush, 2020).

Bacteria have a cell envelope, comprising an inner membrane, and a peptidoglycan layer (Figure 3) (Cox & Wright, 2013; Oz et al., 2014). Peptidoglycan is a polymer composed of sugars and amino acids that form the bacterial cell wall (Gillings, 2013; Moore et al., 2021).

Figure 3: Bacterial cell wall in Gram-positive and Gram-negative bacteria



(Source: The Open University, 2018)

Bacteria can be Gram-positive or Gram-negative, a denomination used to classify the microorganisms based on a bacterial cell wall staining method developed by Hans Christian Gram in 1884 (Gillings, 2013; Culyba et al., 2015; Exner, 2017). The gram staining method involves the use of crystal violet dye, counterstain safranin, and iodine, and is one of the first methods used in the identification of bacteria (Gillings, 2013).

Gram-positive organisms retain a violet colour because they have a thick cell wall composed of peptidoglycan which retains the dye and include the genera *Streptococcus*, *Lactobacillus*, *Clostridium*, and *Staphylococcus* (Moore, 2021). Gram-negative bacteria have a thin peptidoglycan cell wall between the outer and inner membrane of the cell (Figure 2), are unable to retain the crystal violet dye and thus they appear red or pink, and include the genera *Escherichia*, *Vibrio*, *Pseudomonas*, and *Klebsiella* (Moore et al., 2021).

Cell wall structures, in both Gram-positive and Gram-negative cell walls, influence the bacteria's susceptibility to antibiotics (Breijyeh et al., 2020). The outer membrane unique to Gram-negative bacteria, may allow them to be less susceptible to a wide range of antibiotics compared to Gram-positive bacteria (Breijyeh et al., 2020). Gram-positive bacteria's lack of an outer membrane may leave them more susceptible to certain classes of antibiotics, by exposing cell wall targets to the extracellular space (Breijyeh et al., 2020).

2.2 What are antibiotics:

Antibiotics are a type of antimicrobial drug that help prevent or treat infections caused by bacteria, within or on the body (O'Neil, 2014; WHO, 2021). They act by disrupting vital molecular processes on the cell surface and within the bacteria, thus preventing growth and initiating cellular bacterial death. Most antibiotics act through three main mechanisms: disrupting the bacterial cell envelope, blocking the production of new proteins in the cell, and inhibiting DNA and RNA replication, which subsequently prevents bacterial replication (Moore, 2021). Antibiotics are divided into antibiotic classes (see Table 4 below), which group different antibiotics based on their chemical formulation and pharmacological properties.

Antibiotics are often described as being bactericidal or bacteriostatic agents; bactericidal antibiotics cause bacterial cell death, and bacteriostatic antibiotics restrict the bacterial growth and reproduction (Nemeth et al., 2015). Broad-spectrum antibiotics, such as azithromycin, quinolones, and carbapenems, inhibit a wide range of bacteria, whereas narrow-spectrum antibiotics, such as vancomycin and macrolides, are highly specialised and only active against certain classed of bacteria (Moore, 2021). For a better understanding of the different types of antibiotics available and used in the healthcare sector, and to highlight the importance of these drugs in public health, a list of the major antibiotics and their properties has been provided below (Table 1). Table 1 also highlights the complexities involved in selecting antibiotics for treatment, i.e., there is no 'one size fits all', which is important to consider when treatment fails due to the wrong antibiotic being prescribed rather than an incidence of ABR. It also highlights that not all antibiotics are prescribed by GPs.

Table 1: Major antibiotic classes and their properties

Class of antibiotic	Properties, uses, and examples
Beta-lactams (Bactericidal)	Beta-lactams (β-lactams) inhibit cell wall formation by interfering with peptidoglycan synthesis and are mostly used to treat infections caused by gram-positive bacteria. They are also used for the treatment of a wide range of infections, namely: gonorrhoea, pneumonia, urinary tract infections (UTIs), respiratory tract infections, otitis media, skin infections, and dental abscess. This class of drug is the most widely used antibiotics in the NHS. **Penicillins:** Prevent peptidoglycan synthesis which is needed for the formation of bacterial cell wall; resulting in bacterial death. They are usually used to treat infections caused by

Class of antibiotic	Properties, uses, and examples
	gram-positive bacteria (e.g., streptococcal infections) and some gram-negative bacteria (e.g., meningococcal infections). They are among the safest antibiotics to use during pregnancy; however, they are usually used in these cases when the benefits outweigh the risks. Examples are: amoxicillin, ampicillin, and oxacillin **Cephalosporins:** There are five generations of cephalosporins, that provide increasing coverage to also include gram-negative infections. This class of antibiotics is similar to penicillins in its mode of action. The more recent generations of cephalosporins have updated structure that allow a much wider spectrum of activity against bacteria. Ceftaroline, which is a fifth-generation cephalosporin, is active against methicillin-resistant *Staphylococcus aureus* (MRSA). Examples are: cefuroxime, ceftriaxone, ceftazidime, cefotaxime, and ceftaroline **Carbapenems:** Carbapenems are broad-spectrum antibiotics that are highly effective in the treatment of moderate to life-threatening bacterial infections such as gastro-intestinal infections, hepatic infections, pneumonia, and multidrug resistant nosocomial infections. Carbapenems are commonly used as last-resort drugs to help prevent bacterial resistance. Examples are: Imipenem, meropenem, and ertapenem
Tetracyclines (Bacteriostatic)	Tetracyclines are broad-spectrum antibiotics. Even though the use of tetracyclines has decreased due to bacterial resistance, it is still being used to treat certain infections such as acne, intestinal tract infections, UTIs, periodontitis, eye infections, and chlamydia infections. Tetracyclines prevent bacterial growth by interfering with protein synthesis. Examples are: demeclocycline, doxycycline, minocycline, and omadacycline
Sulfonamides (Bacteriostatic)	Sulfonamides are considered as broad-spectrum antibiotics that are mostly active against gram-negative bacteria. They act by inhibiting folic acid synthesis, which is essential for protein synthesis, growth, and reproduction of bacteria cells. Uses of sulphonamides include the treatment and prevention of pneumocystis pneumonia, UTIs, and otitis media. Today this type of antibiotics is rarely used on its own because of the development of bacterial resistance and due to their side effects, such as toxic epidermal necrolysis, and hepatotoxicity. However, it is commonly used in combination with trimethoprim (co-trimoxazole) Examples are: sulfasalazine and sulfamethoxazole
Lincosamides (Bacteriostatic)	Lincosamides are effective against certain gram-negative anaerobes, as well as gram-positive aerobes and anaerobes. This class of antibiotics is used for the treatment of serious infections, such as pelvic inflammatory disease (PID), intra-abdominal infections, lower respiratory tract infections (LRTI), and bone and joint infections. They can also be administered topically on the skin for the treatment of acne. Examples are: Clindamycin, lincomycin, and pirlimycin
Glycopeptides (Bactericidal)	These antibiotics are commonly used as last resort drugs, particularly with MRSA infections, *Clostridium difficile* diarrhoea, complicated skin infections, and enterococcal infections such as endocarditis. Glycopeptide antibiotics inhibit cell wall formation. There are strict guidelines for the uses of glycopeptide antibiotics such as

Class of antibiotic	Properties, uses, and examples
	vancomycin, to delay the development of bacterial resistance to this type of antibiotic. Examples are: vacomycin, telavancin, dalbavancin, and oritavancin
Aminoglycosides (Bactericidal)	This type of antibiotics acts by inhibiting protein synthesis and by binding to the 30s ribosome in the bacterial cell, which eventually leads to bacterial cellular death. This class of antibiotics are very effective and quick-acting bactericidal drugs. Aminoglycosides are used to treat gram-negative bacteria, and some gram-positive bacteria. Because aminoglycosides cannot be absorbed during digestion, they have to be injected intravenously rather than consumed orally. The present-day use of aminoglycosides is limited, due to toxic side effects. Examples are: streptomycin, gentamicin, amikacin, and tobramycin
Chloramphenicol (Bacteriostatic)	This broad-spectrum antibiotic inhibits protein synthesis. Chloramphenicol also has bactericidal properties against a limited number of bacteria. However, due to serious side effects (aplastic anaemia), this antibiotic is only used in cases of life-threatening infections such as meningitis, plague, cholera, and typhoid fever, and in the treatment of conjunctivitis. Due to its low cost and availability, chloramphenicol is more commonly used in developed countries. It is also recommended by the WHO as first line treatment for meningitis in low-income countries. Examples are: chloromycetin, chloroptic, and fenicol
Macrolides (Bacteriostatic)	Macrolides inhibit protein synthesis, thus preventing bacterial growth and reproduction. They are mainly effective against gram-positive bacteria and may be used in the treatment of community-acquired pneumonia, uncomplicated skin infections, whooping cough (pertussis), and other susceptible infections. The spectrum of macrolides is broader than that of penicillins, and they are effective against several species of bacteria that penicillins cannot treat. Although some species of bacteria have shown resistance to macrolides, these drugs are the second most commonly prescribed antibiotics in the NHS, with erythromycin being the most prescribed in the macrolide class. Ketolides are a more recent generation of this class of antibiotics, developed to overcome bacterial resistance to macrolides. Examples are: azithromycin, erythromycin, and clarithromycin
Oxazolidinones (Bacteriostatic)	This class of antibiotics are used in the treatment of infections caused by gram-positive bacteria. They also inhibit protein synthesis, which prevents bacterial growth and reproduction. They are also the only remaining treatment against glycopeptide-resistant MRSA. Examples are: linezolid, cycloserine, and tedizolid.
Quinolones (Bactericidal)	Quinolones (also called fluoroquinolones) interfere with the transcription and replication of DNA in bacterial cells. This synthetic broad-spectrum class of antibiotics are commonly used in the treatment of difficult-to-treat UTIs when other drugs are ineffective, as well as nosocomial infections (hospital-acquired pneumonia) where resistance to older classes of antibiotics has been observed, and bacterial prostatitis. This class of antibiotics are also available as drops to treat ear and eye infections. Quinolones have also been widely used for veterinary purposes and may have contributed to the rapid development of bacterial resistance. Due to potentially disabling side-effects, this class of antibiotics comes with warnings.

Class of antibiotic	Properties, uses, and examples
	Examples are: ciprofloxacin, levofloxacin, and moxifloxacin
Streptogramins (Bactericidal)	Streptogramins narrow-spectrum antibiotics that are administered as a combination of two antibiotics from different groups within the same class of antibiotics: streptogramin A and streptogramin B. On their own, these specific antibiotics only show growth inhibiting activity, but combined they are effective in killing bacterial cells, by protein synthesis inhibition. This class of antibiotics is often used in the treatment of resistant infections, although resistance to streptogramins has developed. Example are: virginiamycin, dalfopristin, and quinupristin
Lipopeptides (Bactericidal)	This is the most recent class of antibiotics to be developed, and Lipopeptides have bactericidal properties against gram-positive bacteria. Daptomycin is the most commonly used antibiotic in this class of drugs and acts by disrupting various characteristics of bacterial cell membrane function. This type of antibiotics is given via injections and are commonly administered for the treatment of tissue and skin infections. Examples are: cubicin and daptomycin
Ansamycins (Bactericidal)	Ansamycins are effective against gram-positive bacteria and certain gram-negative bacteria. They act by inhibiting the production of RNA (Ribonucleic acid), which has a primordial role in the bacterial cells, and therefore would lead to bacterial cell death. Rifamycins are used in the treatment of TB and leprosy. Ansamycins can also demonstrate anti-viral properties. Examples are: rifamycin, geldanamycin, and ansamitocin

(Adapted from: Moore, 2021)

2.2.1 Benefits of using antibiotics

Antibiotics are essential in the treatment of many bacterial infections such as STIs, UTIs, rheumatic fever, TB, pneumonia, sepsis, and many others (WHO, 2021). Antibiotics have a crucial role in prophylaxis treatment before and after certain surgeries such as hip replacement surgery, pacemaker surgery, cataract surgery, caesareans, appendectomies among others (NICE, 2017). These drugs are also vital in the prevention and management of infections that may arise for people following chemotherapy, immunocompromised patients, and patients with chronic diseases, such as end-stage kidney disease (NICE, 2018).

These “miracle drugs” are also commonly used in agriculture, where livestock are treated to not only prevent infections, but to also allow intensive farming to meet the growing demands for affordable food for growing populations (Ayukekbong et al., 2017). Antibiotics used in farming promote the growth of muscle mass in livestock (WHO, 2021a) by inhibiting the growth of microorganisms that consume energy and impede the absorption of nutrients beneficial for animal growth and allowing those nutrients to be consumed by the animal, thus promoting a faster growth for the animal (Chattopadhyay, 2014). They are also used to treat and control bacterial diseases in crops and fish in aquaculture (Ayukekbong et al., 2017).

2.2.2 Side effects of antibiotics

Antibiotics are essential for the treatment of various bacterial infections; however, they can also have numerous side effects that could affect patients (NICE, 2017). Common side effects caused by antibiotics include nausea, vomiting, diarrhoea, cramps, loss of appetite, rash, and fever (Gough et al., 2014; Mohsen et al., 2020). Less common side effects include the formation of kidney stones while taking sulphonamides, photosensitivity caused by tetracyclines, abnormal blood clotting and other blood disorders caused by cephalosporins and trimethoprim, and deafness caused by taking aminoglycosides and erythromycin (Sultan et al., 2019; Mohsen et al., 2020). Certain antibiotics such as cephalosporins, penicillin, and erythromycin may also cause inflamed bowels that could lead to severe bloody diarrhoea and is especially observed among older adults (Gough et al., 2014; Mohsen et al., 2020).

A UK study, assessing the relationship between prescription of macrolides during pregnancy and the risk of major malformation, cerebral palsy, epilepsy and other neurological disorders in children, found that major organ malformations were observed in 186 of 8632 children whose mothers were prescribed macrolides, and 1666 of 95,973 children whose mothers were prescribed penicillins during pregnancy (Fam et al., 2020). Compared to penicillins, the use of macrolides in the first trimester of pregnancy was associated with an increased risk of major malformation (27.65 v 17.65 per 1000, adjusted risk ratio 1.55, 95% confidence interval 1.19 to 2.03), particularly cardiovascular malformations (10.60 v 6.61 per 1000, 1.62, 1.05 to 2.51) and genital malformations (4.75 v 3.07 per 1000, 1.58, 1.14 to 2.19) (Fam et al., 2020); thereby indicating the need for more caution when using macrolides during pregnancy, and the need to prescribe alternative antibiotics to pregnant women when feasible.

Looking at children presenting to the emergency department with adverse drug events (ADEs) in the US, an estimated 69,464 visits to the emergency department were made annually from 2011-2015 for antibiotic ADEs among children, of which 40.7% involved children under 2 years old, and 86.1% involved allergic reactions to antibiotics (Lovegrove et al., 2019). Amoxicillin was the most common antibiotic associated with an emergency department presentation among children younger than 9 years old; whereas sulfamethoxazole/trimethoprim was associated with ADEs among children aged 10-19 years old (Lovegrove et al., 2019). In Baddhour et al.'s (2019) country-wide investigation looking at ADEs from oral antibiotics prescribed in community settings in England, it was found that although the overall ADE rate was low, 63.6% of these ADEs were considered as serious and 1.21% were fatal. Between 2010 and 2017, 320,599,292 antibiotic prescriptions were issued in a community setting in England, with overall reported ADE rate being 57.9/1,000,000 prescriptions (Baddhour et al., 2019). Baddhour et al., (2019) found that the reported rate of ADEs caused by ampicillin (683/1,000,000 prescriptions) was strikingly high, despite the low use of this antibiotic in the community setting, with 437/1,000,000 classified as severe, and 27/1,000,000 as fatal. In a UK retrospective observational study of hospitalised children receiving more than 24 hours of systemic antibiotics, of the 400 antibiotic courses administered to hospitalised children, 21% were associated with at least one adverse event, and each additional day where the hospitalised children were administered antibiotics, was associated with a 7% increase in the odds of developing an adverse event, and 66% of the children who developed adverse events required further clinical interventions (Rebecca et al., 2021). The most common antibiotic associated adverse events were haematological (31%), gastrointestinal (15%), and renal (11%); and the most common antibiotics associated with adverse events were piperacillin-tazobactam (35%), tobramycin (35%), ceftazidime (19%), and vancomycin (18%) (Rebecca et al., 2021).

Findings such as these are important to report, and useful in the development of strategies to optimise prescribing practices (Baddhour et al., 2019; Lovegrove et al., 2019; Rebecca et al., 2021). Quantifying the risks of ADEs from antibiotics and providing detailed national data on antibiotic ADE risks to healthcare providers, may help improve antibiotic prescribing and antibiotic stewardship (Baddhour et al., 2019; Lovegrove et al., 2019; Rebecca et al., 2021), particularly as efforts to reduce unnecessary antibiotic prescribing generally focus on the long-term benefits of reducing antibiotic prescribing, such as reducing antibiotic resistance, rather than the short-term risks of antibiotic ADEs (Lovegrove et al., 2019).

Antibiotic therapy can cause disturbances in the skin, oral, and gut microbiota, causing an immediate change in the microbial diversity in the body (Gough et al., 2014; Sultan et al., 2019). Moreover, chronic use of antibiotics can disrupt certain crucial metabolic reactions in the body that could alter the composition of the human microbiota (dysbiosis), whereby protective microorganisms are decimated, and pathogenic organisms thrive (Gough et al., 2014; Mueller et al., 2015; Sultan et al., 2019). Abnormalities in human microbiota have been associated with many diseases such as allergies, cardiovascular diseases, obesity, diabetes, irritable bowel syndrome, and inflammatory bowel disease (Langdon et al., 2016; Hong et al., 2017; Cully, 2019; Zhong et al., 2019) (section 2.3.1).

The chronic exposure to antibiotic drugs in childhood may be detrimental to child growth, and can also increase susceptibility to developing infections, autoimmune conditions, metabolic diseases (obesity and diabetes), and cancer (Mueller et al., 2015). Although antibiotics are prescribed for both adults and children for various bacterial infections, children are often given antibiotics unnecessarily for viral illnesses and other self-limiting infections, such as colds or flu (Pouwels et al., 2018; NHSBSA, 2021). For example, Hagerdoorn et al.'s (2020) prospective observational study, conducted in emergency departments across 8 European countries (Austria, Germany, Greece, Latvia, the Netherlands, Spain, Slovenia, and the UK), found that in all febrile children being studied (n=35,650) antibiotic prescriptions were inappropriate in 12.5% of prescriptions (6.9% for presumed viral infections), they were of inappropriate duration in 20% of oral antibiotic prescriptions, and 22.3% of oral prescriptions did not follow local guidelines. In Fitzpatrick et al.'s (2021) population-based time-series study of Scottish children, it was reported that out of 6,066,492 antibiotic prescriptions among 452,877 children (<5 years), an estimated 14% were prescribed for common viruses for which antibiotics were not recommended; approximately 6.9% (95% confidence interval, 5.6–8.3%), 2.4% (95% confidence interval, 1.7–3.1%), and 2.3% (95% confidence interval, 0.8–3.9%) of antibiotics were prescribed for RSV, influenza, and HMPV respectively (Fitzpatrick et al., 2021). Unnecessary antibiotics prescribing can be detrimental for the developing microbiota of a child and can lead to side effects and drug toxicity that cause further health complications and also leads to the increased development of resistance, which could prevent them from being effectively treated for certain infections in the future (Gillies et al., 2015; NICE, 2017; Hayhoe, Butler, Majeed & Saxena, 2018; NICE, 2018).

The human microbiome and its interactions with drugs, is subject to intense and ongoing research (Furlong et al., 2019; Sultan et al., 2019; Konstantinidis et al., 2020; Schwartz et al., 2020; Patangia et al., 2022; Fishbein et al., 2023), and there is strong consensus that the interaction between antibiotics and the human microbiome can add weight to the ongoing efforts to reduce antibiotic use (Konstantinidis et al., 2020; Schwartz et al., 2020; Patangia et al., 2022; Fishbein et al., 2023). This could be particularly useful for policy makers to raise public awareness on the long-term effects cause by prolonged antibiotic use, which could eventually change patients' expectations for antibiotic prescriptions during GP consultations and GPs readiness to prescribe antibiotics (Furlong et al., 2019; Sultan et al., 2019).

Although all antibiotics effect the human microbiome, broad-spectrum antibiotics are particularly detrimental to the normal microbiota (Melander et al., 2018; Alm & Lahiri). This can lead to dysbiosis (microbial imbalance in the body), and potentially an overgrowth of harmful pathogens such as *C. difficile* and MRSA (Melander et al., 2018; Alm & Lahiri, 2020) (discussed further in section 2.3.1). Broad-spectrum antibiotics are often associated with increased ABR (Melander et al., 2018; Alm & Lahiri, 2020).

2.2.3 Antibiotic consumption/prescribing monitoring and surveillance:

Exposure to antibiotics is usually measured in terms of antibiotic consumption and antibiotic use. Antibiotic consumption refers to consumption at national level and can be estimated from the volume of antibiotics imported or the volume of antibiotics sold from manufacturer to wholesaler to retailer; whereas antibiotic use describes the use of antibiotics at patient-level and can be obtained from clinical, pharmaceutical, and hospital records (Frost et al., 2021). Monitoring both antibiotic consumption and usage has several benefits. It provides valuable insights into the demand and supply of antibiotics in various sectors of the healthcare system to optimise antibiotic prescribing, identifies antibiotic consumption trends, facilitates the assessment of how effective health policies are and the impact of interventions regarding antibiotic stewardship, provides a better understanding of the emergence of ABR, facilitates comparisons between settings and countries, and can also inform the development of antibiotic therapeutic guidance (Frost et al., 2021; Veterinary Medicines Directorate [VMD], 2023).

Data on antibiotic consumption may be expressed using various technical units of measurements, for example surveillance systems such as the WHO's GLASS (Global Antimicrobial Resistance and Use Surveillance System) and UKHSA's ESPAUR (English Surveillance Programme for Antimicrobial Utilisation) use Defined Daily Doses (DDDs) as a metric to quantify antibiotic consumption. However, other databases may use differing measures, such as standard units (SU), representing one pill/capsule of a particular medicine in kilograms of drugs sold. The lack of a standardised method of interpreting data on antibiotics consumed and used can make comparisons between surveillance systems challenging. Sales data has the potential to overestimate antibiotic consumption, as not all antibiotics purchased are consumed, many antibiotics consumed may not have been prescribed , and not all antibiotic prescriptions are filled (Forst et al., 2021). Furthermore, the exact trends in antibiotic prescribing in many countries, particularly low-income countries, are difficult to follow, due to a lack of resources, which restrict appropriate and sustained surveillance systems being set up (ARC, 2022). This lack of efficient monitoring undermines research on antibiotic prescribing trends in various parts of the world, as data on antibiotic exposure is limited to only quantifying antibiotic consumption (Forst et al., 2021), but it also gives a skewed representation of the real global burden of disease caused by antibiotic resistant infections (Machowska & Lundborg, 2018; ARC, 2022).

2.3 Antibiotic Resistance:

Antibiotic resistance is an evolutionary process that occurs due to the interactions of bacteria with their environment (Gillings, 2013; Culyba et al., 2015; Richardson, 2017; Larsson & Flach, 2021). However, the development of antibiotics and their widespread use in both clinical and non-clinical settings, has supplied another selective pressure that promotes the further increase of ABR, (Darby et al., 2022). Intrinsic resistance is the term used to describe the natural evolutionary phenomenon whereby certain strains of bacteria evolve to develop susceptibility to certain antibiotics due to genetic mutations in their cellular structure (Cox & Wright, 2013; Gillings, 2013; Peterson & Kaur, 2018). Acquired resistance is the term given when a bacterial species, which was initially susceptible to a specific antibiotic compound, displays signs of resistance and non-susceptibility (Leekha, Terrell & Edson, 2011; Oz et al., 2014; Peterson & Kaur, 2018). In clinical settings, resistance is a complex phenomenon that specifically refers to the growth of bacteria in otherwise therapeutic concentrations of an antibiotic (Baym et al., 2016; Exner, 2017; Peterson & Kaur, 2018; Liu et al., 2022).

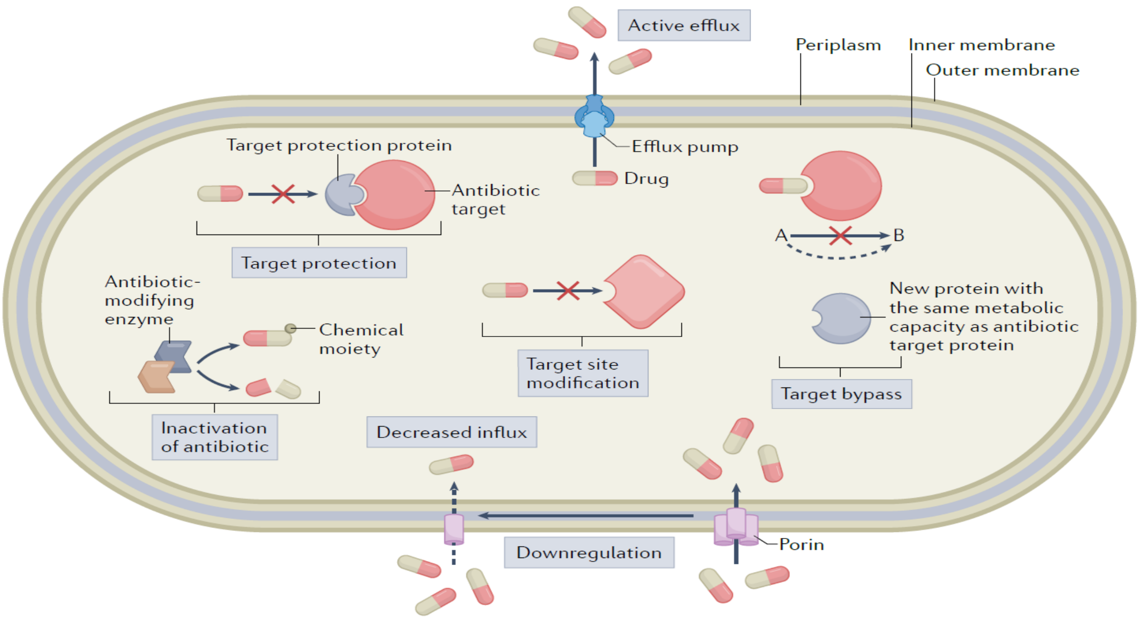
Bacteria display genetic flexibility, which allows them to respond to a wide variety of environmental threats that may jeopardise their existence, such as the presence of antibiotic molecules (Liu et al., 2022). To survive, the bacteria employ two main genetic processes:

genetic mutations and acquisition of foreign DNA through horizontal gene transfer, that codes for resistance (Munita & Arias, 2016; Richardson, 2017; Liu, Thomsen & Olsen, 2022). During mutational resistance, some bacterial cells derived from a susceptible bacterial population, develop genetic mutations that affect the activity of specific antibiotics, thus resulting in the survival of certain bacterial cells in the presence of a specific antibiotic drug (Munita & Arias, 2016; Richardson, 2017; Liu et al., 2022). Once the mutational resistance has occurred, an antibiotic drug could effectively eliminate the susceptible bacterial population, leaving a completely resistant bacterial population (Munita & Arias, 2016; Liu et al., 2022).

The acquisition of foreign DNA material via horizontal gene transfer is frequently responsible for the development of antibiotic resistance (Liu et al., 2022). This process occurs through three main stages: transformation, transductions, and conjugation (Munita & Arias, 2016; Liu et al., 2022). Transformation can be considered as the simplest type of horizontal gene transfer, however only a small number of bacterial species can incorporate foreign genetic material in the bacterial cell to then develop resistance (Munita & Arias, 2016; Liu et al., 2022). During transduction, a bacterial virus (bacteriophage) transfers genetic material from one bacterial cell into another, either through generalised transduction where a bacteriophage can carry any portion of a host's genome, or through specialised transduction which involves the phage picking up only specific portions of the host's genetic material (Liu et al., 2022). During conjugation, resistance develops through the transfer of genetic material during cell-to-cell contact (Munita & Arias, 2016; Liu et al., 2022).

There are various mechanisms of acquired resistance; enzymatic modification/inactivation of antibiotics, reduced influx or enhanced efflux, and alterations of antibiotic target sites (see Figure 4) (Abushaheen et al., 2020; Darby et al., 2022).

Figure 4: Overview of the molecular mechanisms of ABR



(Source: Darby et al., 2022)

Enzymatic inactivation/modification happens in both gram-positive and gram-negative bacteria, where chemical bacterial modifications are made to the antibiotics, to inactivate the antibiotic agent and inhibit binding to the bacteria (Peterson & Kaur, 2018; Abushaheen et al., 2020; Darby et al., 2022). Resistance to many types of antibiotics occurs through enzymatic modification or drug inactivation (Peterson & Kaur, 2018; Abushaheen et al., 2020). For example, the most common mechanism of β-lactam resistance involves the enzymatic hydrolysis of the β-lactam bond within the β-lactam ring of the antibiotic molecule (Ding et al., 2020; Lima et al., 2020). This process is mediated by β-lactamases, which are enzymes secreted by pathogenic bacteria, and results in the antibiotic losing its antibacterial activity (Ding et al., 2020; Lima et al., 2020). The most common mechanism of resistance to aminoglycosides involves aminoglycoside-modifying enzymes, namely N-acetyltransferases, O-phosphotransferases and O-nucleotidyltransferases, which impair the binding of the drug molecule to its bacterial target (Ogawara, 2019; Sanz-Garcia et al., 2019; Ahmed et al., 2020).

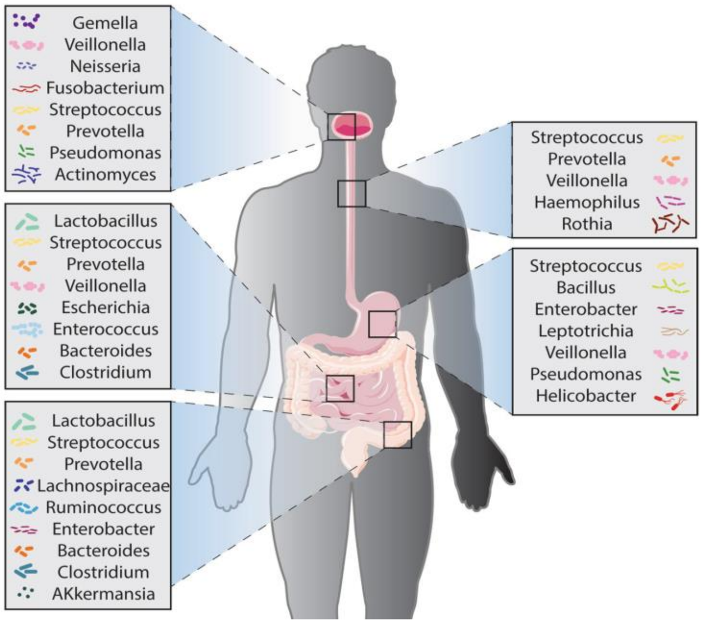
Reduced influx or enhanced efflux occurs to decrease the accumulation of antibiotics inside the bacterial cells, thus inhibiting the drug from accessing its cellular target (Peterson & Kaur, 2018; Darby et al., 2022). During reduced influx, porins (proteins in the bacterial outer membrane that act as a barrier to protect bacteria from harmful substances and are considered the access points for antibiotics) are modified to reduce antibiotic permeability, resulting in a reduction of antibiotics in the bacteria (Atrissi et al., 2021; Darby et al., 2022). For example, *Pseudomonas aeruginosa* commonly develops carbapenem resistance by decreasing the number of porins, the primary gateway for carbapenems through the outer membrane of the bacteria, which restricts the influx of carbapenem molecules into the bacterial cell (Atrissi et al., 2021; Darby et al., 2022). In contrast, during enhanced efflux, pathogenic bacteria produce efflux pumps that are used to expel the antibiotics out of the bacterial cell; thus, reducing intracellular drug concentrations (Peterson & Kaur, 2018; Darby et al., 2022). This active efflux out of the cell is commonly observed with antibiotics such as tetracyclines and fluoroquinolones (Darby et al., 2022; Huang et al., 2022). Multidrug efflux pumps can remove several different classes of antibiotics from the inside to the outside of bacterial cells, thereby contributing to bacterial multidrug resistance (Henderson et al., 2021; Nishino et al., 2021).

Modifications of antibiotic target sites may consist of mutations in the genes encoding the target site, enzymatic changes of the binding site, and replacement of the target; these modifications are used to decrease binding of the antibiotic to the bacterial the target site (Abushaheen et al., 2020; Darby et al., 2022). For example, genetic modification to the active site of penicillin-binding proteins (PBPs), membrane proteins that are the primary target for β-lactams, is a common mechanism among strains of *Streptococcus pneumoniae* (Shelaby et al., 2020). This mechanism prevents the binding of β-lactam drugs to the bacteria, leading to the development of resistance to multiple types of antibiotics within the β-lactam class (Sethuvel et al., 2023). Conversely, strains of *Staphylococcus aureus* develop resistance to methicillin by gaining a new PBP rather than modifying their existing PBPs (Ali et al., 2021). This mechanism allows the development of resistance to methicillin (MRSA), as well as resistance to almost all β-lactam antibiotics (Ali et al., 2021; Sethuvel et al., 2023).

2.3.1 The human microbiome and antibiotic use:

The human microbiota is made up of microorganisms, including bacteria, found on and within the human body (Rajilic-Stojanovic & Vos, 2014; Sender, Fuchs & Milo, 2016; Ganguly, 2019) (Figure 5). The human microbiome is an aggregate of all human microbiota and their genes (Jorge Da Silva & Domingues, 2017; Cheung, 2018; Bush, 2020).

Figure 5: Predominant bacterial genera in the digestive tract



(Source: Ruan et al., 2020)

The human body contains trillions of microorganisms, including bacterial cells (Kumar & Chordia, 2017; Ganguly, 2019), most of which are found in the gastrointestinal tract (Galland, 2014; Wang et al., 2017; Venkova et al., 2018; Ganguly, 2019) (Figure 5). However, all surfaces of the human body are colonised by bacteria, such as the skin, the genital tract, and the respiratory tract, with specialised ecosystems in various sites of the human body (Belkaid & Hand, 2014; Sender, Fuchs & Milo, 2016; Cheung., 2018; Bush, 2020). Although all humans have the same major classes of microorganisms (Lozupone, 2012; Jorge Da Silva & Domingues, 2017), the exact balance of these differ from human to human, therefore each human microbiome is unique (Kumar & Chordia, 2017; Venkova et al., 2018; Bush, 2020). The microbiota has a mutualistic relationship with the human host, and plays a key role in human health (Lozupone, 2012; Sender et al., 2016; Wang et al., 2017; Ganguly, 2019).

It has been reported that bacterial DNA has been detected in-utero, however, whether bacterial colonisation of the human body begins in-utero is still being debated (Robertson, Manges et al., 2018; Valdes et al., 2018; Yang et al., 2021; Yao et al., 2021). During delivery, babies are exposed to maternal microorganisms, such as *Lactobacilli* (Yang et al., 2021; Yao et al., 2021), subsequently they are exposed to bacteria when they come into contact with their mothers' skin and via their mothers' milk (Shao et al., 2019; Yao et al., 2021). The first weeks of a baby's life are critical for the development of its immune system, and the microorganisms that a baby is exposed to will become part of the baby's microbiota (Dominguez-Bello et al., 2016; Robertson, Manges et al., 2018; Yao et al., 2021). Babies delivered vaginally have a microbiota that consists mainly of maternal bacteria from the mother's birth canal, whereas the microbiota of those born through caesarean section mostly comprises bacteria acquired from the skin of their mother and their hospital environment (Thursby & Juge, 2017; Shao et al., 2019; Yang et al., 2021).

In the first days after birth, the types of microorganisms that colonise a baby's gastrointestinal tract will be influenced by mode of delivery and whether it is breastfed or not (Dominguez-Bello et al., 2016; Thursby & Juge, 2017; Valdes et al., 2018; Shao et al., 2019). The difference in microbiota will remain until the baby is around 12 months old (Valdes et al., 2018; Shao et al., 2019). Therefore, any dysbiosis in the mother's microbiota will in turn affect the development of her baby's microbiota (Shao et al., 2019; Hu, Wang, Harwell & Wake, 2021; Dierikx et al., 2022). Babies are exposed to more microorganisms when they begin feed and interact with their surroundings (Thursby & Juge, 2017; Robertson, Manges et al., 2018).

Changes in the human microbiota occur in the first years of life (Valdes et al., 2018; Shao et al., 2019). This is critical for healthy growth and development (Table 2), and are highly influenced by an individual's diet, their surrounding environment, medications they may consume, such as antibiotics, and the people and animals they may interact with (Shao et al., 2019; 2021; Reyman et al., 2022; Thaulow et al., 2022).

Table 2: Importance of the human microbiome for human health

Processes	Influences on the human body
Nutrition	Intestinal bacteria are responsible for the digestion and metabolism of food, particularly carbohydrates, fibres, starches, and sugars. They help release nutrients from food. For example, bacteria in the human gut produce enzymes that aid in the digestion of most carbohydrates ingested by humans. Enzymes produced by intestinal bacteria help in the metabolism of vitamins, which regulate blood sugar, strengthen the immune system, and helps the proper regulation of the nervous system. Examples of such vitamins are: B vitamins (B1, B1, B5, B6, B7, B12) and vitamin K. B vitamins help DNA synthesis and repair. Vitamin K is an important factor in the production of prothrombin and other blood clotting factors.

Processes	Influences on the human body
Immunity	Bacteria at birth and during the first years of childhood help build an immune system, the induction and training of the immune system, which is important to prevent pathogenic infections later in life; these are called commensal bacteria. Bacteria in the gut release compounds that repress the occurrence of an inflammatory response, thereby promoting immune tolerance to beneficial bacteria.
Infection protection	Beneficial bacteria in the body release compounds that keep pathogens from harming the human body. For example, various species of lactobacillus bacteria, that are present in the vagina, release lactic acid to maintain a low vaginal pH, thus inhibiting the survival of harmful bacteria, viruses, and yeast.
Protective barrier	Members of the skin microbiota can produce antimicrobial peptides to inhibit the growth of pathogenic bacteria while communicating with skin cells.
Gut microbiome and the brain	The gut microbiome is also essential for human brain development. Compounds produced by the gut microbiota signal the division of brain cells and are essential for child growth and development. Gut bacteria directly stimulate certain neurons in the gut to send signals to the brain via the vagus nerve. Neurons in the gut carry information to and from the brain (gut-brain axis). Through this mechanism, intestinal bacteria can influence mood, cognition, memory, and sleep. Gut bacteria also produce certain neurotransmitters and hormones, and bacterial receptors for these hormones influence microbial growth and virulence and can also affect metabolism and immunity in the human body.

(Adapted from: Belkaid & Harrison, 2017; Dehner et al., 2019; Konig, 2020)

The human microbiome is essential for immune, metabolic, endocrine, and other physiological processes to take place in the human body (Yu et al., 2015; Kim, Yoo, Kim, 2016; Kim, Zheng et al., 2017; Dehner et al., 2019; Konig, 2020) (Table 2). It has a symbiotic relationship with human cells, where the human host may affect the microbiome and in turn be affected by the microbiome (Belkaid & Harrison, 2017; Vuitton & Dalphin, 2017; De Luca & Shoenfeld, 2019). A healthy microbiota may include pathogenic bacteria, for example *E. coli, Proetus, Enterococcus,* and *Klebsiell*a, which if present at another site, or at higher-than-normal abundance, may cause disease (Vuitton & Dalphin, 2017; Ganguly, 2019). Dysbiosis may be the cause of such phenomena (Kim, You et al., 2016; de Oliveira et al., 2017; De Luca & Shoenfeld, 2019). It is also related to the development of various diseases, including gastrointestinal disorders such as inflammatory bowel disease (IBD), irritable bowel syndrome (IBS), gastric ulcers, colitis, coeliac disease, and colorectal cancer; as well as extra-intestinal diseases, such as cardiovascular disease, metabolic syndrome, asthma, and allergies (de Oliveira et al., 2017; Kim, Zeng et al., 2017; Ganguly, 2019; Thaulow et al., 2022).

An example of how the human host can affect the human microbiome is antibiotic use, which kills pathogenic bacteria and causes collateral damage to the bacteria that form part of the normal human microbiome (Wright, 2010; Kostic, Xavier & Gevers, 2014; Ganguly, 2019; Reyman et al., 2022). When exposure to antibiotics occurs, bacteria that are resistant to the drug will survive the exposure, whereas other bacteria will die, leading to an increase in the number of resistant bacteria (Cox & Wright, 2013; Gillings, 2013; Peterson & Kaur, 2018). Antibiotic resistant bacteria can transmit this resistance to other bacteria, via the transfer of genetic material (section 2.2.3) (Peterson & Kaur, 2018; Ganguly, 2019).

Antibiotic use may lead to dysbiosis, which could eventually lead to disease (Ganguly, 2019; Thaulow et al., 2022). An example of how antibiotic use can lead to the development of a disease, is *Clostridium difficile* (*C. difficile*) associated diarrhoea (Ofosu, 2016; Lee & Kim, 2017; Czepiel, 2019). *C. difficile* is a bacterium that can be found in the gastrointestinal tract of approximately 1 in every 30 healthy adults (Spigaglia, 2016; Czepiel, 2019; Xu et al., 2020). During the *C. difficile* life cycle, spores are formed and shed through faeces (Ofosu, 2016; Czepiel, 2019). Without strict hygiene practices, these spores can be transmitted from person to person, on utensils and in food (Nelson et al., 2017). Although these spores are metabolically inactive, they can survive for weeks on toilets, baths, sinks, and other surfaces (Czepiel, 2019). When a person touches a surface that is contaminated by the *C. difficile* spores, they may accidentally ingest them (Ofosu, 2016; Zacharioudakis et al., 2019). The spores then become active in the person's gastrointestinal tract (Lee & Kim, 2017; Czepiel, 2019; Xu et al., 2020). In a healthy person, their healthy microbiota will control the proliferation of *C. difficile*, and thus prevent an infection from occurring (Zacharioudakis et al., 2019). However, long-term antibiotic use, particularly broad-spectrum drugs, can lead to the proliferation of *C. difficile* (Ofosu, 2016; Zacharioudakis et al., 2019). As the existing intestinal bacteria are suppressed, *C. difficile* will thrive and produce toxins that damage the lining of the colon, causing watery diarrhoea, mild abdominal cramping and tenderness in mild cases; profuse diarrhoea, severe abdominal cramps, and fever in moderate cases; and severe diarrhoea, nausea, dehydration, low blood pressure, intestinal inflammation and bleeding, toxic megacolon, and colon perforation in severe cases (Ofosu, 2016; Zacharioudakis et al., 2019; Xu et al., 2020).

The COVID-19 pandemic unprecedentedly drove the world into an intense discussion of infection prevention and control, highlighting the lack of microbiology literacy in society (Trudel et al., 2020; Barendse et al., 2021; Carvalho & Lima, 2022; Niethamer et al., 2023). Microbiologists are now advocating for increased microbiology literacy, particularly in the current zeitgeist, post-pandemic and with the ABR crisis (Trudel et al., 2020; Barendse et al., 2021; Carvalho & Lima, 2022; Niethamer et al., 2023). Emphasis is being made on the importance of improving microbiology literacy and engaging people in conversations about their microbiota, and consequences of misusing antibiotics; which could allow people to make more informed decisions about their use of antibiotics and their contribution to ABR (Timmis et al., 2019; Timmis et al., 2020; Barendse et al., 2021; Trudel et al., 2020; Niethamer et al., 2023).

2.4 Consequences of antibiotic resistance

This subsection provides an overview of the global, national, and regional consequences of ABR. Due to a lack of surveillance in some areas, and variation in testing coverage (which could affect data representativeness), global ABR rates should be interpreted with caution, particularly where estimates of infection rates are provided (WHO, 2022).

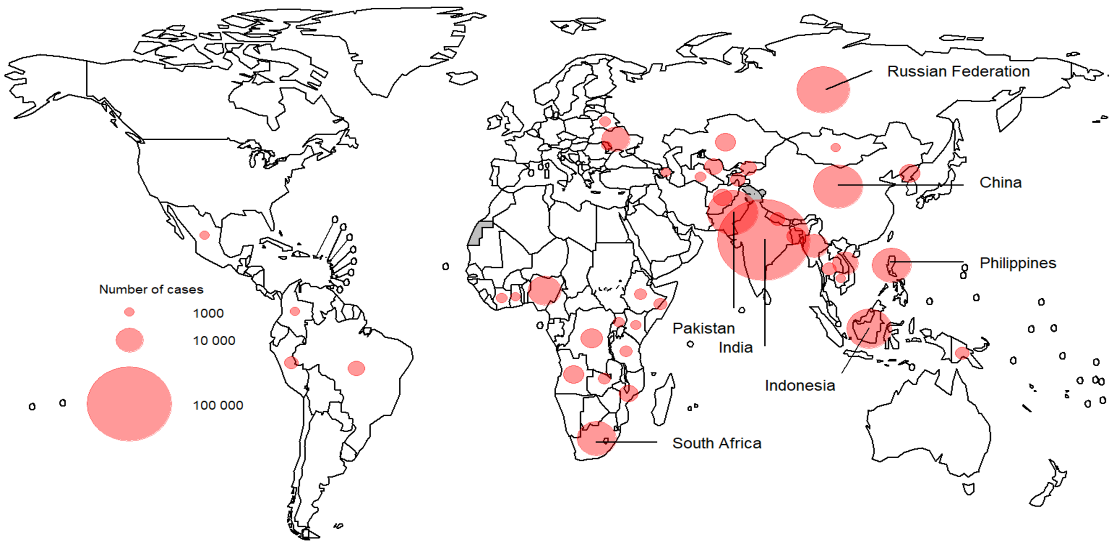
2.4.1 Global consequences of antibiotic resistance

Patients with drug-resistant infections have an increased risk of experiencing poor clinical outcomes, require more healthcare resources, and have a higher risk of mortality compared to patients who have infections with non-resistant strains of the same pathogen (WHO, 2021a; European Centre for Disease Prevention and Control [ECDC] & WHO, 2022). Multidrug-resistant bacteria, such as *Acinetobacter*, MRSA, *Pseudomonas*, and various strains of *Enterobacteriaceae* (*Escherichia Coli*, *Klebsiella*, *Serratia* and *Proteus*), are posing a threat in healthcare facilities such as hospitals and nursing homes (WHO, 2021a; ARC, 2022; ECDC & WHO, 2022). These bacteria have become resistant to many antibiotics used to treat multidrug-resistant bacteria, including carbapenems, third generation cephalosporins, and colistin (WHO, 2021a; ECDC & WHO, 2022). It is estimated that patients with methicillin-resistant *Staphylococcus aureus* infections have a 64% increased risk of mortality because of complications caused by the infection, as opposed to patients with a non-resistant *Staphylococcus aureus* infection (WHO, 2021a). The increased prevalence of multidrug-resistant bacteria is a major source of many hospital-acquired infections, such as pneumonia, central nervous system infections, and septicaemia, particularly in immunocompromised patients, intensive-care unit patients, and new-borns (Wang et al., 2019; UKHSA, 2021; ECDC & WHO, 2022).

Antibiotic resistant infections, particularly caused by third-generation cephalosporin-resistant *Escherichia coli*, methicillin-resistant *Staphylococcus aureus* and third-generation cephalosporin-resistant *Klebsiella pneumoniae*, have been reported to be a considerable burden on public health, particularly in terms of attributable deaths and disability-adjusted life years (DALYs) (ECDC, 2022). Antibiotic resistant infections in the EU/EEA increased from 685 433 (95% UI 589 451 – 792 873) in 2016 to 865 767 (95% UI 742 802 – 1 003 591) in 2019 (ECDC, 2022). The annual number of attributable deaths increased from 30 730 (95% UI 26 935 – 34 836) in 2016 to 38 710 (95% UI 34 053 – 43 748) in 2019 (ECDC, 2022). Analysed as DALYs, these antibiotic resistant infections led to an annual health burden of 909 488 (95% UI 813 858 – 1 013 060) in 2016 to 1 101 288 (95% UI 988 703 – 1 222 498) (ECDC, 2022). Between 2016 and 2020, approximately 70.9% of cases of antibiotic resistant infections (95% CI 68.2 – 74.0%) were healthcare-associated infections, with 71.4% attributable deaths (95% CI 69.0 – 74.4%) and 73.0% DALYs (95% CI 70.0 – 75.8%) linked to these healthcare-associated antibiotic resistant infections (ECDC, 2022). In the same period, an increasing trend in the estimated number of infections ($p<0,001$), attributable deaths ($p<0.001$) and DALYs ($p<0.001$) per 100 000 population due to antibiotic resistant bacteria was reported (ECDC, 2022). The burden of antibiotic resistant infections was highest among infants and the elderly (ECDC, 2022). It is important to note that the number infections, attributable death, and DALYs decreased slightly between 2019 and 2020, for example DALYs decreased slightly from 1 101 288 (95% UI 988 703 – 1 222 498) in in 2019 to 1 014 799 DALYs (95% UI 908 022–1 129 999) in 2020, most likely due to changes in healthcare practices during the pandemic and the measures put in place to control the spread of COVID-19, such as increased infection prevention and control (ECDC, 2022).

Estimates by the WHO show that in 2021, there were approximately 450,000 (95% uncertainty interval [UI]: 399 000–501 000) incident cases of multidrug resistant tuberculosis (MDR-TB), which increased by 3.1% from 437,000 (95% UI: 390 000–483 000) in 2020 (WHO, 2022). Although these are estimates, they provide an indication of the current situation with regards to TB incidence and TB detection. The estimated increase in MDR-TB between 2020 and 2021, has been attributed to the overall increase in TB incidence (having increased by 3.6%) during the same period, due to the impact of COVID-19 on TB detection. MDR-TB is a type of TB resistant to two of the core anti-tuberculosis drugs (isoniazid and rifampicin); only one in three people with MDR-TB are estimated to have accessed treatment in 2020 (WHO, 2021a). The estimated number of MDR-TB cases differs considerably among countries (see Figure 6), with the highest burden of MDR-TB being reportedly in India, Pakistan, the Russian Federation, South Africa, China, Indonesia, and the Philippines (WHO, 2022); 7 countries that accounted for approximately two thirds of all MDR-TB cases worldwide in 2021 (WHO, 2022). The countries with the largest number of MDR-TB cases are India (26% of global cases), the Russian Federation (8.5% of global cases), and Pakistan (7.9% of global cases).

Figure 6: Map showing the estimated number of cases of MDR in 2021, for countries with at least 1000 incident cases.



(Source: WHO, 2022)

In 2021, 166,991 cases of extensively drug-resistant tuberculosis (XDR-TB) was documented by 81 countries, a form of TB that has shown resistance to at least four of the main anti-TB drugs used for treatment (WHO, 2022). Extensively resistant strains of TB are a major concern for immunocompromised people and those who have HIV (WHO, 2021b).

Over the past decades, strains of *Neisseria gonorrhoea* that have shown resistance to many classes of antibiotics such as sulphonimides, penicillins, and tetracyclines, and more recently to last resort antibiotics (third generation cephalosporins) (ECDC, 2019b). Multi-drug resistant *N. gonorrhoea* has been confirmed in at least ten countries, namely France, Sweden, Austria, Japan, South Africa, Canada, Australia, Slovenia, Norway, and the UK (WHO, 2022b). The first 3 cases of extensively drug-resistant *N. gonorrhoea* were reported in the UK (1 case) and in Australia (2 cases), in 2018 (ECDC, 2019b).

Due to the rapid increase ABR around the world, the treatment and prevention of infections such as malaria, UTIs, TB, hospital-acquired infections, and STIs, have become more challenging (O'Neill, 2014; Hay et al., 2018; WHO, 2022b). The WHO estimates that ABR is likely to exacerbate global health and economic inequalities, particularly in poorer countries (WHO 2018; WHO, 2021a). Multidrug resistance can spread across borders, and the accelerated propagation of resistant infections such as TB, Malaria, and HIV, could jeopardise the gains of the Millennium Development Goal (MDG) six, which aimed to combat HIV/AIDS, malaria, and other diseases and infections (WHO, 2021a). This would also inhibit the achievement of the Sustainable Development Goals (SDGs) three (good health and well-being) and six (clean water and sanitation) (Sachs, 2012; WHO, 2021a).

A study published in the Lancet, looking at the global burden of ABR in 2019 using predictive statistical models, estimated that 1.27 million (95% uncertainty levels 0.911-1.71) deaths were caused by ABR in 2019 (ARC, 2022). This systematic analysis study, which estimated deaths and DALYs attributable to ABR in 204 countries and territories, asserted that there were 6 major pathogens that accounted for 73.4% (95% uncertainty interval 66·9–78·8) of deaths associated with ABR globally, namely *Escherichia coli*, followed by *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* (ARC, 2022). The ARC (2022) study also found that ABR death rates (for all ages) were highest in low- and middle-income countries (LMICs); for example, death rates due to ABR was highest in sub-Saharan Africa, with 27.3 deaths per 100,000 people (20.9-35.3). It is important to note that there are factors that influence high bacterial ABR burdens in LMICs, such as insufficient regulations to monitor the purchase and use of antibiotics, lack of microbiological diagnostic tests, prevalence of substandard antibiotics, poor sanitation and hygiene, and frequency of critical infections (e.g., bloodstream infections and lower respiratory infections) (ARC, 2022; WHO, 2022). As we have seen with how quickly COVID-19 spread to different countries over a short time due to globalisation, antibiotic resistant infections are predicted to spread from various parts of the world to others, due to increased trade, migration, and travel (Nellums et al., 2018; van den Brink, 2021; Desai et al., 2022; Sharma et al., 2023).

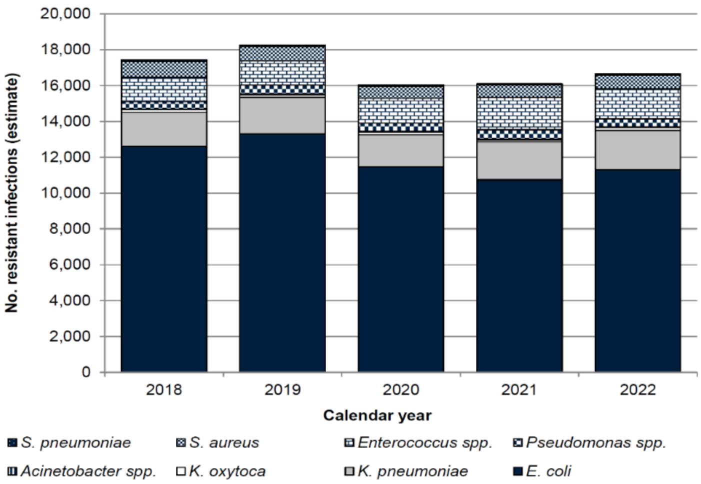
In terms of the economic cost of antibiotic resistance, it is estimated that if AMR continues to rise, treating antimicrobial resistant infections will cost G7 countries (Canada, France, Germany, Italy, Japan, UK, and USA) more than 4 million USD PPP (Purchasing Power Parity – macroeconomic analysis metric that is used to equalize the purchasing power of different countries) annually between 2015 and 2050 (OECD [Organisation for Economic Cooperation and Development]-WHO, 2022). In their systematic review and metanalysis, looking at the economic burden of ABR, Poudel et al. (2023) highlight the lack of evidence on the economic burden of ABR in low-income and lower-middle-income settings, thus providing a skewed representation of the impact ABR has globally. Although treating both resistant and susceptible infections exacerbate health costs, there are considerably more costs involved in treating resistant infections (Serra-Burriel et al., 2020; OECD-WHO, 2022). Complications caused by antibiotic resistant bacteria necessitate additional investigations, advanced laboratory tests, longer hospital stays, as well as greater reliance on intensive medical procedures and on more expensive treatment (Dadgostar et al., 2019; Naylor et al., 2019; Zhen et al., 2019; OECD-WHO, 2022). Poudel et al. (2023) reported that the attributable cost of antibiotic resistant infection varies from -US$2,371.4 to +US$29,289.1 (adjusted for 2020 price) per patient episode. Furthermore, the mean excess length of stay is 7.4 days (95% CI: 3.4–11.4), the odds ratios of mortality for resistant infection is 1.844 (95% CI: 1.187–2.865) and readmission is 1.492 (95% CI: 1.231–1.807 (Poudel et al., 2023). Using microsimulation models, the OECD and the WHO (2022) estimate that ABR will increase pressure on hospital resources and treating resistant infections across the G7 will result in more than 7 million additional days spent in hospitals each year between 2015 and 2050. In terms of individual costs, the previously mentioned extended hospital stays and more intensive medical procedures involved in treating antibiotic resistant infections may increase patient costs, in terms of transport, childcare, as well as potential loss of income due to missed work (Jit et al., 2020).

2.4.2 National and regional consequences of antibiotic resistance

In 2020, 1 in 5 people with a bloodstream infection (BSI) were found to be infected with an antibiotic resistant pathogen, in the UK (PHE, 2020c; UKHSA, 2021a, UKHSA, 2023). The estimated number of bloodstream infections caused by antibiotic resistant pathogens increased from 61,946 to 65,583 between 2018 and 2019 (PHE, 2020c). However, between 2019 and 2020 there was a 15.3% decrease in the number of antibiotic resistant infections most likely due to the COVID-10 measures put in place for infection prevention and control, followed by a 2.2 % increase in 2021 (post-pandemic) (UKHSA, 2022).

Data published by the UKHSA (2023) have shown that the total burden of antibiotic resistant BSIs was dominated by *E. coli*, which comprised 82.0% of the total number of resistant infections in 2022. The overall burden of ABR (estimated by the total number of priority BSI pathogens resistant to one or more key antibiotics), decreased by 4.6% between 2018 (n=17,437) and 2022 (n=16,643), with the largest reduction (13.3%) observed between 2019 and 2020 (at the start of the pandemic) (see Figure 7 below) (UKHSA, 2023).

Figure 7: Annual estimated total of the burden of antibiotic resistant bloodstream episode in the UK, from 2018 to 2022.

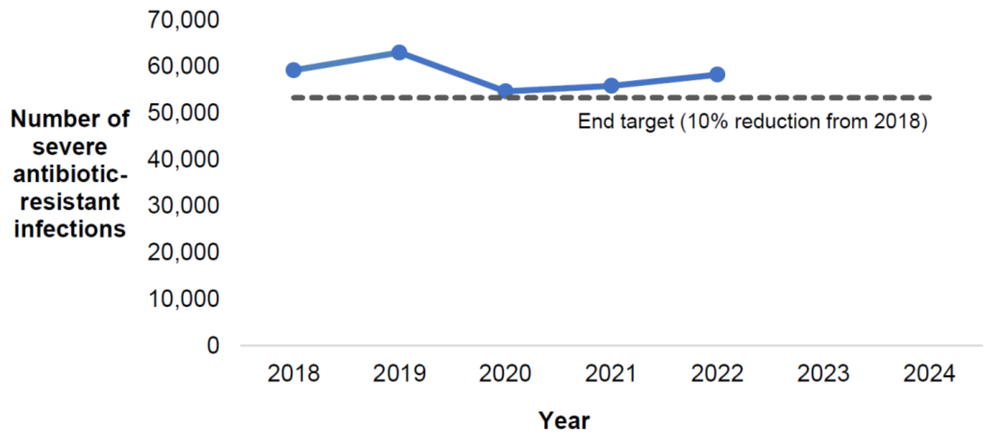


(Source: UKHSA, 2023)

This reduction is reported to primarily be due to reduction in the number of BSIs caused by *E. coli* (UKHSA, 2023), which coincided with the COVID-19 pandemic and driven by reductions in the community-onset bacteraemias (UKHSA, 2023).

The estimated number of deaths attributable to severe antibiotic resistant infections decreased from 2,382 deaths in 2019 to 2,202 deaths in 2022 (UKHSA, 2023). Between 2019 and 2020, the decrease in the number of antibiotic resistant BSIs and the number of deaths attributable to antibiotic resistance were possibly due to multiple factors (UKHSA, 2021a; UKHSA, 2023). Public health measures implemented during the COVID-19 pandemic, such as social distancing, increased sanitation and hand hygiene, as well as changes in treatment guidance, antibiotic prescribing, antibiotic usage, laboratory testing capacity, and health-seeking behaviour, could all have contributed to this reduction (Mahase, 2021; UKHSA, 2023). With the end of pandemic restrictions and the return to pre-pandemic levels of healthcare activity, there has been a 6.6% increase in the estimated total number of antibiotic-resistant infections in the UK between 2020 and 2022 (USKHA, 2023), however the number of resistant infections remain below pre-pandemic levels, as shown in Figure 8 below (UKHSA, 2023).

Figure 8: Estimated number of severe antibiotic resistant infections in the UK by year



(Source: UKHSA, 2023)

An increase in community-onset infections has been observed post-pandemic, such as invasive group A *Streptococcus* (iGAS), Scarlet fever, *Escherichia coli* BSI, and *Streptococcus pneumoniae* BSI (OECD-WHO, 2022; UKHSA, 2023).

According to UKHSA (2023), in 2022 the NW had the second highest ABR burden rate per 100, 000 (32.9), with the London region having the highest ABR burden rate population (39.2 per 100,000), and South West recording the lowest (22.8 per 100,000). Variations in ABR burden according to indices of multiple deprivation (measured by quintile, where the first quintile represents the most deprived 20% of areas in England and the fifth quintile represents the least deprived 20% of areas), has been observed in 2022 (UKHSA, 2023) (Table 3). As shown in the table below, the number of antibiotic resistant BSI was higher in the most deprived areas (first quintile) in England (33.0 per 100,000, n=3,729; 20.2% resistant) compared to the least deprived areas (fifth quintile) (23.4 per 100,000, n=2,567; 18.6% resistant).

Table 3: ABR burden from BSI by IMD quintile in England in 2022

IMD quintile	Rate of BSI per 100,000 population (n)	Rate resistant per 100,000 population (n)	Percent resistant (95% confidence intervals)
1 (most deprived)	163.3 (18,455)	33.0 (3,729)	20.2% (19.6 to 20.8)
2	146.8 (17,078)	29.2 (3,397)	19.9% (19.3 to 20.5)
3	142.8 (16,399)	28.6 (3,288)	20.0% (19.4 to 20.7)
4	135.0 (15,090)	25.5 (2,846)	18.9% (18.2 to 19.5)
5 (least deprived)	125.9 (13,793)	23.4 (2,567)	18.6% (18.0 to 19.3)

(Source: UKHSA, 2023)

Variation in ABR burden from BSIs has only recently (since 2022) been reported by ethnic group (see Table 4), with the highest number of BSI cases being recorded in people of White ethnicity (83.6% of priority BSI episodes; n=68,983) in 2022 (UKJSA, 2023). The highest percentage resistant was observed among Asian and Asian British ethnic group (34.6%; n=1,450) (UKHSA, 2023); however, no further explanation has been given regarding the variations observed in percentage resistant and rates of BSI per 100,000 ethnic population.

Table 4: ABR burden from BSI by ethnic group in England in 2022

Ethnic group	Rate of BSI per 100,000 ethnic population (n)	Rate resistant per 100,000 ethnic population (n)	Percent resistant (95% confidence intervals)
White	150.7 (68,983)	28.1 (12,870)	18.7% (18.4 to 18.9)
Asian or Asian British	77.1 (4,185)	26.7 (1,450)	34.6% (33.2 to 36.1)
Black, African, Caribbean or black British	94.0 (2,240)	24.0 (570)	25.5% (23.7 to 27.3)
Mixed or multiple ethnic groups	33.4 (558)	6.4 (107)	19.2% (16.0 to 22.5)
Any other ethnic group	25.3 (311)	4.7 (58)	18.7% (14.3 to 23.0)
Not known or Not stated	N/A (1,262)	N/A (190)	15.0% (13.1 to 17.0)

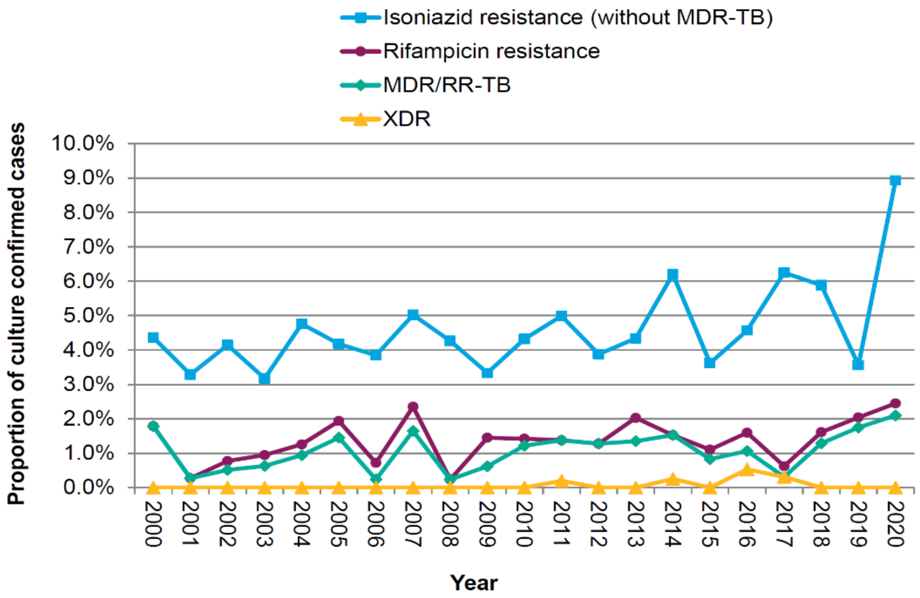
(Source: UKHSA, 2023)

It is important to note that the Second Generation Surveillance System (SGSS) run by UKHSA, is a national database containing laboratory data supplied by approximately 98% of hospital microbiology laboratories in England, however, it does not include information on ethnicity and deprivation. Therefore, estimates of the total number of BSIs based on demographic factors, such as ethnicity and deprivation, are derived from incidence data of all pathogens obtained from cases reported to the AMR division of the SGSS.

TB is a major contributor to ABR, and drug resistant TB has threatened the progress made in TB care and control (WHO, 2023a). In the UK the total number of TB cases have gradually decreased from 4,725 in 2019 to 4,125 in 2020 (UKHSA, 2022b). Non-UK born individuals accounted for 86.3% of the number of TB cases diagnosed in 2020 (UKHSA, 2022b), being 15 times more likely to be diagnosed with TB (UKHSA, 2022b). Drug resistance has been seen in 11.6% of the laboratory-confirmed TB cases, and 2.4% of these were multidrug-resistant, the highest percentage recorded since 2000 (UKHSA, 2022b). While the total number of TB cases has decreased since 2019, MDR-TB cases have increased (UKHSA, 2022b). Most non-UK born TB cases in 2020 originated from Pakistan, India, Eritrea, Somalia, and Romania; and TB infections were 11 times higher in non-White ethnic groups compared to White ethnic groups (UKHSA, 2022b). Between 2017 and 2021, the highest proportion of people with MDR-TB was reported in the East of England (2.5%), compared to the NW (1.7%), South East (1.5%), and London (1.7%) (UKHSA, 2022b).

According to UKHSA, TB incidence is unevenly distributed and disproportionately affects the most deprived populations, including people born outside the UK, and those at risk of exclusion and other health inequalities (UKHSA, 2021b; Manchester City Council [MCC], 2023). The population groups having a higher risk of acquiring TB are migrants, refugees, asylum seekers, and those with social risk factors (UKHSA, 2022b; MCC, 2023). In 2020, 22.2% of TB cases were reported in areas containing the 10% most socio-economically deprived populations in the NW and were highest among people born outside the UK (69.8%), and 9.2% of the reported TB cases in NW had a least one social risk factor (alcohol misuse, history of drug misuse, homelessness, or imprisonment) (UKHSA, 2021b). Socio-economic deprivation is defined as the lack of social and economic resources that influence quality of life, such as income, education, occupation, and housing among others (Townsend, 1987; Lillini et al., 2019). In the same year, 15.2% of TB cases in the NW were reported to be resistant to one or more antibiotics used in first-line treatment (an increase from previous years), with 10.8% resistant to isoniazid, 2.4% being resistant to rifampicin, and 2.1% was classified as MDR-TB (see Figure 9) (UKHSA, 2021b). However, no cases of XDR-TB were reported in the NW in 2020.

Figure 9: Proportion of drug resistant TB cases in the NW, 2000 to 2020



(Source: UKHSA, 2021b)

Looking at GM, Manchester has the highest TB incidence in GM (21.1 per 100,000) (MCC, 2023; OHID, 2023). Annual TB incidence in Manchester is also substantially higher than the annual average for England (7.8 per 100,000) (see Table 5 below).

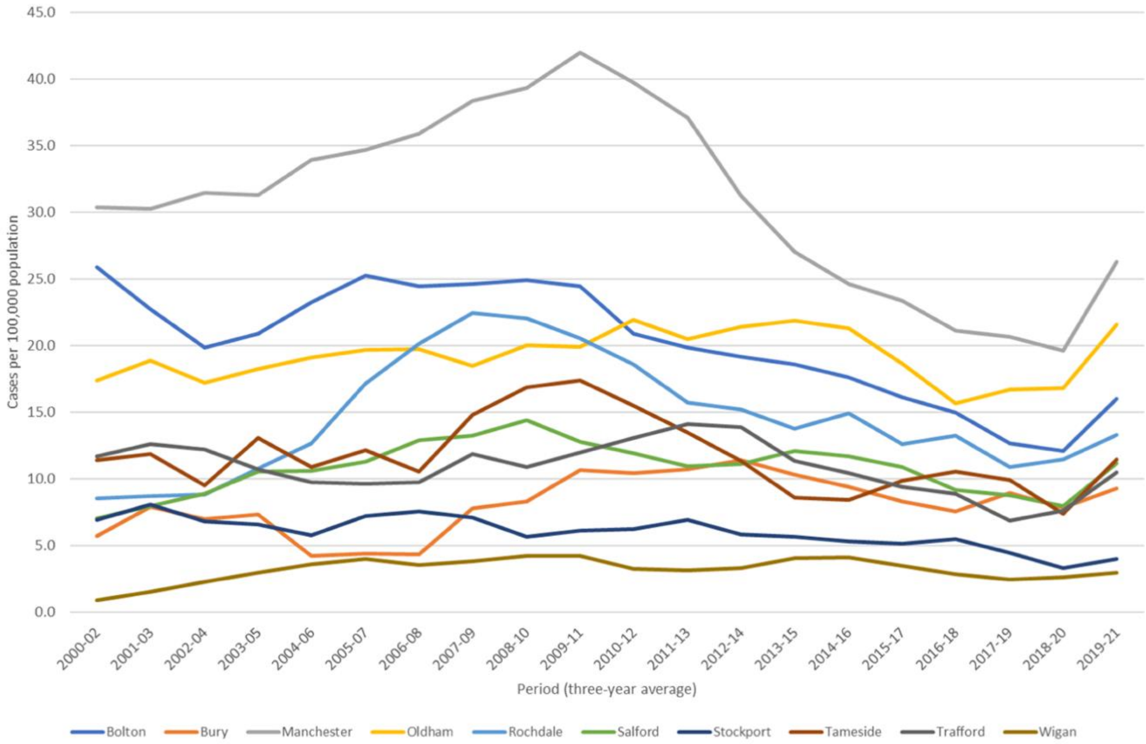
Table 5: the three-year average numbers of TB case notifications and rates by local authority in GM, 2019-2021

Borough	Average annual no. of cases	Average annual rate per 100,000	95% CI (Lower)	95% CI (Upper)
Bolton	104	11.9	9.8	14.4
Bury	40	7.0	5.0	9.4
Manchester	**350**	**21.1**	**19.0**	**23.4**
Oldham	120	16.7	13.9	19.9
Rochdale	58	8.7	6.6	11.1
Salford	68	8.6	6.7	10.8
Stockport	18	2.0	1.3	3.2
Tameside	57	8.3	6.4	10.7
Trafford	56	7.9	6.0	10.2
Wigan	22	2.2	1.4	3.3
NW	**1,457**	**8.2**	**7.8**	**8.7**
England	**13,253**	**7.8**	**7.7**	**8.0**

(Source: OHID, 2023)

Although TB incidence in Manchester steadily decreased between 2009 and 2018 (see Figure 10 below), cases started to rise from 2018, a similar trend observed in other boroughs in GM (Manchester City Council, 2023). With GM's ethnic profile (see Appendix 2; and section 3.2.4.1 Figure 20), high numbers of migrants, and deprivation levels (see Appendix 1 & Appendix 2), drug-resistant TB and MDR-TB could be a serious growing public health concern, particularly in the wake of the COVID-19 pandemic.

Figure 10: TB incidence rate per 100,000 population in GM from 2000 to 2021 (3-year average)



(Source: Manchester City Council, 2023)

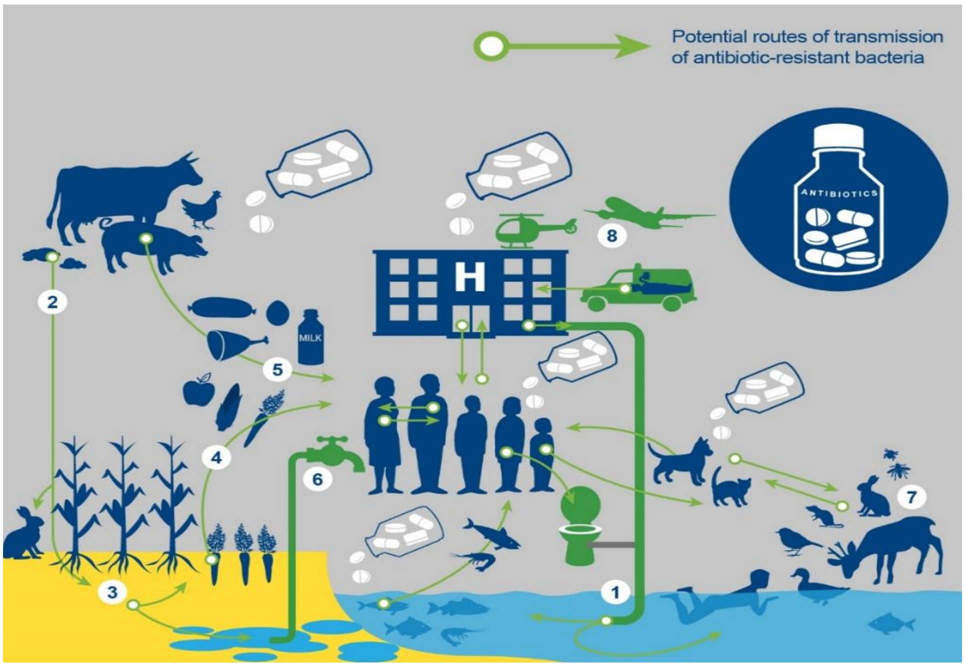
The long-term effect of the pandemic on TB incidence has been reported to be difficult to determine at this stage post-pandemic (Manchester City Council, 2023). It is important to note that data regarding TB incidence rates should be interpreted with caution due to the potential impact of the COVID-19 pandemic on TB detection and transmission (WHO, 2023).

The OECD and WHO have estimated that between 2015 and 2050, approximately 2,120 deaths are expected yearly in the UK due to resistant infections, which corresponds to 1.3 times the combined number of deaths caused by HIV, TB, and influenza, in 2019 (OECD-WHO, 2022). It is projected that the annual health expenditure for the treatment of antimicrobial resistant infections will exceed GBP 104.8 million from 2015 to 2050, and that in the same period the additional hospital stays attributable to antibiotic resistant infections are projected to average around 339,500 annually (OECD-WHO, 2022).

2.5 Drivers of antibiotic resistance

There is consensus that human action drives the rapid emergence and propagation of ABR (Shallcross & Davies, 2014; Aslam et al., 2018; ECDC & WHO, 2022). Resistant bacteria can be transmitted via various pathways, including food sources, contaminated water, or by vectors such as farm animals (Gillings, 2013; Prestinaci et al., 2015; Singer et al., 2016; Aslam et al., 2018; Larsson & Flach, 2021; ECDC & WHO, 2022) (see Figure 4).

Figure 11: Routes of transmission of antibiotic resistance



(Source: Biomerieux, 2022)

Antibiotic resistant bacteria can spread in healthcare settings (e.g., hospitals) with poor infection prevention and control, for example by contact between infected patients or with healthcare staff, contaminated surfaces, contaminated medical devices, or via the water sanitation systems, as wastewater treatment facilities do not treat wastewater enough to remove resistant bacteria before releasing water into the environment (route 1; Figure 11). Environmental pathways are an important channel, as animal and human waste can easily contaminate water and soil environments with antibiotic resistant organisms (see Figure 11) (Alexander et al., 2020; Anand et al., 2021; Larsson & Flach, 2021; Mukherjee et al., 2021).

Resistant bacteria can also spread with the use of contaminated manure for crop cultivation, where the bacteria can develop on plants (route 2; Figure 11), and can also spread from animal and human waste, via sludge and effluent through the seepage into the soil and water sources (route 3; Figure 11) (Alexander et al., 2020; Larsson & Flach, 2021; Mukherjee et al., 2021).

Extensive reliance on antibiotics in farms and animal husbandries, as prophylaxis for infections and for growth promotion, is strongly highlighted in current literature as contributing vastly to the propagation of resistant bacteria (Ayukekbong et al., 2017; Exner et al.; 2017; Tian et al., 2021). Drug-resistant bacteria have also been observed along the food supply chain, where they can remain on plant products intended for human consumption (Patel et al., 2020) (route 4; Figure 11). When these products are improperly handled, cleaned, or cooked, drug-resistant bacteria may be spread to humans, which can then cause antibiotic resistant *Campylobacter* and *Salmonella* infection (Patel et al., 2020). Animals grown for food products are also reservoirs for antibiotic resistant bacteria, a major risk for the transmission and spread of resistant strains of bacteria via the food chain (Economou & Gousia, 2015; Exner et al.; 2017; Patel et al., 2020) (route 5; Figure 11). Through seepage of wastewater, sludge, and manure into groundwater, resistant bacteria can also contaminate water reserves, thus potentially contaminating drinking water (Pruden et al., 2013; Anand et al., 2021; Larsson & Flach, 2021; Mukherjee et al., 2021) (route 6; Figure 11). Wildlife in contact with other animals carrying antibiotic resistant bacteria, or contaminated food and drink sources, can also be reservoirs for these bacteria (route 7; Figure 11). Tourism, migrations, and food imports also contribute to the fast propagation of resistant strains of bacteria across borders (route 8; Figure 11).

Various recent studies have confirmed the link between antibiotic use and the development of ABR (Wang et al., 2019; Megraud et al., 2021; Gong et al., 2022; Allel et al., 2023; Poku et al., 2023). For example, a global ecological study, published in the Lancet, using country-level data (countries included in the study represented every WHO region) to examine the drivers of ABR found significant associations between antibiotic consumption and ABR in food-producing animals (OR 1·05 [95% CI 1·01–1·10]; p=0·013), as well as in humans (1·06 [1·00–1·12]; p=0·035) (Allel et al., 2023). Although this study had certain limitations, such as the limited data available from low- and middle-income countries leading to bias in the results, and the use of modelled estimates for antibiotic consumption in animals, this study found a global bidirectional association between the use of antibiotics in animals and humans and ABR; greater antibiotic use in food-producing animals increased ABR in humans, while the high rates of human consumption of antibiotics increased the risk of ABR in animals (Allel et al., 2023).

While the overuse of antibiotics in agriculture and farming is a major contributing factor in ABR, along with various other important pathways involved in the spread of antibiotic resistant bacteria, the focus of this PhD is on human health, specifically the use of antibiotics. Human consumption of antibiotics as a driver of ABR has been illustrated in a systematic review examining the temporal relationship between antibiotic use and the development of ABR in hospitalised adults in Europe, which found that ABR for specific antibiotics/antibiotic combinations occurred between 0 to 6 months after the use of these antibiotics (Poku et al., 2023). Similarly, Megraud et al.'s (2021) observational study looking at antibiotic resistant *H. pylori* cases (n=1211) in 24 centres from 18 European countries, found a significant association between the community use of macrolides and *H. pylori* clarithromycin resistance (p=0.0019, incidence rate ratio (IRR): 1.17, 95% CI 1.07 to 1.29), and the consumption of quinolones and levofloxacin resistance (p=0.0002, IRR: 1.57, 95% CI 1.29 to 1.92). In Gong et al.'s (2022) retrospective study investigating antibiotic use and ABR in children in China, it was reported that there was a marked increase (between 2016 and 2021) in the use of carbapenem, monobactams, cephalosporin, fluoroquinolones, and antibiotic combinations, which correlated with a significant increase (between 2016 and 2021) in the resistance rates of *A. baumannii* to carbapenems ((r=0.763, p<0.001; r=0.806, p<0.001), *E. cloacae* to carbapenems (r=0.675, p<0.001; r=0.417, p=0.043), and *P. aeruginosa* to ceftazidime (r=0.625, p=0.001; r=0.753, p< 0.001). The study also found a significant increase in resistance rates *E. faecium* to ciprofloxacin, *S. pneumoniae* to ceftriaxone, and *E. coli* to cefepime (all p<0.05) (Gong et al., 2022).

2.5.1 The demand and supply of antibiotics in primary care

There is evidence that the mismanagement of antibiotic drugs is the primary cause and driver of antibiotic resistance (Prestinaci et al., 2015; Machowska & Lundborg, 2018; WHO, 2021a; ECDC & WHO, 2022; Allel et al., 2023). The exponential increase in antibiotic resistance may stem from the behaviours and attitudes of antibiotic users and dispensers (Rather, Kim, Bajpai & Park, 2017; Aslam et al., 2018; Dadgostar, 2019; Chokshi et al., 2019), and the demand and supply for these antibiotics has a major influence on the propagation of antibiotic resistance (Baym et al., 2016; Aslam et al., 2018; Dadgostar, 2019; Chokshi et al., 2019). As mentioned previously, the responsible use of antibiotic drugs has become a critical public health challenge in many countries around the world today, including the UK (UKHSA, 2021a; WHO, 2021a; ECDC & WHO, 2022), and controlling the amount of antibiotics prescribed would be beneficial in the prevention of increased ABR (Pouwel et al., 2018; UKHSA, 2021a; UKHSA, 2023).

Although the fundamental role of healthcare practitioners is to treat and prevent the development and spread of diseases, the over-prescribing of antibiotics has a significant contribution to the accelerated propagation of antibiotic resistance (UKHSA, 2021a; WHO, 2021a; ECDC & WHO, 2022).

2.5.1.1 Use of broad-spectrum antibiotics

In many countries, broad-spectrum antibiotics are often prescribed or administered without a definite diagnosis on which pathogens are causing the illness or whether antibiotics are necessary for treatment (Kotwani et al., 2010; Aiken et al., 2014; Tarrant et al., 2021). Broad-spectrum antibiotics are favoured instead of narrow-spectrum antibiotics due a lack of resources, specifically antibiotic sensitivity tests, that would not only help obtain a definite diagnosis on certain infections but would also allow better and more responsible prescription of antibiotic drugs for specific pathogenic bacteria (Spellberg et al., 2008; Ventola, 2015; Tarrant et al., 2021).

In the UK, broad-spectrum antibiotics are often favoured instead of narrow-spectrum antibiotics, being prescribed unnecessarily for self-limiting infections (Curtis et al., 2019; Krishnakumar et al., 2019; Nowakowska et al., 2019; Hagedoorn et al., 2020; NHSBSA, 2021; Russell et al., 2021; Tarrant et al., 2021; Allen et al., 2022; Malik et al., 2023; Zhong et al., 2023). Between 2019 and 2020, around 30 million antibiotic prescriptions were dispensed in the UK; 12% (3.6 million) were prescribed to children aged 0 to 14 years, of which 48% were prescribed to children aged 0-4 years (NHSBSA, 2021). Amoxicillin, a broad-spectrum antibiotic, is the most prescribed antibiotic for children, accounting for 53% of the total number of antibiotic items prescribed for children aged between 0 and 4 years in the UK (NHSBSA, 2021). There is significant season variability linked to antibiotic prescribing in children, and the greatest rates of prescribing are reported during the winter months for respiratory infections (NHSBSA, 2021). Amoxicillin is often unnecessarily prescribed for self-limiting infections, such as URTI and otitis externa, which does not align with national guidance recommendations (Nowakowska et al., 2019; Zhong et al., 2023). Between 2021 and 2022, there was a slight increase (1.7% - from 0.124 to 0.126 items per 1,000 inhabitant per day) in broad-spectrum antibiotic prescribing in primary care, although usage remained below pre-pandemic 2019 levels (0.128 items per 1,000 inhabitant per day) (UKHSA, 2023). Amoxicillin usage between 2021 and 2022 increased by 21.9% (UKHSA, 2023). This was likely due to the rise in infections rates post-pandemic, such as BSIs and community-acquired infections such as invasive group-A Streptococcal infections (iGAS) and scarlet fever (OECD-WHO, 2022; UKHSA, 2023).

Although national guidance on antibiotic prescribing recommends the prescribing of narrow instead of broad-spectrum antibiotics, due to their association with ABR (UKHSA, 2021), the pattern of prescribing broad-spectrum antibiotics, could be associated with diagnostic uncertainty and precautionary prescribing (Nowakowska et al., 2019; Allen et al., 2022). In a recent study looking at trends in antibiotic prescribing, using data from GP practice prescribing records from 1072 English GP surgeries and from a UK longitudinal survey (the General Practitioner Work-life Survey), it was found that there could be a causal link between GPs working under pressure and the rates of broad-spectrum antibiotic prescribing (Allen et al., 2022). Allen et al.'s (2022) longitudinal study found that the percentage of broad-spectrum antibiotics prescribed increased by 6.4% as pressure increased on GPs in the UK. In this study, prescribing data from English general practices (from 2010 to 2017), and repeated cross-sectional data from the General Practitioner Worklife Survey (from 2010 to 2017), suggested that broad-spectrum antibiotics were at times favoured by GPs as they are less resource demanding, and consequently easier and quicker to prescribe when working under pressure (Allen et al., 2022). Therefore, Allen et al. (2022) suggested that as pressure on GPs increases, adherence to clinical guidelines on antibiotic prescribing decreases (Allen et al., 2022). However, even though this was a longitudinal study, the repeated cross-sectional aspect of the study prevents causal inference to be made (Wang & Cheng et al., 2020).

Regarding the prescribing of broad-spectrum antibiotics for children, Miller et al.'s (2022) cohort study (n=2493) in the UK found that the odds of prescribing amoxicillin were higher for infants in their first year of life, if they were from socioeconomically deprived households (based on socioeconomic status) (aOR 1.36, 95% CI = 1.00 to 1.86), and if they had a mother with a Pakistani ethnic background (with mothers born in the UK [aOR 1.44, 95% CI = 1.06 to 1.94] and outside [aOR 1.42, 95% CI = 1.07 to 1.90]). Other risk factors that influenced amoxicillin prescribing was childcare attendance, birth characteristics (e.g., congenital abnormalities), household overcrowding, and prematurity at birth (Miller et al., 2022). As mentioned previously, the pattern of prescribing broad-spectrum antibiotics, such as amoxicillin, may be related to diagnostic uncertainty and GP concerns about illness progression and worsening (Krishnakumar et al., 2019; Nowakowska et al., 2019). GPs may prefer broad-spectrum over narrow-spectrum antibiotics for children who may be at higher risks of complications (e.g., those with congenital abnormalities), or for children with repeated infections (e.g., those who attend childcare or those in crowded households) (Krishnakumar et al., 2019; Miller et al., 2022).

Increased antibiotic prescribing is often observed in more deprived areas (Covvey et al., 2013; Mölter et al., 2018; Thomson et al., 2020; Devine et al., 2022; Zhong et al., 2023). There is consensus that the prevalence of infections is higher in deprived areas (Lule et al., 2020; Nguipdop-Djomo et al., 2020; Chaudhuri et al., 2021; Upshaw et al., 2021). Therefore, it would be expected that GPs in these areas would prescribe higher proportions of broad-spectrum antibiotics, as suggested by Miller et al. (2022). Thomson et al. (2020) examined the association between area-level deprivation (measure by IMD 2015) and trends in antibiotic prescribing (from 2014 to 2018), and also found that the deprivation was a significant predictor of increased antibiotic prescribing in all deprivation deciles (deciles 1–8, $p < 0.01$; decile 9, $p < 0.05$). However, this study that included 29,631 GP surgeries in the analysis for antibiotic prescribing, also found that GP surgeries located in the most affluent areas prescribed a higher proportion of broad-spectrum antibiotics than those located in the most deprived areas. However, the reasons for the high proportions of broad-spectrum antibiotics prescribed in more affluent areas, reported by Thomson et al. (2020) are unclear. Nevertheless, certain factors may contribute to how people living in affluent areas navigate the healthcare system; for example, they may have better access to emergency GP appointments, or access to out-of-hour primary care services where people are reported to receive more broad-spectrum antibiotics (Curtis et al., 2019). Although Thomson et al., (2020) assessed the amount of antibiotics prescribed per area, they did not consider whether the prescription was appropriate, nor did they consider the characteristics of the patients for who the antibiotics were prescribed; therefore, conclusions regarding why a higher proportion of broad-spectrum antibiotics were prescribed in more affluent areas is challenging to make.

The frequent use of broad-spectrum antibiotics is not only considered to favour the development of ABR (Cižman & Plankar Srovin, 2018; Dunning, 2023), but it is also reported to increase complications and mortality in patients who are treated with unnecessary broad-spectrum antibiotics (Rhee et al., 2020; van Werkhoven et al., 2021; NHS, 2023; Rafey et al., 2023). Based on findings from both Allen et al.'s (2020) and Miller et al.'s UK studies suggesting that areas having more deprivation, ethnic minority communities, and pressure on GP surgeries, have higher rates of broad-spectrum antibiotic prescribing, as well as studies that have reported increased antibiotic prescribing in areas with higher deprivation levels (Mölter et al., 2018; Devine et al., 2022; Zhong et al., 2023), it can be expected that broad-spectrum antibiotics would be prescribed unnecessarily in certain areas of GM given its ethnic profile, levels of deprivation, and health inequalities. Broad-spectrum antibiotics should be prescribed with care, particularly for children, as these antibiotics have damaging effects on the human microbiota, causing dysbiosis, which could eventually cause further metabolic and immune disorders (Melander et al., 2018; Alm & Lahiri, 2020; Elvers et al., 2020) (mentioned previously in section 2.3.1).

2.5.1.2 Lack of knowledge and understanding on antibiotic usage

A major issue regarding the inappropriate use of antibiotics in health care settings are the misconceptions that exist among the general public regarding appropriate antibiotic usage (Cabral et al., 2015; Dyar et al., 2018; McNulty, Collin & Cooper et al., 2019; Sobeck et al., 2021; Hawkins et al., 2022). International and national research have evidenced significant gaps in the public's knowledge and understanding of antibiotic therapy guidelines, how ABR occurs, and ABR consequences (Roope et al., 2018; McNulty et al., 2019; Anderson, 2020; Bianco et al., 2020; Sobeck et al., 2021; Guo et al., 2022; Hawkins et al., 2022). Table 6 below briefly described what the public are expected to know about antibiotic, antibiotic use, and

ABR, based on public health information provided by the CDC (2021), the NHS (2022), and Cleveland Clinic (2024).

Table 6: Summary of what the public should know about antibiotics, antibiotic use, and ABR.

ABR topics	Information on antibiotics, usage, and ABR that the public should know
What are antibiotics?	Antibiotics are drugs that treat infections caused by bacteria in humans and animals.
What does antibiotic mean?	Antibiotic refers to any substance that stops bacteria from growing or kills bacteria.
How do antibiotics work?	Antibiotics work by killing bacteria or stopping them from multiplying. For example, antibiotics can destroy bacterial DNA or cell wall, which is crucial for bacteria to survive, which causes the bacteria to die. Antibiotics can also inhibit the growth of bacteria by preventing them from making certain proteins necessary for multiplication.
What do antibiotics treat?	Antibiotics only treat certain infections caused by bacteria. Some examples are: <u>Skin and soft tissue infections:</u> Cellulitis, Gas gangrene, Impetigo, Infections from animal bites, Necrotizing fasciitis etc. <u>Infections of the throat and respiratory system:</u> Bacterial pneumonia, Strep throat, Whooping cough, tuberculosis etc. <u>Infections in the urinary system and reproductive system:</u> Gonorrhoea, chlamydia, syphilis, UTIs, pyelonephritis, cystitis, bacterial vaginosis. <u>Eye infections:</u> Pink eye, blepharitis, keratitis, orbital cellulitis etc. <u>Other conditions:</u> Anthrax, endocarditis, Lyme disease, sepsis due to a bacterial infection
What don't antibiotics treat?	Antibiotics do not work on viruses. Therefore, they are useless to treat: Colds, flu, most sore throats (except strep throat) etc.
Are antibiotics necessary for all bacterial infections?	Antibiotics are not needed for some common bacterial infections, including: many sinus infections and some ear infections, as they are self-limiting infections, i.e., infections that will get better on their own.
What are the side-effects of antibiotics?	Anytime antibiotics are used, they can cause side effects. Side -effects can vary from minor to severe, and can include: Minor side-effects: Rash, nausea, diarrhoea, yeast infection, loss of appetite, stomach discomfort, etc. Severe reactions may lead to: Skin blisters, swelling of face, lips, tongue or throat, breathing problems including wheezing.

	More serious side effects include: *C. difficile* infection, which causes diarrhoea that can lead to severe colon damage (toxic megacolon) and death.
Can antibiotics cause allergic reactions?	Antibiotics can cause allergies (especially with penicillin and cephalosporins), which range from mild to severe. Symptoms include: hives, coughing, wheezing, tightness of throat, difficulty breathing, anaphylaxis.
What are the benefits of antibiotics?	Antibiotics have many benefits. They can successfully clear bacterial infections, ease symptoms, speed recovery, prevent the spread of infection, prevent serious illness and complications, prevent infections during surgeries, and save lives.
Why is it important to take antibiotics only when necessary?	Anytime antibiotics are used they can cause side effects and contribute to antibiotic resistance, one of the most urgent public health issues. When antibiotics are necessary, their use and benefits outweigh their risks (side-effects and ABR). However, when antibiotics are over-used and/or misused their use is threatened.
What is unnecessary antibiotic use?	Unnecessary antibiotic use happens when patients are prescribed antibiotics unnecessarily, for example for viral infections such as for colds and flu; or for bacterial infections that do not need antibiotics, such as sinus infections and some ear infections.
What is misuse of antibiotics?	Misuse of antibiotics happens when a person is prescribed the wrong antibiotic, the wrong dose of an antibiotic, or is given an antibiotic for the wrong length of time.
How should antibiotics be taken?	If antibiotics are prescribed, they should be taken as recommended by the healthcare provider who prescribed it. Antibiotics should not be shared, should not be saved for later, and should not be taken if they were prescribed for someone else. If antibiotics are not taken properly, they can delay treatment of the infection, make patients sicker, or cause side-effects.
What will happen if antibiotics are taken for a viral infection?	Taking an antibiotic for a viral infection will not cure the infection, will not prevent the spread of the virus, and will not help people feel better. Taking antibiotics for a viral infection will cause needless and harmful side effects. The antibiotic will attack the microbiota and kill helpful bacteria that are needed in the body. Using antibiotics unnecessarily will also promote antibiotic resistance.
What is antibiotic resistance?	The development of bacterial resistance to antibiotics is normal and expected. However, when antibiotics are overused or misused, the drugs affect how quickly and to what degree ABR occurs. When bacteria display resistance to antibiotics, this protects them from the drug's effects on the bacteria. Bacteria that survive antibiotic treatment can multiply and pass on drug-resistant properties to other bacteria.
What are the consequences of ABR?	ABR cause problems healthcare systems around the world. Antibiotic resistant infections cause millions of infections yearly around the worl, and results in thousands of deaths. Furthermore, ABR cause more serious infections that are harder to treat, cause longer recovery time, more frequent or longer hospital stays, more expensive treatments, more pressure on healthcare systems due to increased visits.

(Adapted from: CDC, 2021; NHS, 2022; Cleveland Clinic, 2024)

Misconceptions about ABR and how to use antibiotics effectively can lead to patients taking the drugs inappropriately, not completing the required treatment regimen advised by their doctor, skipping doses, and even sharing the remaining antibiotics with others, which can speed up the spread of ABR (Dyar et al., 2018; McNulty et al., 2019; Bianco et al., 2020; Mallah et al., 2021). These misconceptions can also lead to patients pressuring general practitioners to prescribe antibiotics even when it is not necessary (Cole, 2014; Cabral et al., 2015; Fletcher-Lartey et al., 2016; Salm et al., 2018; Vazquez-Cancela et al., 2021).

Studies have found education level was a predictor of good knowledge and understanding about antibiotics and ABR (Anderson, 2018; Salm et al., 2018; McNulty et al., 2019; Bianco et al., 2020). As there are strong associations between low levels of knowledge and misusing antibiotics (Salm et al., 2018; Bianco et al., 2020; Mallah et al., 2021), improving health literacy could improve antibiotic usage (Salm et al., 2018; McNulty et al., 2019).

Health literacy is crucial for the understanding and use of public health information, necessary to make informed health decisions to promote and maintain good health and wellbeing in various settings across the life course (NHS, 2021; Schulz et al., 2022). Therefore, a health literate individual can make informed decisions based on various types of information, understand and comply with self-care instructions, plan and make lifestyle changes, consent to medical procedures, and participate in community dialogue regarding health and healthcare (Kyabaggue et al., 2022).

Health literacy has been defined in numerous ways, and there is a certain amount of discrepancy in the interpretation of this concept and how it is applied to public health interventions (Parker & Ratzan, 2019; Parnell et al., 2019; Urstad et al., 2022). Although there is consensus that it is an important and quickly changing concept, there is debate on how best to define health literacy given its complex and dynamic nature (Parker & Ratzan, 2019; Parnell et al., 2019; Liu et al., 2020; Nutbeam & Lloyd, 2021; Urstad et al., 2022).

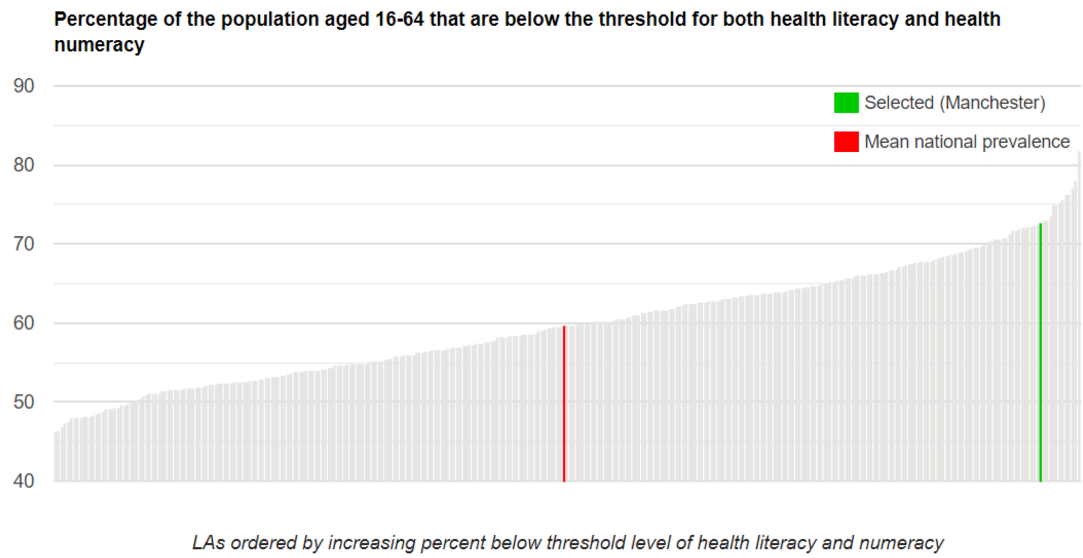
Nutbeam (2000) posited 3 levels of health literacy, basic/functional, communicative/interactive, and critical. Level one, basic/functional health literacy, involves having adequate literacy skills to be able to function well in daily situations (Nutbeam, 2000). Communicative/interactive health literacy, the second level, involves more advanced cognitive, literacy, and social skills, used to obtain and understand information from various forms of communication, to be able apply this information to various changing circumstance, and to actively participate in daily activities (Nutbeam, 2000). The final and highest level, critical health literacy, involves more advanced cognitive and social skills used to critically analyse information, which can be used to exert greater control over various daily life events (Nutbeam, 2000). Although Nutbeam's (2000) classification demonstrates how health literacy levels gradually allow for better autonomy and personal empowerment, and are dependent upon cognitive development, distinguishing between interactive and critical health literacy may be challenging, these definitions could benefit from clearer guidance as to how they can be applied practically (Urstad et al., 2022).

There is consensus that health literacy needs to be seen through a different lens, i.e. one that accurately addresses the involvement and accountability of health professionals and policy makers, rather than simply assigning the responsibility of health literacy to the individual (Parker & Ratzan, 2019; Parnell et al., 2019; Nutbeam & Lloyd, 2021). Most definitions of health literacy lay emphasis on individual capacities; however, it is important to note that there are various intrinsic and extrinsic factors that may affect individuals' health literacy levels, such as cultural background, physical condition, language barriers, doctor-patient communication, complexity of medical information provided, and support from medical and non-medical partners in the community (Parnell et al., 2019). Therefore, when discussing health literacy, emphasis should be placed on the bidirectional exchange between patients and healthcare providers, as well as its dynamic and changing nature as it can vary between individuals and across different situations (Hermsen et al., 2020).

There is a strong correlation between deprivation levels and low health literacy (Berkman et al., 2011; Eyal et al., 2013; Knighton et al., 2017; Jansen et al., 2018), which can affect the knowledge, understanding, and perceptions of people regarding ABR and the proper use of antibiotic drugs (Knighton et al., 2017; Protheroe et al., 2017; Salm et al., 2018; Bianco et al., 2020). Health literacy is defined as the ability of an individual to gain, process, and understand basic health information and to make adequate health decisions (PHE, 2015b; Knighton et al., 2017). People with low health literacy levels may struggle with understanding medical 'jargon', grasping health concepts, and engaging with health information and services (PHE, 2015b).

Low literacy levels have been shown to influence how people read, understand, and use health information, how they use health services, their involvement in clinical decision-making, their willingness to express health concerns, and compliance with medical advice and treatment (NHS, 2021; Kyabaggu et al., 2022; Schulz et al., 2022). They are also linked to low use of preventative services (e.g., screening and vaccinations), increased A&E attendance, unhealthy lifestyles, poor general health, and decreased life expectancy (NHS, 2021; NIHR, 2022). According to recent reports, more than 4 in 10 adults struggle to understand health information and more than 6 in 10 adults struggle with health information that includes statistics (NHS, 2021; NIHR, 2022). This is because a lot of the public health information available to the public are unintentionally developed for people with higher levels of health literacy (NHS, 2021). GM having higher deprivation levels compared to the national average (GMCA, 2020; Marmot et al., 2021), would be expected to also have lower health literacy levels (see Appendix 2), which could affect the public's knowledge and understanding of ABR, and their use of antibiotics (Castro-Sánchez et al., 2016; Salm et al., 2018; Hermsen et al., 2020). Approximately 72.6% of the population aged 16-64 are below the threshold for low health literacy and health numeracy in Manchester (see Figure 12), compared to the mean national prevalence (59.64%) (GeoData Institute, 2023).

Figure 12: Percentage of Manchester population aged 16-64 that are below the threshold for health literacy and numeracy, compared to the mean national prevalence.



(Source: GeoData Institute, 2023)

Low health literacy levels are more likely to be seen in communities with cultural and language barriers, and in people who have limited education, low income, are older, and live in deprived areas (measured by IMD) (Hickey et al., 2018; Chiu et al., 2020; NHS, 2021; NIHR, 2022); and could influence how patients communicate with healthcare professionals, obtain and understand health information, use health services, or engage with health promotion (Kyabaggu et al., 2022; NIHR, 2022).

International studies have shown that people displaying high levels of health literacy also show high awareness of ABR and antibiotics (Salm et al., 2018; Hemsen et al., 2020; Harani et al., 2021; Mostafa et al., 2021; Muflih et al., 2021). Muflih et al.'s (2021) cross-sectional study (n=194) in Jordan found that high levels of education and health literacy were substantially ($p<0.05$) associated with greater knowledge and awareness of ABR, and those with good health literacy levels had a better understanding of antibiotics (OR=1.37, p=0.017). Mallah et al.'s (2021) study (n=1,421) conducted in Lebanon, found that individuals who agreed that antibiotic treatment can be stopped after a few doses and that leftover antibiotics can be shared with relatives and friends, were five times more likely to misuse antibiotic compared to individuals whose knowledge and understanding of antibiotic use complied to guidance on the appropriate use of antibiotics. A cross-sectional study (n=2022), conducted in randomly selected households across England, reported that the less educated participants (those without formal education) had significantly less knowledge in all areas, including understanding of antibiotics and ABR (McNulty et al., 2022). Although McNulty et al. (2022) reported that education level was an independent determinant of knowledge about antibiotics, for example regarding the effect of antibiotics on the microbiome (p=0.001), they only provided limited information on how education is correlated to knowledge on ABR and antibiotic use. However, the study also reported that participants from ethnic minorities and lower social grades displayed less knowledge regarding antibiotics and less awareness on ABR (McNulty et al., 2022).

As there are strong associations between low levels of knowledge and misusing antibiotics (McNulty et al., 2019; Bianco et al., 2020; Mallah et al., 2021), improving health literacy could potentially improve antibiotic usage (Charani et al., 2021). A narrative review of public knowledge, attitudes, and perceptions of antibiotics use, found that level of education was positively correlated to the level of knowledge about antibiotics (Antwi et al., 2020). The review, which included studies from developed and developing countries, also found that better educated participants were able to identify unnecessary antibiotic prescribing and improper diagnosis (Antwi et al., 2020). A German cross-sectional study (n=2,000) found that individuals with insufficient health literacy were 0.57 times more likely to have a recent history of antibiotic use compared to individuals with sufficient health literacy (Salm et al. 2018). Interestingly, they also concluded that patients who had used antibiotics within the last 12 months had higher knowledge of antibiotics despite having low health literacy levels, as they were more likely to have fragmentary knowledge on antibiotics due to their recent involvement with the topic; therefore, health literacy could be a preventative mechanism to using antibiotics more critically (Salm et al., 2018).

Similarly, the uptake of vaccinations (as a public health intervention), has been extensively reported in the various studies conducted in the UK, with vaccine hesitance/resistance found to be higher among ethnic minorities, women, those with lower education levels, and those with lower socioeconomic status (Kadambari & Vendersloth, 2021; Murphy et al., 2021; Robertson et al., 2021). For example, a UK-wide longitudinal study (n=12,035) conducted during the COVID-19 pandemic, found that vaccine hesitancy was higher: in women than men (21% vs 14.7%), among young adults aged between 25-34 years old (28.3%) than other age groups, among those with GCSE level education (24.6%) compared to those with degrees (13.2%), and among Black (71.8%) and Pakistani/Bangladeshi (42.3%) ethnic groups (Roberston et al., 2021). Although this study provided evidence on the groups who are most likely to display vaccine hesitancy, the survey used was web-based which could have introduced selection bias, as only computer-literate members of the public would have participated. Furthermore, small numbers obtained for certain ethnic groups prevented detailed analysis of those groups.

People with higher socioeconomic status and higher education levels have been reported to have greater vaccine literacy and vaccination acceptance (Zeng et al., 2019; Cadeddu et al., 2021; Cascini et al., 2021; Rozek et al., 2021; Bono et al., 2022; Biasio et al., 2023). There is an increased prevalence among people of higher socioeconomic status to be vaccine hesitant/resistant (Aharon et al., 2017; Swaney & Burns, 2019; Kirbiš et al., 2023; Wand et al., 2023). Regarding antibiotic use, a systematic review and meta-analysis, looking at education level and misuse of antibiotics in the general population, found that in Europe high levels of education is associated with a 25% higher odds of antibiotic misuse (OR = 1.25, 95% CI 1.00, 1.58) (Mallah et al., 2022). Mallah et al. (2022) also found that high levels of education are associated with 41% higher odds of storage of antibiotics (OR = 1.41; 95% CI 1.22, 1.64). This indicates that limited health literacy may not only be restricted to people with low educational attainment.

The paradoxical link between vaccine scepticism, anti-vaccination attitudes and an individual's higher levels of education and income, can potentially be explained by the sociological concept of "healthism" (Swaney & Burns, 2019; Kirbiš et al., 2023), which frames the problem of health and disease as the responsibility of the individual (Crawford, 1980). Healthism is also known as "the beliefs, behaviour and expectations of the articulate, health-aware and information-rich middle-classes" (Greenhalgh & Wessely, 2004, page 197). Healthism attitudes are increasingly being seen among a subculture of socioeconomically privileged classes (middle- and upper-classes) who are increasingly wanting to exercise more control on their health, and who display relatively high levels of distrust of medical institutions and healthcare systems (Swaney & Burns, 2019; Kirbiš et al., 2023). Interestingly, critical health literacy (also considered as the highest level of health literacy) has been found to be related to healthism and have been associated with lower rates of vaccination (Aharon et al., 2017; Swaney & Burns, 2019; Kirbiš et al., 2023). Individuals with healthism beliefs tend to be university educated, inclined to seek health information from various sources including online, are more likely to spread misinformation, mistrust healthcare professionals, lack social responsibility, and reject high-impact health promotion interventions, such as vaccination interventions, under the guise of postmodern luxury medicine (Swaney & Burns, 2019; Kyabaggu et al., 2022; Kirbiš et al., 2023). Interestingly, healthism has been extensively discussed in the literature for public health issues such as vaccine uptake/hesitancy, obesity, physical activity, food choices, and smoking. However, there is a lack of studies that consider healthism with regards to antibiotic use and ABR.

2.5.1.3 Perceived patients' expectations and pressure on healthcare providers

Various factors, such as patient expectations and diagnostic uncertainty, influence the prescribing of antibiotic drugs (Borek et al., 2020; Devine et al., 2021; Hampton et al., 2021; Rose et al., 2021; Saliba-Gustafsson et al., 2021). A survey of more than 1000 GPs in the UK, conducted in 2014, found that more than half of the respondents (55%) felt under pressure from patients to prescribe antibiotics, even when the prescription was not necessary in their opinion (Cole, 2014). 45% of GPs prescribed antibiotics despite the knowledge that this treatment would not be effective, and 44% admitted to prescribing antibiotics to insistent patients so that they would leave the surgery (Cole, 2014). In 2015, NICE reported that 9 out 10 GPs in the UK felt pressured by their patients to prescribe antibiotics, and that 97% of the patients who requested antibiotic prescriptions were given them (NICE, 2015b).

Healthcare providers sometimes experience pressure from patients for unnecessary antibiotics, and eventually give in and prescribe the antibiotics, due to exhaustion or to avoid conflict (O'Doherty et al., 2019; van der Zande et al., 2019; Borek et al., 2020; Rose et al., 2021; Borek et al., 2022). For example, a qualitative review critically assessing published literature on drivers influencing over-prescribing by GPs in primary care, found that GPs experienced pressure to maintain a good relationship with patients (Rose et al., 2021). Other drivers that contributed to over-prescribing were to avoid risk and misdiagnosis in case of diagnostic uncertainty, to provide a satisfactory service in short consultation times, dealing with patient pressure and expectation, as well as lack of patient education and awareness (Rose et al., 2021). Similar findings have been found internationally, in both developing and developed countries, where physicians reported similar factors affecting how they prescribed antibiotics (Lum et al., 2018; Biezen et al., 2019; Kohut et al., 2019; Bisgaard et al., 2021; Tarrant et al., 2020; Saliba-Gustafsson et al., 2021). In a qualitative study (n=13) conducted in the Mid-West of Ireland, GPs complained about the pressure to prescribe antibiotics for private patients, i.e., patients who paid a fee for a GP consultation (O'Doherty et al., 2019). O'Doherty et al. (2019) mention the ethical challenge that may occur in the private health sector, where GPs may face a possible conflict between their duty to provide healthcare based on the best evidence, and meeting patient's expectations in order to maintain patient satisfaction and retaining these patients' custom. GPs also complained of the high expectations that some patients have, due to antibiotics being unnecessarily prescribed in the past by other GPs (O'Doherty et al., 2019). O'Doherty et al. (2019) suggest that this pattern of learned behaviour, could potentially undermine the GPs' decision not to prescribe antibiotics for self-limiting symptoms, and increase patient expectation of receiving antibiotics. Although this study was conducted in Ireland and had a small sample of participants which could have biased the results obtained, the findings reported in this study are potentially relevant for GPs in other settings who may face pressure from patients to prescribe antibiotics due to past experience and learned behaviours.

In their systematic review, Krockow et al.'s (2019) reported that although the prescription of broad-spectrum antibiotics can majorly contribute to ABR, it is often seen in practice as an attractive choice when treating patients who are subject to diagnostic uncertainty. Due to diagnostic uncertainty, the risks of negative patient outcomes, and the potential professional risks that may arise from failing to treat an infection properly or misdiagnosing a patients, GPs may choose to adopt a defensive approach to prescribing, i.e., prescribing antibiotics, particularly broad-spectrum antibiotics, just-in-case (Krockow et al., 2019). Prescribing broad-spectrum antibiotics is seen as involving low-risk and low-cost, the decision-making process involved in prescribing these drugs may be quick, thus avoiding the need for complex decision-making (Krockow et al., 2019). Interestingly, the findings from this systematic review, corroborate the later findings reported in Allen et al.'s (2022) longitudinal study (previously discussed in section 2.4.1.1), i.e. that that prescribing broad-spectrum antibiotics was considered quicker and easier for GPs working under pressure. These findings are of concern, given that GPs are at the forefront of antibiotic stewardship.

ABR may be considered a dilemma for healthcare providers, with patient welfare being their priority (Krockow et al., 2019; Tarrant et al., 2020). Antibiotic stewardship and the harmful impact of ABR on public health tends to be minor factor for some GPs while deciding whether to prescribe antibiotics (Hayhoe et al., 2018; Krockow et al 2019). Some clinicians believed that precautionary prescribing of antibiotics was more important in cases of diagnostic uncertainty, and superseded the potential contribution to ABR that precautionary prescribing may have (Krockow et al., 2019). Tarrant et al.'s (2020) qualitative study with prescribers (n=46) from 7 hospitals in 3 countries (Sri Lanka n=18, South Africa n=13, and UK n=15), found that although prescribers recognised the importance of responsible antibiotic prescribing and the tensions involved in balancing the interests of individuals and society, some minimised the risk of ABR and downplayed their role in this public health issue, prioritising their responsibilities towards their patients. This argument was used to justify precautionary prescribing, particularly broad-spectrum antibiotics, which was used under conditions of uncertainty rather than based on objective clinical evidence (Tarrant et al., 2020).

Diagnostic uncertainty, and fear of further health complications, has been an important factor mentioned in various studies about precautionary antibiotic prescribing for children. Clinicians, in these national (Cabral et al, 2015; Horwood et al., 2016) and international

(Lopez-Vazquez et al., 2012; Fletcher-Lartey et al., 2016; King et al, 2019) studies, prescribed antibiotics “just in case” due to diagnostic uncertainty and to protect themselves from medicolegal problems. In Horwood et al., (2016) qualitative study (n=28; 22 GPs and 6 nurses) conducted in the UK (6 GP practices, from a mixed of deprived and affluent areas – measured by IMD scores) GPs believed that it was better to prescribe antibiotics as a precaution for a child who may subsequently become seriously ill, or experience complications from their illness. This was particularly observed in less experienced GPs, who had less confidence in their diagnosis or who did not have enough experience with serious respiratory infections in children (Horwood et al., 2016). In this study, parents consulting multiple times for the same illness, would increase GP anxiety regarding the possibility of complications; GPs were more likely to prescribe antibiotics even in the absence of signs and symptoms that they would usually use to help their prescribing decisions (Horwood et al., 2016). Preserving a good relationship with parents and protecting themselves from medicolegal problems were reasons GPs gave for prescribing antibiotics even when not warranted (Horwood et al., 2016). These findings had also been previously reported in Cabral et al.’s (2015) cross-study analysis involving 3 primary qualitative studies in the South-West England and one systematic review. In Biezen et al.’s (2019) Australian mixed methods cross-sectional study (involving interviews with 20 GPs, and a survey and focus group discussions with 50 parents), fear of litigation was also reported, as clinicians felt that a misdiagnosis could potentially threaten their professional standing. In this study, GPs reported that barriers to reducing inappropriate antibiotic prescribing included parental pressure and expectation for antibiotics, parental lack of knowledge, diagnostic uncertainty, and time pressure during consultations (Biezen et al., 2019). However, the survey findings (looking at antibiotic knowledge, attitudes, and behaviours) in this mixed-methods study, contradict interview findings from the GPs; parents displayed good knowledge of respiratory tract infections, antibiotics, and antibiotic use in the survey used (Biezen et al., 2019). Survey findings showed that 66% (n=33) wanted management advice and reassurance, 22% (n=) wanted over-the-counter medication (not antibiotics), and only 8% (n=4) expected antibiotics (Biezen et al., 2019). A potential explanation for this contradictory finding could be that parents’ need for reassurance regarding their child’s illness and treatment may be construed as pressure to prescribe antibiotics, potentially indicating communication challenges during GP consultations (Biezen et al., 2019). Looking at the sample used in this study, most participants were women (94%, n=47), aged 31-40 years old (62%, n=31), were high earning (48%, n=24), and were university graduates (72%, n=36); no association was found between parental demographic characteristics and knowledge. Looking at Biezen et al.'s (2019) methodology, there is the possibility that response bias could have occurred, i.e., parents responding the way they think the researcher wants them to in the survey (acquiescence bias) and focus groups (social desirability bias or conformity bias), and/or that GPs interviewed provided answers they believed were socially desirable (social desirability bias).

Although the doctor-patient dynamic is complex, and there are many factors that can influence antibiotic prescribing during medical consultations. Other studies have also shown that most parents are not expecting or seeking antibiotics prescriptions for their child, but rather solutions and reassurance regarding their child's illness and/or symptoms (Biezen et al., 2019; Cabral et al., 2019; Bosley et al., 2021). Results from Cabral et al.'s (2019) mixed methods study, involving conversation analysis of 56 video-recorded consultations in GP practices in the South West of England, did not suggest any causal link between how parents communicated during consultations and antibiotic prescribing, and parents typically trusted and accepted the GPs recommendations and suggestions. Parents were recruited from 6 GP practices selected from a range of neighbourhoods including deprived and affluent neighbourhoods (no information provided on how this was deduced); parents and children were from both deprived and affluent neighbourhoods; and 36% of parents were of non-white ethnicity. As this study focused on parental communication patterns, associations between demographic characteristics (e.g., deprivation) and the influence of parent-clinician communication on antibiotic prescribing were not reported (Cabral et al., 2019). Bosley et al. (2021) also found that most mothers in their mixed-methods study (Southern England), trusted their GP's expertise, and wanted reassurance and advice rather than antibiotic treatment for their child. Mothers in this study were mainly White, British, educated to degree level and aged 26-35 years of age (Bosley et al. 2021). However, some mothers in this study also mentioned trying to persuade GPs to prescribe antibiotics to avoid return appointments, which could be due to inconvenience of getting another appointment, child-care issues, or employer pressure. This would be an interesting point to investigate further in the UK, where in 2018 ONS figures showed that 75.1% of mothers with dependent children were in work, 56.2% of working mothers admitted to having to change their employment for childcare reasons, and three out of ten mothers reported reducing their work because of childcare (ONS, 2018; ONS, 2019).

Studies conducted in the UK, Australia, Spain and India showed that parents expected their child to receive an antibiotic prescription, even if it was not warranted by the GP, as this would improve the outcome of the child's infection, shorten the duration of the symptoms, improve school attendance, reduce the likelihood of needing a re-consultation, and the potential financial impact that could occur if additional time off work was needed (Kotwani et al., 2010; Rooshenas et al., 2014; Fletcher-Lartey et al., 2016; Bosley et al., 2018; Hardman et al., 2021). However, most of these studies looked at antibiotic prescribing from GP perspectives. Bosley et al.'s (2018) systematic review found that some parents believed that antibiotics would improve recovery time; therefore, parents could avoid taking time off work, which would prevent loss of earnings, as well as childcare issues. This was also reported in Hardman et al.'s (2021) qualitative study conducted in the UK, where 18 parents (no demographic information provided) were interviewed regarding prophylactic antibiotic prescribing for various respiratory conditions experienced by their child. This study found that parents hoped antibiotic prescription would help prevent poor school attendance due to repeat infections, as well pressure from employers (Hardman et al., 2021).

Parents have been found to be encouraged to seek antibiotics by their childcare providers. For example, a Welsh mixed methods study (217 survey respondents [daycare providers]; 52 interviews with parents) found that day-care providers (DCPs) encouraged parents to consult GPs and seek antibiotics for their child through non-evidence-based policies and practices (Rooshenas et al., 2014). In this study, 91% of the DCPs reported advising parents to consult a GP for their child and 41% advised that their child may need antibiotic treatment (Rooshenas et al., 2014). To avoid the sickness-exclusion policies maintained by the DCPs, more than half of the parents interviewed mentioned consulting a GP for their child, and half of these parents reported requesting antibiotics to prevent exclusion and allow their child to be readmitted to day-care (Rooshenas et al., 2014). Antibiotic treatment was therefore perceived as a way to bypass exclusion periods for sick children (Rooshenas et al., 2014). Parents from 3 different nurseries mentioned that an antibiotic prescription would allow their child to be readmitted, despite having persisting symptoms; as long as they were following an antibiotic treatment (Rooshenas et al., 2014). Some parents in this study mentioned instances where GPs refused to prescribe antibiotics for their child as they were not warranted; other parents reported that some GPs sympathised with their predicament, and prescribed the antibiotics while also disclosing that antibiotics were not needed (Rooshenas et al., 2014). All parents in this study reported consulting a GP whenever their child was excluded from day-care due to an infection (Rooshenas et al., 2014). It is important to point out that this study is nearly 10 years old, and no recent studies corroborate these findings. However, various studies have reported external factors that could influence antibiotic expectation among parents (Kotwani et al., 2010; Fletcher-Lartey et al., 2016; Bosley et al., 2018; Biezen et al., 2019; Bosley et al., 2021; Hardman et al., 2021). Hence, this study is important to include, as it would be interesting to see whether similar findings would be seen if this study was replicated in a setting like GM, with high deprivation levels and unemployment rates.

Levels of deprivation was found to contribute to higher antibiotic prescribing in both van der Zande et al.'s (2019) and Borek et al.'s, (2019) qualitative studies exploring factors that GPs believed affected prescribing behaviours. Van der Zande's (2019) study, undertaken with 41 GPs working in the NW of England, explored these factors in low, high, and medium prescribing GP practices, and found that many GPs (from all prescribing groups) reported experiencing antibiotic expectations from parents, and that higher levels of deprivation resulted in higher antibiotic prescribing (van der Zande et al., 2019), which was also reported in Borek et al.'s (2020) qualitative study with 22 CCG and 19 GP professionals. Comparisons regarding the settings of these studies cannot be made as Borek et al., (2019) provides little information pertaining to their study's setting. High prevalence of infections, presence of comorbidities, difficulty in getting GP appointments, need for illness proof (e.g., sick notes), and overstretched practices, were all factors observed in more deprived areas (measured by IMD deciles for England), which contributed to high antibiotic prescribing (van der Zande et al., 2019). Van der Zande et al. (2019) also reported that prescribing antibiotics due to parental pressure was easier and quicker than not prescribing them and having to convince parents that they were not needed. Borek et al. (2020) found that ethnic minorities were perceived by clinicians as needing more antibiotics, who reported that patients' cultural and ethnic backgrounds influenced antibiotic expectations, in terms of health-related cultural norms or were difficult to reassure regarding their self-limiting infections, due to language barriers. The findings reported by both van der Zande et al. (2019) and Borek et al. (2020), are indicative of some of the problems that could impede antibiotic stewardship in other deprived areas of the NW. GPs working in practices in deprived areas reported staff shortages, large workloads, and time constraints, as issues that did not allow them to engage with antibiotic stewardship (van der Zande et al., 2019), similar trends may be observed in GM, and would be exacerbated by the NHS crisis.

Time pressure experienced by many healthcare professionals were reported to lead to antibiotic prescribing when dealing with anxious parents, even if the prescription was not warranted (Cabral et al., 2015; Horwood et al., 2019; Biezen et al., 2019; Rose et al., 2021; Allen et al., 2022). In the UK, GP consultation length is shorter than in many European countries, with the mean duration being 10.9 minutes (Gopfert et al., 2021). Shorter GP consultations are linked to higher deprivation and higher consultation rates, as GP surgeries in deprived areas tend to have shorter than average consultation times and increasing need and demand for healthcare services, compared to those in more affluent areas (Baird et al., 2016; Stevens et al., 2017; McCullum et al., 2019; Gopfert et al., 2021). GP workforce shortages are another factor impacting prescribing behaviours, which disproportionate affect more deprived areas of the country (Nussbaum et al., 2021), and are estimated to worsen within the next decade (Wise, 2022; Beech et al., 2023; Cooksley et al., 2023; Spooner et al., 2023; Williams & Pagel, 2023; BMA, 2024), likely furthering a decrease in antibiotic stewardship. GP consultation length, rushed consultations, communication issues, and a lack of GPS (Wise, 2022) are important factors to consider while investigating parents' knowledge, attitudes, and perceptions of ABR and antibiotic use, particularly in a setting like GM.

2.6 National and regional trends in antibiotic prescribing and antibiotics use

A critical discussion regarding trends in antibiotic prescribing and antibiotic use, at a national and regional level, is provided in the following sub-section.

2.6.1 National trends in antibiotic prescribing and antibiotic use

There has been continued progress in the reduction of antibiotic prescribing in primary care, which could reflect improvements in stewardship activities over the past 5 years (PHE, 2020c; UKHSA, 2021a; UKHSA, 2023).

The majority of antibiotics prescribed in England over the past 5 years were in GP settings; 72.7% in 2020, as shown in the figure above (UKHSA, 2021a), and the trend continued in 2022 accounting for 72.1% of overall antibiotic prescribing (UKHSA, 2023). Hospital inpatients accounted for 13.1% of the overall antibiotic prescribing, followed by hospital outpatients (6.7%), other community settings (4.4%), and dental practices (3.7%) (UKHSA, 2023). Between 2016 and 2019 a 10.4% reduction was seen, and a further 9.4% reduction was seen between 2019 and 2020 (UKHSA, 2021a). Although positive changes in antibiotic prescribing in general practice settings were observed between 2019 and 2020, there was a 17.6% increase in antibiotic consumption in dental settings, which may be due to a lack of access to dental care and services during the pandemic (UKHSA, 2021a). Between 2018 and 2022, total antibiotic consumption decreased by 5.3% in England from 18.3 Defined Daily Doses (DDDs) per 1,000 inhabitants per day (DID) to 17.4 DID. During the COVID-19 pandemic antibiotic prescribing decreased even more, from 18 DDD per 1,000 inhabitants per day in 2019 to 16 DDDs in 2020; there was a 10.9% reduction in antibiotic consumption (UKHSA, 2023).

The reduction in antibiotic prescribing and consumption in GP settings coincided with the COVID-19 pandemic and the public health and health promotion measures that were in place at the time. There were various factors that changed antibiotic demand and prescribing behaviours, for example changes in healthcare delivery, with fewer hospital admissions and face-to-face consultations in primary care (UKHSA, 2021a; UKHSA, 2023). Factors such as infection control measures (e.g., increased hand hygiene and increased sanitation) by healthcare professionals and the general population, reduced social contact and travel due to the lockdown, changes in healthcare seeking behaviours, and increased knowledge, have altered the transmission patterns and spread of infections, as well as the demand for antibiotic therapy (UKHSA, 2021a; Devine, O'Kane & Buholc, 2022; UKHSA, 2023). Post pandemic, with the easing of restrictions and healthcare services resuming, the antibiotic consumption trends also reflect this change; although total antibiotic consumptions continued to decrease between 2020 and 2021, the decline was smaller (0.4%) compared to that observed with pre-pandemic and pandemic levels (UKHSA, 2023).

As mentioned previously (section 1.3.1), the COVID-19 pandemic saw a change from face-to-face GP consultations to telehealth. The number of face-to-face appointments decreased from 8,758,600 in February 2020, to 2,783,535 in April 2020; simultaneously telephone consultations increased from 2,203,203 in February 2020, to 6,221,869 in August 2021 (Green et al., 2022). Vestesson et al.'s (2023) cohort study (with 600,000 patients from 400 English GP practices) estimated that between April 2021 and March 2022, 42% of remote consultations for children and 43% of face-to-face consultations for children led to an antibiotic prescription. For adults, 52% of remote and 42% of face-to-face consultations led to antibiotic prescribing (Vestesson et al., 2023). It was also reported that adults were 23% more likely (odds ratio [OR] 1.23, 95% CI: 1.18–1.29) to be prescribed antibiotics during a remote consultation, than if they had had a face-to-face consultation (Vestesson et al., 2023). No significant association was found between the type of consultations and the chances of antibiotics being prescribed (OR 1.04 95% CI: 0.98–1.11). The Commonwealth Fund's International Health Policy Survey of primary care physicians (2022) compared the experiences of primary care physicians in 10 countries (including 1,010 GPs from the UK) and found that in a typical week (between February and September 2022) on average a GP in the UK conducted 40% of their consultations face-to-face, 55% by telephone, and 5% by video (Beech et al., 2023). As reported by Vestesson et al. (2023), higher rates of antibiotic prescribing during remote consultations could be problematic for antibiotic stewardship if consultations remain multi-modal.

Post-pandemic, changes in the seasonality of infections were observed, with out-of-season increases in scarlet fever and iGAS infections (UKHSA, 2023). There were also increased amounts of co-circulating viral infections during the 2022 winter period, namely influenza, respiratory syncytial virus, and hepatitis linked to adeno-associated virus. This unprecedented increase in infections, caused by the circulating pathogens alongside reduced immunity, brought about by the various COVID-19 public health restrictions, led to an 8.4% increase in the total consumption of antibiotics in 2022 compared to 2021, although they still remained 3.8% lower than pre-pandemic levels (UKHSA, 2023).

Between 2021 and 2022 there was an increase in the use of almost all antibiotic groups, and the greatest increase was seen in penicillins with an increase in 0.82 DID in this period; primarily amoxicillin (+0.53 DID, +21.9), phenoxymethylpenicillin (+0.28 DID, +41.5%), and piperacillin/tazobactam (0.007 DID, +8.6%) (UKHSA, 2023). iGAS infections were unprecedentedly high in 2022 in children under 15 years, which exacerbated the demand for antibiotics (UKHSA, 2023). Interestingly, a peak in antibiotic prescribing for children aged between 0-14 years old was observed in direct response to the publication of interim clinical guidelines that encouraged a lower threshold for antibiotic prescribing (specifically penicillin V) in children who presented with sore throat or a RTI (UKHSA, 2023). This increase in demand for penicillin V (a narrow-spectrum antibiotic), and the subsequent increase in prescribing rates for this drug, led to stock shortages, which resulted in the prescribing of alternative antibiotics being prescribed for sore throat and RTIs (UKHSA). Hence, amoxicillin (a broad-spectrum antibiotic) prescribing increased by 221% in 2022 compared to 2021 (UKHSA, 2023). Guidance on antibiotic prescribing for children for the management of sore throat has now reverted to prior guidance (NICE Sore Throat [Acute] NG84 guideline), i.e., clinicians need to revert to their usual practice of prescribing antibiotics, as cases of GAS infection are now in line with infection rates observed in previous years (NHS, 2023).

Prior to the COVID-19 pandemic, the positive changes seen in the estimates for primary care prescribing levels demonstrated some success of antibiotic stewardship and interventions at primary care level (UKHSA, 2021a). However, trends in antibiotic prescribing vary widely from region to region in England (Covvey et al., 2013; Mölter et al., 2018; Thomson et al., 2020; Devine et al., 2022). Pre-COVID-19, some of the highest rates of antibiotic prescribing were seen in some northern areas of the country such as Northumberland and North Cumbria, whereas the lowest were seen in the southern regions of the country such as Oxfordshire, North Hampshire, Horsham and Mid Sussex (PHE, 2018b). According to the UKHSA (2021a) in 2020, the NW had one of the greatest levels of antibiotic consumption in England based on DDDs.

2.6.2 Regional variations in antibiotic prescribing

There are multiple factors that determine antibiotic prescribing, namely medical diagnosis or medical history, patient expectation, doctor-patient relationships, and area level drivers such as socio-economic deprivation (as discussed in section 2.4). Mölter et al.'s (2018) spatial pattern analysis of antibiotic prescribing rates in GP practices (n=7216) in England showed that on average areas that have higher antibiotic prescribing rates show higher deprivation levels (identified by IMD). Mölter et al. (2018) found that the areas with the highest numbers of antibiotic prescription rates were significantly more deprived in terms of employment rates, income, crime rates, education, and health outcomes. Their pattern analysis identified hot and cold spots of antibiotic prescribing, with hot spots being mostly found in the North of

England (Mölter et al. 2018). There are clear differences in levels of deprivation of the patient catchment between hot and cold spots, with GP practices in hot spots being high prescribing and serving more deprived patients (Mölter et al. 2018). These findings were corroborated by more recent similar studies conducted by Thomson et al. (2020) (see section 2.5.1.1) and McCloskey et al., (2023). McCloskey et al.' (2023) study, aiming to capture the time-series trends for common antibiotics prescribed (n=62,949,272) for respiratory and UTIs in GP surgeries (n=6,370) in England, reported a steady decrease in the antibiotic prescribing between 2014 and 2022. The study also looked at regional variations in deprivation and prescribing rates between seven NHS regions (East of England, London, Midlands, North East and Yorkshire, NW, South East and South West) and found that the most deprived areas (defined by IMD), i.e. the NW, had the largest number of deprived patients and they appeared to be prescribed antibiotic disproportionately compared to the other areas studied; the overall highest number of prescription per 100,000 were observed in the more deprived areas of the NW (56.3%), and North East and Yorkshire (26.7%), whereas the least deprived areas, e.g. the South East (12.5%), received fewer antibiotic prescriptions. The study also found that that the most deprived areas had by far the highest average monthly rate of antibiotic prescriptions (approximately 1450 prescriptions per 100,000 patients), while other less deprived areas exhibited a much lower average monthly rate of between ∼940 and ∼1040 prescriptions per 100,000 patients, indicating poorer health maintenance in less affluent areas (McCloskey et al., 2023). There was also a higher level of deprivation and antibiotic prescribing around major cities, and in the NW this was observed around Manchester, Liverpool, Sheffield, and Newcastle-upon-Tyne (McCloskey et al., 2023).

Similar findings were reported in studies conducted in Wales (Adekanbi et al., 2020) and Ireland (Devine et al., 2022) where antibiotic prescribing varied similarly by levels of deprivation. Higher prescribing rates in deprived areas could be due to people in those areas tending to consult more for infections or could reflect different GP prescribing behaviours (Adekambi et al., 2020). Factors such as high prevalence of infections, presence of comorbidities, and overstretched practices all contribute to high antibiotic prescribing in deprived areas (van der Zande et al., 2019; Adekanbi et al., 2020). Devine et al. (2022) also found that GP practices deprived rural areas (compared to urban) were associated with higher rates of antibiotic prescribing, as were areas with high percentages of the population aged over 65 years and under 15 years

The findings reported by Mölter et al. (2018), Adekanbi et al. (2020), Thomson et al. (2020), Devine et al. (2022), and McCloskey et al. (2023), provide good insight into how antibiotic prescribing is distributed across the country. However, policies, interventions and awareness strategies tend to be developed under the assumption that antibiotic prescribing trends are homogenously distributed across the country (Mölter et al., 2018). It is important to understand the various drivers of increased antibiotic prescribing in certain primary care settings, particularly in the more deprived areas where high rates of antibiotic prescribing have been observed, to give more insight into the development of antibiotic interventions and policies for a target population group (Mölter et al., 2018; Adekanbi et al., 2020; Thomson et al., 2020; Devine et al., 2022).

2.6.3 Local trends in antibiotic prescribing

Antibiotic prescribing trends in primary care across GM vary widely compared to other regions in England (Covvey et al., 2013; Mölter et al., 2018; Thomson et al., 2020; Devine et al., 2022), and differing trends between low and high-income areas with GM can be seen as well (OHID, 2023). Figure 13 highlights the total number of prescribed antibiotic items per 1000 resident individuals per day (twelve-month rolling). The areas with the highest total number of prescribed antibiotic items per 1000 resident individuals, were Wigan and Oldham, followed by Stockport, Bury, Manchester, and Bolton (OHID, 2021). It is important to note that these are the most deprived boroughs in GM (see Appendix 2) (PHE, 2020b). Trafford and Tameside, which are the least deprived boroughs in GM, have the lowest number of prescribed antibiotic items compared to the rest of the areas in GM (Figure 13) (OHID, 2021). Interestingly, Rochdale also has one of the lowest number of antibiotics prescribed (OHID, 2021).

Figure 13: Twelve-month rolling total number of prescribed antibiotic items per 1000 resident individuals per day (September 2021; Crude rate – per 1000/day)

Area	Recent Trend	Count	Value	95% Lower CI	95% Upper CI
England	→	24,305,436	1.22	-	-
Greater Manchester	↓	1,413,342	1.34*	1.34	1.34
NHS Wigan Borough CCG	→	173,103	1.43	-	-
NHS Oldham CCG	→	122,475	1.41	-	-
NHS Stockport CCG	→	150,355	1.40	-	-
NHS Bury CCG	→	96,738	1.39	-	-
NHS Manchester CCG	→	278,534	1.37	-	-
NHS Bolton CCG	→	140,713	1.34	-	-
NHS Salford CCG	→	125,479	1.31	-	-
NHS Trafford CCG	→	111,684	1.29	-	-
NHS Heywood, Middleton And Rochdale CCG	→	102,611	1.26	-	-
NHS Tameside And Glossop CCG	→	111,650	1.17	-	-

(Source: OHID, 2021)

There is a national target to reduce the use of broad-spectrum antibiotics such as the cephalosporin, quinolone, and co-amoxiclav classes (UKHSA, 2021a; UKHSA, 2023). According to quarterly prescribing data in GM published by OHID, the area with the highest percentage of prescribed antibiotic items from the cephalosporin, quinolone, and co-amoxiclav classes is Trafford (11.95% of all antibiotics prescribed are from these broad-spectrum antibiotics) (Figure 14) followed by Salford (10.25%) (OHID, 2021).

Figure 14: Twelve-month rolling percentage of prescribed antibiotic items from cephalosporin, quinolone and co-amoxiclav class (March 2022; proportion - %)

Area	Recent Trend	Count	Value	95% Lower CI	95% Upper CI
England	→	2,547,815	8.76	-	-
Greater Manchester	↓	138,572	8.35*	8.31	8.40
NHS Trafford CCG	→	15,470	11.95	-	-
NHS Salford CCG	→	15,161	10.26	-	-
NHS Wigan Borough CCG	→	20,173	9.59	-	-
NHS Manchester CCG	→	26,917	8.37	-	-
NHS Stockport CCG	→	13,958	7.72	-	-
NHS Heywood, Middleton And Rochdale CCG	→	9,257	7.63	-	-
NHS Tameside And Glossop CCG	→	9,222	7.56	-	-
NHS Oldham CCG	→	10,088	6.97	-	-
NHS Bolton CCG	→	10,971	6.68	-	-
NHS Bury CCG	→	7,355	6.31	-	-

(Source: OHID, 2021)

The areas with the lowest proportions of prescribed broad-spectrum antibiotics are Bury, Bolton, and Oldham (Figure 14) (OHID, 2021). This variation could be due to factors relating to different areas, such as greater GP practice size, greater proportion of patients older than

65 years or younger than 18 years, higher percentages of patients with long-term conditions, higher percentage of patients with co-morbidities, or simply the limitations with the availability of antibiotic prescribing data (Curtis et al., 2019). Variations in prescribing (e.g., greater proportion on broad-spectrum antibiotics prescribed in Trafford), could be due to hospitals in this are being more specialised in respiratory infections, UTIs, or cancer treatment, that would require the use of broad-spectrum antibiotics which are usually not used for first-line treatment, but rather in ICU or emergency medicine (e.g. cephalosporin used in ICU and co-amoxiclav is usually used in emergency medicine). Although there is consensus that high rates of broad-spectrum antibiotic prescribing are expected in deprived areas (as mentioned in section 2.4.3.1), Thomson et al. (2020) observed that GP surgeries in affluent areas prescribed higher proportions of broad-spectrum antibiotics (discussed in section 2.4.1.1). However, reasons for this remain unclear, although the researchers suggest that access to out-of-hour primary care services, where more broad-spectrum antibiotics are prescribed, could potentially explain this (Thomson et al., 2020).

Tackling the rise in antibiotic resistance while targeting a reduction in antibiotic prescribing is a complex public health challenge and the evidence suggests this should be done using a multi-level approach involving individuals, families, communities, healthcare facilities, national and global stakeholders (Tomson & Vlad, 2014; NICE, 2016; WHO 2021). Understanding the determinants of antibiotic resistance along with local and national dynamics is very important (Mölter et al., 2018).

The next section provides a critical discussion on the interventions that have been conducted in the UK to improve awareness on ABR and the proper use of antibiotics.

2.7 Review of interventions to improve knowledge and awareness on ABR and antibiotic use

Guidance on ABR awareness and antibiotic stewardship has been developed by many agencies and emphasise the need for interventions to improve the public's awareness on ABR; however, they do not provide recommendations on the specific components of such interventions (NICE, 2015; McParland et al., 2018; Price et al., 2018; Redfern et al., 2020; Parveen et al., 2022).

Evidence from various systematic reviews (conducted between 2015 and 2022), have shown that several multifaceted interventions have been conducted nationally and internationally to change the public's awareness of ABR, improve the public's antibiotic stewardship behaviours, and improve public engagement with ABR (McDonagh et al., 2018; McParland et al., 2018; Price et al., 2018; Lim et al., 2020; Van Katwyck et al., 2020; Parveen et al., 2022; Craig et al., 2023; Ghigha et al., 2023). However, the effectiveness of interventions that target the general public to engage with ABR awareness is mixed, as the public continues to show poor knowledge on antibiotic use and misperceptions regarding ABR (Price et al., 2018; Lim et al., 2020; Parveen et al., 2022; Ghigha et al., 2023).

The literature has shown that the overall levels of public knowledge and understanding of ABR are generally low, particularly regarding their potential contribution to the development and propagation of ABR through antibiotic misuse (McNulty et al., 2019; Anderson, 2020; Sobeck et al., 2021; Hawkins et al., 2022). However, heterogeneity can also be observed in the public's ABR knowledge and understanding, and variation in this aspect can be seen in both low and high-income settings (Salm et al., 2018; McNulty et al., 2020; Hermsen et al., 2020). It is important to note that there are currently no standardised ways of measuring the public's knowledge and understanding of ABR and stewardship-related behaviours (McDonagh et al., 2018; Price et al.; 2018; Parveen et al., 2023). Furthermore, McParland et al.'s (2028), Price et al.'s (2018), Ghigha et al.'s (2023), and Parveen et al.'s (2023) systematic reviews show consensus that a change in the public's awareness, knowledge, and beliefs, might not necessarily lead to the desired behaviour change among the targeted audience (the link between knowledge and behaviour change is discussed further on in this section). Therefore, it can be quite challenging to evaluate the effectiveness of these interventions (McDonagh et al., 2018; Price et al.; 2018; Ghigha et al., 2023; Parveen et al., 2023). Most of the interventions reported in this section sought to improve knowledge and awareness among participants, with some also focusing on also changing attitudes and behaviours.

Evidence provided, by the systematic reviews, shows substantial heterogeneity in the outcomes of the interventions, as they targeted different groups of participants, made use of various tools to aid in the delivery of the interventions, were delivered in a number of different settings, and in a heterogenous way (McParland et al., 2018; Price et al., 2018; Ghigha et al., 2023; Parveen et al., 2023). Most of the interventions did not have a theoretical basis informed by any behavioural change theory, which potentially affected the outcome of the interventions (McParland et al., 2018; Price et al., 2018; Atkins et al., 2020; Fletcher-Miles et al., 2020; Van Katwyk et al., 2020). Evidence from the literature highlight the need for multifaceted interventions that are informed by behavioural change theories, which could improve the outcomes of the interventions aimed at improving knowledge, understanding, attitudes, and perceptions on ABR and the use of antibiotics (McParland et al., 2018; Price et al., 2018; Fletcher- Miles et al., 2020; Atkins et al., 2020; Van Katwyk et al., 2020).

In the next section the evidence from a range of interventions conducted in the UK, to improve the public's knowledge and awareness of ABR, is reviewed (see Table 7); particularly interventions that aimed to improve the public's knowledge and behaviours with regards to antibiotic use, change their perceptions on antibiotic prescribing, and raise awareness and improve public engagement on ABR. Studies reporting on, or evaluating interventions aimed at improving the public's knowledge and understanding of AMR/ABR, awareness on AMR/ABR, and/or the proper use of antibiotics/antimicrobials were included, as well as interventions aimed at improving communication between patients and healthcare professionals, with respect to antibiotic use, and interventions conducted to improve public engagement with AMR/ABR. Only studies conducted in primary care and community settings were included, with those conducted in secondary care (e.g., hospitals) excluded.

Out of all the primary studies that aimed to improve public knowledge, attitudes, perceptions on ABR and antibiotic use, 26 were conducted in the UK (see Table 7). More than half of the interventions targeted the general public (n=16); 3 were in healthcare settings and involved healthcare professionals (Francis et al., 2009; Allison, Chapman et al., 2020; Hayes et al., 2021) and 5 involved the use of websites (Madle et al., 2004; Chaintarli et al., 2016; Roope, Tonkin-Crine et al., 2020; Chan et al 2021; Wilding et al., 2021). Of the total interventions, 8 were in school settings and involved children (McNulty et al., 2001; McNulty et al., 2007; Lecky et al., 2010; Farrell et al., 2011; Hawking et al., 2013; Young et al., 2017; Eley, et al., 2019; Hall et al., 2020). Parents were involved in 5 intervention studies, 1 of which was in a holiday resort (Lecky et al., 2014). Interactive workshops were used in 4 studies, 2 of which involved children (McNulty et al., 2001; Young et al., 2017), and 1 involved parents only (Van Hecke et al., 2020) (see Table 7).

Table 7: Summary of interventions conducted in the UK, to improve knowledge and awareness, public engagement, and behaviour change, regarding ABR and antibiotic use.

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
Interventions Based in a Healthcare Setting, and/or Targeting Patients or Parents of Paediatric Patients						
Communication Interventions in a Healthcare Setting	(Francis, Butler, Hood, Simpson, Wood & Nuttall, 2009) Effect of using an interactive booklet about childhood respiratory tract infections (RTI) in primary care consultations on reconsulting and antibiotic prescribing: a cluster randomised controlled trial.	Yes	Yes	No	No	Design: Randomised controlled trial (RCT) Setting: 61 general practices in England and Wales. Participants: 558 children (6 months to 14 years old) Method: Online training for GPs to use an interactive booklet on RTIs as a consultation aid (to increase doctor/patient communication). Booklet was also a take home resource for parents. Control group included clinicians who conducted their consultations without training or booklet. Results: Reductions overserved in antibiotic prescribing and consumption (22.4% in intervention vs. 43% in control; OR=0.35, 95% CI: 0.18 to 0.66) and in the proportion of parents who stated they would seek future medical consultations if their child presented with a similar illness again (55.3% in intervention vs. 76.4% in control; OR=0.34 [95% CI: 0.20 to 0.57]). No differences observed in parental satisfaction, reassurance about illness, parental enablement, or parents' perception of the usefulness of the information received about their child's illness. Limitations: participants may have altered their behaviour as a result of their participation in the study (social desirability bias). Selection bias could have occurred. Deprivation was not looked at in this study.
	(Allison, Chapman, Howard, Thornley, Ashiru-Oredope, Walker et al., 2020)	Yes	Yes	Yes (COM-B)	No	Design: Feasibility study Setting: 12 community pharmacies in 1 English locality Participants: 43 pharmacists and pharmacy staff Methods: Intervention involved an educational webinar for staff, and antibiotic checklist (AC) for patients and staff to fill in. The AC guided staff on what patients needed to know and

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	Feasibility of a community pharmacy antimicrobial stewardship intervention (PAMSI): an innovative approach to improve patients' understanding of their antibiotics					where their knowledge was lacking. In one month, 931 ACs were completed for an average of 40% of antibiotics dispensed. Results: 20% of patients did not know how long it would take them to feel better with antibiotics; 17% did not know whether they should take their antibiotics with or without food; 17% were unaware of side effects. Follow-up with patients/carers showed that they had followed advice given to them with the help of the checklist. Limitations: results are not representative of other areas in England, as on 12 pharmacies in one locality piloted the intervention Deprivation was not looked at in this study.
	(Hayes, Mahon, Sides, Allison, Lecky & McNulty, 2021) Empowering patients to self-manage common infections: qualitative study informing the development of an evidence-based patient information leaflet	Yes	Yes	Yes (Theoretical Domains Framework)	Yes	Design: Pre- post- mixed methods study Setting: not provided but conducted in the UK Participants: healthcare professionals (n=12) and patients (n=52) Method: Focus groups and online questionnaires were used to inform the development of a patient information leaflet. The leaflet provided advice and information on preventing infections, signs of illness, self-care advice for specific symptoms, and advice on when antibiotics can help certain infections. Results: All healthcare providers reported they were likely to use the leaflet with patients. Most ethnic minority patients reported that the leaflet provided all the information they would need to self-manage common infections. Participants also provided feedback on the design of the leaflet, including language used. Limitations: leaflet does not provide specific advice form patients (e.g. those with pre-existing conditions, therefore it might not be suitable as tool on its own. Sampling bias could

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						have occurred, as participants volunteered to participate. Only selected ethnic minorities as an inclusion criteria, did not look at education/literacy level, and socioeconomic status. Did not look at deprivation.
Interventions Based Within Primary or Secondary Schools and/or Targeting School Aged Children						
Educational Interventions Targeting School-aged Children	(McNulty, Swan & Boland, 2001) Schools' antimicrobial resistance: National Advice to the Public campaign – A pilot study.	Yes	No	No	No	Design: Pre- post- study Setting: State school in Gloucestershire Participant: 48 children (9-10 years old) Method: two-day workshop titled Antibiotics and Your Good Bugs and a questionnaire before and after the workshop was used to improve knowledge and understanding of antibiotics and normal bacterial flora. Results: workshop did improve knowledge on antibiotics 45% before and 73% after the workshops correctly answered all the questions on antibiotics ($p<0.0001$). Workshops improved knowledge that the normal flora could be killed by antibiotics (26 % before, 69% ($p=0.0001$)). Although the intervention effectively improved knowledge of microbes/infection, antibiotics, and appropriate antibiotic use, it did not have any effect on awareness of AMR. Limitations: This intervention may not be practical in another setting, such as in a more deprived area, with more limited resources. Some terms (e.g.: virus) used may have been too complex for the age group to understand which could create more confusion. Did not look at deprivation.
	(McNulty, Bowen, Gelb & Charlett, 2007) "The Bug Investigators": Assessment of a	Yes	Yes	No	No	Design: Pre- post- study Setting: Schools (Gloucestershire) Participants: 251 children (10-11 years old) Method: Use of "Bug Investigators" pack (comprising of information on microorganisms, antibiotics, and hygiene).

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	school teaching resource to improve hygiene and prudent use of antibiotics.					Questionnaires were given to the children before and after lessons using the pack. Results: increase in children's knowledge of antibiotics (27% improvement, CI: 22.8, 31.1) and how to use them (31% improvement, CI: 23.4, 37.7). Knowledge about resistant bacteria and "superbugs" (p=0.25) also increased a little. Limitations: Low response rate, and teachers found it challenging to incorporate the "Bug Investigators" pack to their teaching plans as it was not part of the National Curriculum. Students who participated in the study were from schools with relatively high science attainment levels, which could affect the generalisability of the study findings. Did not look at deprivation.
	(Lecky, McNulty, Touboul, Herotova, Benes & Dellamonica et al., 2010) Evaluation of e-Bug, an educational pack, teaching about prudent antibiotic use and hygiene, in the Czech Republic, France and England.	Yes	No	No	No	Design: Non-RCT study Setting: state schools in two regions of England (Gloucestershire and London), France (Nice and Bordeaux) and the Czech Republic (Prague and Ostrava) Participants: children; juniors (9-11 years old) and seniors (12-15 years old). 781 intervention group students and 416 control group students Methods: students in the control or intervention groups evaluated the e-bug educational programme. All students completed a questionnaire before, immediately after, and 6 weeks after the e-bug educational programme intervention, which focused on knowledge of prudent antibiotic use and hygiene. The intervention aimed to assess knowledge retention and change of children participating in the intervention. Results: Although the e-Bug educational pack used in the intervention showed significant improvement in the children's "knowledge of infection" in some countries/regions, such as in England and Czech Republic,

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						there was inconsistent evidence that the e-bug programme could effectively improve knowledge on AMR. In England (n=2136), knowledge of microbes, of how infections are spread, and how to treat and prevent infection did not differ much between junior school children (9- to 11-year-olds) who were exposed to the intervention, and the children in the control schools. However, there were varied improvements among senior school children (12- to 15-year-olds) following the intervention, and at six months follow up (p-values were not reported); for example, there was a 24.4% knowledge change (95% confidence interval) regarding treatment and prevention of infection. There was no significant difference in knowledge change and retention between the control and intervention groups. A possible explanation could be that knowledge in the control group improved as the students had to answer the same questionnaire 3 times. Limitations: High dropouts and teacher transferred to different schools during the intervention period affected the response rates, therefore control group was smaller. Did not look at deprivation.
	(Hawking, Lecky, Verlander & McNulty, 2013) Fun on the farm: evaluation of a lesson to teach students about the spread of infection on school farm visits.	Yes	No	No	No	Design: Pre- post- study Setting: 7 schools in 5 regions (NW, East Midlands, West Midlands, East of England, and South East) Participants: 210 children (9-11-years old) Methods: a free interactive lesson plan for teachers and an online resource to support students, about microbes and hygiene. Results: overall significant improvement in the percentage of correct answers from baseline (baseline scores for girls was 62% and 72% for boys) of 11% ($p<0.001$) in boys and 18% ($p<0.001$) in girls, regarding farm hygiene. Regarding

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						microbes, girls significantly increased their knowledge by 21% ($p<0.001$) from 58% correct questions at baseline, whilst boys increased knowledge by 14% ($p<0.001$) from 69% correct questions before No significant difference in knowledge between children from schools in rural areas compared to those in urban areas. Both girls and boys had similar post-intervention knowledge, however girls showed lower pre-intervention knowledge about microbes and hygiene compared to boys. Limitations: Potential non-random sampling bias. No schools from inner cities were included, therefore this may reduce generalisability of results. Knowledge retention was not tested. Did not look at deprivation.
	(Young, Cole, Lecky, Fettis, Pritchard, Verlander et al., 2017) A mixed-method evaluation of peer-education workshops for school-aged children to teach about antibiotics, microbes and hygiene.	Yes	No	No	No	Design: Pre- post- mixed methods Setting: 11 schools (South-West England). Participants: 476 students from secondary schools and 589 students from primary schools Methods: study evaluating peer-education workshops. Students completed questionnaires (before and after workshops) evaluating improvements in knowledge. The e-Bug science show was delivered to 20-30 students (peer educators), split into 5. They were then divided into groups and were trained on how to deliver the e-Bug science show to their peers. A training booklet was also provided. Interviews and focus groups were conducted to assess changes in participants' skills, confidence and behaviour. Results: improvement in knowledge was observed for all topics covered in the intervention, although this varied by region (improvement was greatest in rural schools and lowest in inner city schools). Peer-educators' knowledge increased

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						regarding antibiotic topics. Focus groups showed improvements in peer-educator skills and behaviour. Limitations: intervention is time consuming and may be challenging to implement. Study setting is not representative of other areas in England, therefore affecting representativeness. Did not look at deprivation.
	(Hall, Jones, Robertson, Hiley, Nathwani & Perry, 2020) 'The Mould that Changed the World': Quantitative and qualitative evaluation of children's knowledge and motivation for behavioural change following participation in an antimicrobial resistance musical	Yes	Yes	Yes (Theoretical Domains Framework)	No	Design: Pre- post- mixed methods study Setting: 2 Scottish primary schools Participants: 182 children (9-11 years) Method: musical intervention developed to engage children with AMR awareness. Online questionnaires were given before rehearsals began and at 2-weeks post-performance with a 6-month evaluation. Results: Children were more likely to answer questions on key messages of the musical correctly, at two weeks post-performance (response rate 88%, n = 161) compared with the pre-rehearsal questionnaire (response rate 99%, n = 180) (bacteria can become resistant to antibiotics OR=4.63, CI: 2.46–9.31 p<0.0001, antibiotic resistant infections can be life threatening OR=3.26 CI: 1.75–6.32 p=0.0001, prudent use of antibiotics will slow the rise of antibiotic resistant infections OR=2.16, CI: 1.39–3.38, p=0.0006). They also demonstrated long term knowledge gain with a consistent level of correct answers on key messages between two weeks and 6 months post musical. Focus groups were conducted before rehearsals began and 2-weeks post-performance. Children reported a greater understanding of the risks of overusing antibiotics and AMR and being motivated to influence their friends' and families' attitudes to antibiotics. Limitations: applying intervention may be challenging due to the time and resources required to practice and perform the

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						musical. It is impossible to assess whether changes in knowledge, attitude and engagement translated into behaviour change. Did not look at deprivation.
	(Hayes, Eley, Ashiru-Oredope, Hann & McNulty, 2021) Development and pilot evaluation of an educational programme on infection prevention and antibiotics with English and Scottish youth groups, informed by COM-B	Yes	Yes	Yes (COM-B)	Yes	Design: Pilot evaluation Setting: England and Scotland Participants: youth group leaders (n=14) and children from scout groups (n=232) Methods: participants were recruited to trial Antibiotic Guardian Youth Badge, which included learning through interactive e-Bug activities regarding infection prevention and prudent antibiotic use. Quantitative (questionnaire) and qualitative (open-ended questions) data was collected. Results: All leaders who delivered the intervention agreed that the topics covered were important for children to know. A high number of children reported that they would improve their hand-hygiene behaviours (99%) and encourage friends and family to do so as well (79%). Children (85%) also reported intentions to educate their families about antibiotics. Limitations: Quantitative findings were not properly reported. Convenience sampling was conducted; therefore, participants could not be selected based demographic characteristics, such as socio-economic status and ethnicity. Written questionnaires may not be feasible for younger children and verbal approach could lead to social desirability bias. Did not look at deprivation.
Intervention involving gaming and	(Farrell, Kostkova, Weinberg, Lazareck,	Yes	No	No	No	Design: Pre- post- study Setting: schools in Glasgow, Gloucester and London; and online

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
targeting school children	Weerasingh, Lecky et al., 2011) Computer games to teach hygiene: an evaluation of the e-Bug junior game.					Participants: 1736 children (9-15 years old); n=62 in schools & n=1674 online. Method: Use of a computer game (e-Bug, a Europe-wide antibiotic and hygiene teaching resource) developed to teach children about hygiene. To test increase in knowledge, a 'game show' quiz was included in the game. Results: The majority of participants did not show a change in the knowledge for the learning outcomes set within the game; except for 3 out of 21 learning outcomes, where players experienced a statistically significant change in knowledge ($p \leq 0.02$), regarding microbes ($p < 0.001$, $\chi 2 = 14.46$), their presence in the surrounding environment ($p = 0.02$, $\chi 2 = 5.60$), and the use of soap against microbes ($P = 0.02$, $\chi 2 = 5.28$). Limitations: High dropout rate (50% dropout after the first level of the game; more dropouts after subsequent levels), 652 players completed level 1, only 54 players completed level 5. Difficult to ascertain whether participants' knowledge gain was from their science lessons at school or from the e-Bug pack, as this information was not collected. Did not look at deprivation.
	(Eley, Young, Hayes, Verlander & McNulty, 2019) Young people's knowledge of antibiotics and vaccinations and increasing this knowledge through gaming:	Yes	No	No	No	Design: Pre- post- mixed methods study Setting: Schools in Gloucestershire, Buckinghamshire, and South Wales (included rural and urban schools) Participants: 473 students (aged 7-16 years [123 junior and 350 senior students]) Method: using 2 e-Bug games to improve knowledge on microbes, infection prevention, and antibiotics. Questionnaires on knowledge of the topics were completed before and after the playing the games. Focus groups were also conducted (n=26).

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	mixed-methods study using e-Bug.					Results: Baseline knowledge about antibiotics was low in junior and senior students (<40% and <67% correct responses, respectively). Significant improvement in knowledge ($P<.05$) was reported, about antibiotic use ($OR=2.88$, CI: 1.24-7.43; $p=0.01$), appropriate sneezing behaviours ($OR=4.00$, CI: 1.29-16.4; $p=0.01$), and vaccinations ($OR=3.00$, CI: 1.23-8.35; $p=0.01$) for both juniors and seniors. Positive knowledge change for juniors was greater compared to senior students, suggesting that the 2 games had a greater impact on junior student knowledge. Limitations: researchers report that a range of schools in various areas of the UK, with different levels of deprivation, were involved in the study; however, no information is provided regarding deprivation and how this was measured. Looked at deprivation, but no information provided.
Interventions Targeting the General Public						
Interactive Science Show/Event/ Workshop	(Lecky, Hawking, Verlander & McNulty, 2014) Using interactive family science shows to improve public knowledge on antibiotic resistance: does it work?	Yes	No	No	No	Design: Pre- post- study Setting: Holiday resort in England Participants: 406 parents (19 years and above) and children (5-11 years old) Method: Flyers were distributed to families at a resort, to advertise a science show involving a 3-minute presentation on microbes, and interactive stalls where information on microbes, hygiene, and antibiotic resistance, were offered to the families present. Questionnaires were distributed to participants before and after the science show. Results: marked improvement in antibiotic knowledge among the children, post intervention, with an overall increase in knowledge of 25% ($p<0.001$). For parents the impact was less marked; baseline knowledge for the adults were high (correct response at baseline for questions ranged from 52.4% to 95.4%), and the science show

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						showed no significant knowledge change among parents who attended the science show. Adults were less knowledgeable (52.4% correct response at baseline) regarding whether antibiotics could be used to treat viral infections. Limitations: Self-selection bias may have occurred as participants volunteered to participate. No information about whether knowledge change via the intervention had lasting effects. Did not look at deprivation.
	(Ahmed, Bashir, Brown, Cox, Hilton, Hilton et al., 2019) The drugs don't work: evaluation of educational theatre to gauge and influence public opinion on antimicrobial resistance	Yes	No	No	No	Design: Pre- post- study Setting: Museum (Birmingham) and a science festival (Cheltenham) Participants: the general public and students (n=242) Method: a play was developed regarding antibiotics and the consequences of antibiotic misuse. Questionnaires were distributed before and after the play. Questions were scored to evaluate whether the participants knowledge had improved. Results: knowledge had significantly changed regarding areas of microbiology ($p<0.0001$), antibiotics ($p<0.0001$), and the seriousness of ABR ($p<0.0002$). Findings also show that after the play, participants had lower expectations of receiving antibiotics for a sore throat. Limitations: Difficult to ascertain whether this type of intervention would have positive results if implemented in other settings and other areas (with higher deprivation levels). Also, this intervention does not seem to be accessible to people of different socioeconomic status, particularly if the setting is in a museum and science festival. Did not look at deprivation.
	(Van Hecke, Lee, Butler, Moore &	Yes	No	No	Yes	Design: Mixed-methods study Setting: Oxfordshire

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	Tonkin-Crine, 2020) Using evidence-based infographics to increase parents' understanding about antibiotic use and antibiotic resistance: a proof-of-concept study					Participants: parents Method: Phase 1 summarized antibiotic use for 3 childhood infections, phase 2 (n=8) involved the co-design of a series of evidenced-based infographics (EBIs) with parents, and phase 3 involved an online national survey of parents (n=998) including 8 EBIs. Results: Focus groups in phase 2 showed that parents found the EBIs novel, with a clear message. Parents in phase 2 were quickly overwhelmed when too much information was provided on the infographic. In phase 3, survey findings reported that nearly two-thirds of respondents found the information provided by the infographic to be novel (median 63%, IQR 59%–67%); 40% reported that their perceptions of antibiotic use for their child had somewhat changed, 32% reported that their perceptions had definitely changed, 45% found the infographics very useful. EBIs improved knowledge by more than a third across the board (34%, $P < 0.001$). Limitations: Participants were mostly of white ethnicity (85%) and Female (70%). Social desirability bias regarding what participants' behaviours with regards to antibiotics. Convenience sampling was used; therefore, survey was limited to those with interest in the subject and internet access. Did not look at deprivation.
	(Tyrrell, Conlon, Aboklaish, Hatch, Smith, Mathias et al., 2022) "Superbugs": raising public awareness of antimicrobial	Yes	No	No	Yes	Design: Public engagement event Setting: large shopping centre in Wales Participants: general public (n=6,566) and young antibiotic resistance champions (n=1,626) Method: study aimed at providing an interactive and immersive microbiology experience for participants. Primary school children and parents were also involved in the development of the material used in the pop-up science shop.

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	resistance through a pop-up science shop.					Schools attended by child participants were mapped by the Welsh Index of Multiple Deprivation (WIMD) based on the geographical location; most participants were from least deprived areas (57.8%). Results: Researchers reported a significant increase in knowledge and understanding of AMR; 91.7% indicated that they had a better understanding after the event. Improvement was observed in the knowledge of microbes (92.7% of cases), antibiotics and how they work (92.5% of cases), and antibiotic resistance (91.7% of cases). Limitations: Baseline knowledge was not reported. Difficult to ascertain whether knowledge and understanding improved. Data collected was mostly regarding the engagement event and its components, rather than whether knowledge was imparted effectively. Study was reported in a confusing way, with not much quantitative data. Did look at deprivation. Measured deprivation by mapping participants' schools with the WIMD, to evaluate whether the intervention reached a wide demographic, beyond cohorts who usually engage with scientific research.
	(Eley, Young, Hayes, Parkinson, Tucker, Gobat et al., 2018) A mixed methods pilot of Beat the Bugs: A community education course on hygiene, self-care and antibiotics.	Yes	Yes	No	No	Design: Pre- post- evaluation mixed methods study Setting: community learning environment and children's community centre in the England Participants: 12 adults with learning, physical and/or mental health difficulties and young parents Method: "Beat the Bugs" 6-session course were conducted in Questionnaires were completed by the participants before and after each session. Questionnaires for each learning environment were designed to suit participant ability. 2 participant focus groups and 2 course leader interviews were conducted to explore retention of knowledge and views on the course.

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						Results: Questionnaire results showed improvement in participant knowledge; a significant ($p< 0.05$) improvement in knowledge was seen in every session except Food Bugs which was approaching significance ($p=0.06$). Focus groups and interviews showed that participants had retained knowledge. A positive behaviour change was also reported, including an increase in appropriate handwashing behaviour. Limitations: Behaviour change was self-reported rather that measuring actual behaviour change; therefore, social desirability bias could have occurred. Small sample size. Not much quantitative data reported. Did not look at deprivation.
	(Hayes, Eley, Brown, Syeda, Verlander, Hann et al., 2020) Improving educator's knowledge and confidence to teach infection prevention and antimicrobial resistance.	Yes	Yes	No	No	Design: Pre- post- study Setting: 7 regions of the UK (Belfast, Birmingham, Glasgow, Gloucestershire, South Gloucestershire, Manchester, and Norfolk). Participants: 262 educators (46% primary, 17% secondary, 2% college, 29% healthcare, and 7% community) Method: to evaluate and educational intervention using surveys. 13 workshops were organised by PHE and conducted with participants being educators. Workshops consisted of teaching infections prevention and control and AMR, using e-Bug, and interactive demonstrations and activities. Knowledge and confidence surveys were completed before and after the workshop. Results: Questions around antibiotics had >88% correct knowledge. Knowledge of the questions about microbes improved from 74% to 89.3%, as well as questions on handwashing (45.3% to 89%). There was a significant improvement ($p < .05$) in participants' confidence to teach all topics; for example, 86% of primary educator felt confident to teach all topics. A difference in confidence change

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						between educator types was observed. Primary and community educators improved the most. Limitations: Due to an imbalance in the sample sizes of the types of educators, uncertainty in statistical analyses may have occurred, and may prevent generalisability. Did not look at deprivation.
Web-based Educational Intervention	(Madle, Kostkova, Mani-Saada, Weinberg & Williams, 2004) Changing public attitudes to antibiotic prescribing: can the internet help?	Yes	No	No	No	Design: Pre- post- study Setting: Science Museum in London Participants: general public (n=277) Method: using a website on AMR with frequently asked questions and facts about AMR and antimicrobial drugs. The aim of the website was to offer current information and guidelines on antimicrobial prescribing and AMR, and to provide links to resources for more intervention, so as to eventually reduce patient pressure on doctors and antimicrobial prescribing. Participants were asked to complete a questionnaire before and after using the website. Results: was significant improvement in knowledge on AMR and use of antimicrobial drugs; for example, 46% (n=81) correctly stated that people cannot become resistant to antibiotics after using the site, compared with 10% (n=17) of users before using the site, which is an increase of 36% ($p<0.001$, $\chi2 = 60.357$, 95% CI of change 27.47 to 44.53). The health information website also significantly improved peoples' attitudes towards prescribing; for example, before using the website 51% (n=90) believed that doctors should prescribe antibiotics for acute otitis media, but after use this decreased to 33% (n=58). The mean score decreased from 3.33 to 2.84, a change of –0.49 ($p<0.001$, 95% CI of difference in means –0.72 to –0.26). A little over a quarter of the health professionals who answered the questionnaire were misinformed about AMR before using the website and

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						believed that people could not become resistant to antibiotics. also significantly improved peoples' attitudes towards prescribing (i.e., expectation of being prescribed antibiotics for acute otitis media decreased). Limitations: Difficult to ascertain whether knowledge and attitude changes were due to passive or active learning while using the website. Only the immediate impact of the website was evaluated. Sample was not representative of the general population in the UK, as it was conducted in a museum setting (with participants having a high level of education) and almost a quarter of respondents were doctors. Did not look at deprivation.
	(Chaintarli, Ingle, Bhattacharya, Ashiru-Oredope, Oliver & Gobin, 2016) Impact of a United Kingdom-wide campaign to tackle antimicrobial resistance on self-reported knowledge and behaviour change.	Yes	Yes	No	No	Design: Cross-sectional study Setting: Online (UK) Participants: antibiotic guardians (n=2478) Method: to evaluate the impact of the Antibiotic Guardian (AG) campaign. Antibiotic guardians completed a survey (68.4% were healthcare professionals & 31.6% were members of the public). Results: 96.3% of respondents had prior AMR knowledge. Findings showed that members of the public were more likely to act in line with their pledge compared to professionals (OR =3.60, 95% CI: 2.88-4.51). 44.5% of participants reported acquiring more knowledge about AMR post-campaign, and participants who reported being confused about AMR prior to the campaign, reported getting more knowledge post-campaign (OR=3.10, 95 % CI: 1.36-7.09). Limitations: participants self-reported changes in behaviour and knowledge gain; therefore, acquiescence bias could have occurred. Demographic groups that have limited access to the internet could be under-represented. Did not look at deprivation.

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	(Roope, Tonkin-Crine, Herd, Michie, Pouwels, Castro-Sanchez et al., 2020) Reducing expectations for antibiotics in primary care: a randomised experiment to test the response to fear-based messages about antimicrobial resistance	No	Yes	No	No	Design: Pre- post- randomised experiment Setting: Online panel (UK) Participant: general public (n=4000) Method: participants were randomised to receive 3 different messages about antibiotic use and AMR, designed to induce fear about AMR to varying degrees. Researchers wanted to test whether fear-based messages, containing empowering information about self-management without antibiotics, would be more effective than fear alone. Results: in terms of novelty, the 'fear-only' message was new to 28.5% of respondents, 'mild-fear-plus-empowerment' was new to 22.4%, and 'strong-fear-plus-empowerment' was new to 25.9% (p=0.002). Among those who found the messaging new, only those who received the 'strong-fear-plus-empowerment' message stated they would be less likely to request antibiotics if they visited a doctor for a flu-like illness (p< 0.0001; 46.9%). For those who did not find the information new, they stated that they would be less likely to request antibiotics for flu-like illness (p<0.0001) across all messages. Findings show that fear, combined with empowering messages on managing symptoms without antibiotics, could be effective in public campaigns to reduce inappropriate antibiotic use. Limitations: Reported intentions may differ from actual behaviour. Sample was limited to those with internet access, basic computer literacy, and those who are interested in completing surveys; therefore, other population groups may have been underrepresented (Sampling bias). Did not look at deprivation.
	(Chan, Horne, Lycett, Raebel,	Yes	No	No	No	Design: Pre- post- online study Setting: online survey network (Amazon mTurk) in the UK

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	Guitart, Wildman et al 2021) Changing patient and public beliefs about antimicrobials and antimicrobial resistance (AMR) using a brief digital intervention					Participants: general public aged above 18years (n=100). Method: Participants were presented with a hypothetical scenario of cold and flu symptoms. The online intervention comprised of a message designed to change participants' beliefs regarding inappropriate demand for antibiotics and improve awareness and knowledge on antibiotics. Results: A significant change in beliefs regarding antibiotic expectation and demand was observed after the intervention, with a decrease in beliefs about antibiotic necessity (scores reduce by 2.29 points; t-test=7.254; p<0.0001), an increase in antibiotic concerns (mean difference in scores pre- and post-intervention of 0.930; t-test=−7.214; p<0.0001), and increases in antibiotic and AMR knowledge (increase in scores by 1.08; t-test=−4.651; p<0.0001). Limitations: Sample was limited to those with internet access, basic computer literacy, and those who are interested in completing surveys; therefore, other population groups may have been underrepresented (Sampling bias). Study was conducted over a short timeframe and followed up occurred immediately after intervention exposure; hence, it is unknown whether the effects seen in this intervention are sustainable in the long-term. Sample size was small. Did not look at deprivation.
	(Wilding, Kettu, Thompson, Howard, Jeuken, Pownall et al., 2021) Development and randomized controlled trial of	Yes	Yes	Yes (COM-B)	No	Design: RCT Setting: Online recruitment website (Prolific) Participant: UK general public (n=417) Method: use of an animated film to reduce antibiotic expectation and acquiring behaviours among patients. Results: The majority of the participants in both groups agreed that the film was informative. After the film 87% of the people from the Intervention group reported that they

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	an animated film aimed at reducing behaviours for acquiring antibiotics					would not ask for antibiotics, compared to 81% in the control group. Furthermore, 3.8% of participants in the intervention group intended to ask for antibiotics, compared to 7.9% in the controlled group. Those in the intervention group had significantly higher knowledge scores ($p < 0.01$) than those in the control group, after the film. After 6 weeks, follow-up showed that the knowledge gained during the intervention remained; however, intentions not to expect or ask for antibiotics had decreased. Limitations: majority of participants were female and of White ethnicity, which introduces challenges regarding study generalizability. Study needed more demographic diversity. Participants were already well informed about the issue, so results may be different in other population groups. Sample was limited to those with internet access, basic computer literacy, and those who are interested in completing surveys; therefore, other population groups may have been underrepresented (Sampling bias). Did not look at deprivation.
Mass Media (Adverts in Magazines and Newspapers, Posters and Leaflets) Interventions	(Parsons, Morrow & Underwood, 2004) Did local enhancement of a national campaign to reduce high antibiotic prescribing affect public attitudes and prescribing rates?	Yes	No	No	No	Design: Pre- post- study Setting: London borough of Barking and Degenham Participants: (1999 n=982, 2000 n=1941) Method: locally enhancing a nationwide public education campaign known as CATNAP (Campaign on Antibiotic Treatment and the National Advice to the Public) to promote the importance and need to preserve normal bacterial microbiota. Postal questionnaires were used to assess the public's attitudes before and after the local campaign. Results: no significant change in the public's knowledge of appropriate antibiotic use and attitudes towards antibiotic prescribing in an area of high prescribing. There was no significant change in the questionnaire results pre- and post-

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
						local campaign, and there was significant misunderstanding regarding antibiotic use for viral infections. However, the proportion of adults who agreed that children should be prescribed antibiotics for fever significantly decreased, 56% to 49%, decreasing by 7% in the follow-up survey (95% confidence limit 13.5%). Limitations: low response rate was obtained from the postal questionnaires. Sample was limited to those who were interested in completing surveys; therefore, results represent those views rather than the population as a whole (Sampling bias). Difficult to determine participants' exact exposure to the campaign and its messages. Did not look at deprivation.
	(Lambert, Masters & Brent, 2007) Can mass media campaigns change antimicrobial prescribing? A regional evaluation study	Yes	Yes	No	No	Design: Retrospective controlled before and-after study Setting: North East England Participants: General public Method: 2 sequential mass-media campaigns (newspapers, TV, and radio, posters & leaflets) were run between from winter 2004 to winter 2005, on the appropriate use of antimicrobial drugs. The campaigns coincided with flu season. Results: volume of antibiotics during the winter months of the intervention period (2004-2005) significantly reduced, where 21.7 fewer antibiotic items were prescribed per 1000 population ($p<0.0005$) for the intervention populations, which was equivalent to a 5.8% reduction in antibiotic prescribing during the intervention period. Limitations: Difficult to identify which component of the mass media campaigns was most effective at reducing antibiotic demand and prescribing, and whether the effects of other media campaigns from other interventions influenced the results obtained. Did not look at deprivation.

Type of Intervention	Authors & Title	Improving Knowledge/ Awareness	Behaviour Change	Behaviour Change Theories/ Models	Participatory Approaches	Effectiveness
	(McNulty, Nichols, Boyle, Woodhead & Davey, 2010) The English antibiotic awareness campaigns: did they change the public's knowledge of and attitudes to antibiotic use?	Yes	No	No	No	Design: Pre- post- study (with controlled post-intervention) Setting: England & Scotland Participants: members of the public (≥15 years old), n=1888 in 2008 [England=1706, Scotland=182]; n=1830 in 2009 [England=1707, Scotland=123]). Method: participants were interviewed about their attitudes toward antibiotics and antibiotics use. Results: that there was a small increase in recollection of the posters used in public health antibiotic campaigns (2009 23.7% compared to 2008 19.2%; p=0.03). No knowledge and understanding improvements were observed in either England or Scotland regarding antibiotic use and the lack of benefit of using antibiotics to treat viral infections. Reported antibiotic use did not improve, and there was a significant increase in the number of respondents keeping leftover antibiotics (from 2.2% to 7.0%, p≤0.0001). Limitations: study showed little evidence that the 2008 English public antibiotic poster campaigns were effective and had no impact on the antibiotic use and attitudes. Surveys relied on self-reported behaviour therefore bias could have occurred (acquiescence bias). Although distribution of campaign material, by a third party, to GPs and pharmacies, was commissioned by the Department of Health, this was not audited and the number or pharmacies and GPs that used and displayed the material remains unknown. Therefore, poor recollection could be either due to the materials used or because the materials were not available to the general public at the time. Did not look at deprivation.

Poor reporting of the methodology used, and findings obtained, were noted in a few of these interventions (n=8) (Madle et al., 2004; Lambert et al., 2007; Francis et al., 2009; McNulty et al., 2010; Ahmed et al., 2019; Allison et al., 2020, Hayes et al., 2021a; Tyrell et al., 2022). A clear reporting of the methodology allows the study to be replicated, which permits the verification of findings, confirming the study's reliability and generalisability (Diaba-Nuhoho et al., 2021). The remaining interventions conducted in the UK and looking at increasing the public's knowledge and awareness of ABR, showed mixed evidence regarding the effect the interventions had on changing the public's knowledge, attitudes, perceptions, and behaviours towards ABR and antibiotic stewardship.

Of the total interventions described above, 20 studies sought to improve knowledge, understanding and awareness of ABR. Those targeting the general public used various media tools to improve knowledge and understanding (Madle et al., 2004; Parsons et al., 2004; Lambert et al., 2007; Francis et al., 2009; McNulty et al., 2010; Lecky et al., 2014; Chaintarli et al., 2016; Hayes et al., 2020; Wilding et al., 2021; Tyrrell et al., 2022). Most mass media interventions reviewed were multimodal and made use of a variety of resources and outlets to improve awareness and knowledge on ABR and antibiotic use, such as interactive workshops or events (Lecky et al., 2014; Hayes et al., 2020; Tyrrell et al., 2022), websites, billboards, newspapers and magazines, television and radio advertisements, and printed material including leaflets, brochures, pamphlets, posters and stickers (Parsons et al., 2004; Lambert et al., 2007; McNulty et al., 2010; Farrell et al., 2011). Printed material was also used in other interventions, either in combination with educational workshops or presentations (McNulty et al., 2007; Lecky et al., 2010; Lecky et al., 2014) or as a single resource (Francis et al., 2009).

The evidence provided for the interventions targeting the general public showed less clarity, particularly regarding their efficiency in improving the public's knowledge and attitude towards ABR, compared to the interventions that targeted specific groups (Parsons et al., 2004; Lambert et al., 2007; McNulty et al., 2010; Lecky et al., 2014; Ahmed et al., 2019; Hayes et al., 2020; Wilding et al., 2021). For example, Parsons et al.'s (2004) pre-post study found that locally enhancing a nationwide public education campaign targeting the general public did not significantly change the public's knowledge of appropriate antibiotic use and attitudes towards antibiotic prescribing in an area of high prescribing (see Table 7). A similar trend was observed in McNulty et al.'s study (2010) which aimed to determine the effect of public antibiotic campaigns (used 1 year before the study was conducted) on the public's knowledge, attitudes, and behaviour with respect to antibiotic use. It was reported that no knowledge and understanding improvements were observed in either England or Scotland regarding antibiotic use and the lack of benefit of using antibiotics to treat viral infections. McNulty et al (2010) suggest that the reason for this may be due to the poor material used, the small recollection of campaign material, and the potential that the campaign materials were not used by all practices and pharmacies. They also concluded that the use and visibility campaign materials need auditing to better evaluate how efficient they may be in improving knowledge, understanding, and behaviours (McNulty et al., 2010).

Interventions targeting school children and parents showed more potential for increasing the public's knowledge and attitudes on ABR, compared to those that targeted the general public (McNulty et al., 2001; McNulty et al., 2007; Lecky et al., 2010; Hawking et al., 2013; Lecky et al., 2014; Young et al., 2017; Eley et al., 2019; Hall et al., 2020). McNulty et al.'s pre-post studies (McNulty et al., 2001; McNulty et al., 2007) showed that school-based interventions, targeting school aged children, effectively improved their knowledge of microorganisms and infections caused by these organisms, and appropriate antibiotic usage. A similar result was observed in Hawking et al.'s (2013) and Hall et al.'s (2020) pre-post study using a school-based intervention, where children showed a significant improvement in the overall knowledge of hand hygiene and microbes (Hawking et al., 2013) and antibiotic use (Hall et al., 2020) (see Table 7).

Children are the next generation of antibiotic consumers and prescribers, and improving their knowledge, understanding, awareness, and perceptions of antibiotics usage, infection prevention and control, infection treatment, and ABR could aid them in making better and more informed decisions regarding their health, the prudent use of antibiotics, and ABR (McNulty et al., 2001; McNulty et al., 2007; Lecky et al., 2014; Alejandro et al., 2023; Calvo-Villamañán et al., 2023). Experiences in early childhood have profound and long-lasting consequences (Calvo-Villamañán et al., 2023); therefore, there is consensus that early childhood is the optimal age for introducing ABR education (McNulty et al., 2001; McNulty et al., 2007; Lecky et al., 2014; Alejandro e al., 2023; Calvo-Villamañán et al., 2023). Lecky et al. (2014) proposed that as children are future antibiotic prescribers and users, investing in their education is crucial to allow them to antibiotics more efficiently. This was also previously discussed in McNulty et al.'s (2001) and (2007) studies, where they suggested that educating children will not only allow them to be more informed about infections and the responsible use of antibiotics, but it will also reinforce adult education campaigns aimed at reducing parental expectation for antibiotics. Systematic reviews conducted by Price et al. (2018) and Alejandro et al., (2023) also suggest that parents and caregivers play a pivotal role children's attitudes and behaviour towards antibiotics in the future. Alejandro et al. (2023) argues that parental lack of knowledge regarding the appropriate use of antimicrobials will lead to poor treatment choices and irresponsible antibiotic use for their children. Price et al. (2018) suggests that attitudes and antibiotic stewardship behaviours may be passed on through generations; therefore, using the power of familial social influence and parental duty, where children's ABR knowledge is reinforced at home by parents, may be a more efficient approach in achieving behavioural change when it comes to antibiotic stewardship (Price et al., 2018).

Among the interventions aimed to improve knowledge and awareness of ABR and antibiotic use among the UK public, 12 also aimed for a behaviour change in their target population as well as improving knowledge and awareness (McNulty et al., 2007; Lambert et al., 2007; Francis et al., 2009; Chaintarli et al., 2016; Eley et al., 2018; Allison et al., 2020; Hall et al., 2020; Hayes et al., 2020; Roope et al., 2020; Hayes, 2021a; Hayes, 2021b; Wilding et al., 2021). Although these studies reported positive behaviours changes, it is necessary to acknowledge that these behaviours were described as intent to perform a specific behaviour (e.g., intention not to request antibiotics) or were self-reported by participants (e.g.: increased handwashing behaviour); therefore, behaviour change was not specifically measured. For example, in Roope et al.'s (2020) study, participants exposed to the intervention stated that they would be less likely to request antibiotics for flu-like symptoms. Although this may be considered a positive outcome from the study, it is important to note that reported intentions may differ from actual behaviours, even though they have been found to be correlated with each other (Ajzen & Fisbbein, 1974). Intent to change a specific behaviour was also reported in other studies mentioned in Table 7 (Chaintarli et al., 2016; Hall et al., 2020; Hayes et al., (2021a); Wilding et al., 2021). Studies that relied on self-reported behaviour changes after exposure to the intervention rather than measuring behaviour change, such as Eley et al.'s (2018) mixed methods study where participants reported increased handwashing behaviours, and Francis et al.'s (2009) RCT where participants reported changing antibiotic-seeking behaviour, could be subject to social desirability bias. Social desirability bias (or conformity bias) stems from the social norm to be aggregable and conform to the norm and occurs when a participant offers responses that are based on their perception of what is the socially acceptable answer, or what they believe the researcher wants to hear (Kuru & Pasek, 2016; Kreitchmann et al., 2019). Social desirability bias can introduce errors in data, which can lead to incorrect conclusions (Kuru & Pasek, 2016; Kreitchmann et al., 2019). However, in Francis et al.'s (2009) RCT, the reduction in antibiotic seeking behaviours was corroborated by a reduction in antibiotic prescribing and consumption in the intervention group (see Table 5); which could potentially show the relationship between intention and behaviour.

Only 4 studies sought to improve public engagement with ABR awareness (Hall et al., 2020; Van Hecke et al., 2020; Hayes et al., 2021a; Tyrell et al., 2022). Hall et al. (2020) and Hayes et al. (2021a) both looked at children's engagement, whereas Van Hecke et al. (2020) looked at parental engagement and Tyrell et al. (2022) reported on improving public engagement. Behaviour change was also a research outcome in two of the studies that wanted to improve public engagement, and both studies reported positive behaviour changes (Hall et al., 2020; Hayes et al., 2021a). Hayes et al.'s (2021a) study, looking at improving knowledge and understanding among youth groups, utilised various activities to improve knowledge on infection prevention, antibiotics, and ABR. Engagement with ABR and antibiotics awareness was consolidated by engaging children to present and share what they had learned to other peers, youth groups, family and friends, and at their school (Hayes et al., 2021a). A high number of children (99%) reported they would improve their hand hygiene behaviours, educate their families about antibiotics and encourage them to improve their hand hygiene behaviours as well; however, as previously stated intentions, while associated with, may differ from actual behaviour. Hall et al. (2020), engaged with children by means of a musical on antibiotics and ABR; children displayed knowledge gained from key messages from the musical, and reported being motivated to influence their friends' and families' attitudes to antibiotics. However, it was impossible to ascertain whether changes in knowledge and engagement translated into behaviour change (Hall et al., 2020). In Tyrell et al.'s (2022) study on raising awareness through a pop-up science shop, public engagement was measured by; how long visitors stayed at the event (10 minutes to an hour), the number of antibiotic resistance champions created, public engagement with the various activities provided (e.g., creation of 500 pieces of artwork at the 'create your own microbes' station), the 233% increase in footfall traffic over the course of the event, website hits on their official website, and posts on Twitter about the event. Although the researchers reported a significant increase in knowledge of microbes, antibiotics, and ABR, baseline knowledge and further statistical analysis were not reported; therefore, it is difficult to evaluate whether knowledge and understanding was indeed improved.

Of all the interventions reported in Table 7, only 4 made use of participatory approaches in their intervention development (Van Hecke et al., 2020; Hayes et al., 2021a; Hayes et al., 2021b; Tyrell et al., 2022), i.e. collecting data from stakeholders who would be using and benefitting from the interventions developed. It has been evidenced in the literature that using a participatory approach, i.e. engaging end-users in the development of public health interventions, increases effectiveness of the intervention and adherence by empowering end-users, (discussed further in section 3.2.3) (Leask, Sandlund, Skelton, Altenburg, Cardon, Chinapaw et al., 2019). For example, in Hayes et al.'s (2021b) study healthcare providers and patients participated in focus groups and interviews, to test out and provide feedback on a patient information leaflet designed to empower patients to self-manage common infections. Youth group leaders also provided input on the content of an educational programme regarding infection prevention and antibiotics, which informed the development of the intervention (Hayes et al., 2021a). Families with children aged 7-14 years were invited to participate in a focus group, in Tyrell et al.'s (2022) study. Children and their parents helped in the development of activities, that were going to take place at a public engagement event, to improve awareness on ABR (Tyrell et al., 2022). Van Hecke et al.'s (2020) study also involved eight parents, who participated in focus groups and co-designed evidence-based infographics on responsible antibiotic usage for parents. Parents in this study provided feedback on the type of information presented in the infographics, the language used, and where the infographics should be displayed (Van Hecke et al., 2020).

Although all four studies, that used a participatory approach, reported achieving their aims and objectives, only 2 provided details on how involved the participants were in the development of the interventions (Van Hecke et al., 2020; Hayes et al., 2021b). Both described using a rigorous participatory approach. In Hayes et al.'s (2021b) study it was reported that a large sample of participants (52 patients and 12 healthcare professionals) contributed to the development and evaluation of the tool used in the intervention, a patient leaflet to be used in primary care and community pharmacy settings. As mentioned in Table 5, 34 participants (27 patients and 7 healthcare professionals) took part in interviews and focus groups to develop an information leaflet, followed by 30 participants (25 patients and 5 healthcare professionals) providing feedback, via questionnaires, on a draft of the leaflet (Hayes et al., 2021b). Although patients were recruited based on their ethnicity, demographic characteristics such education, health literacy levels, and socioeconomic status did not factor in the recruitment process (Hayes et al., 2021b). This study found that it was important to put end users at the centre of developing the leaflet, to lead to positive behavioural outcomes, although this was not tested (Hayes et al., 2021b).

In Van Hecke et al.'s (2020) study, evidence-based infographics were co-designed with parents (n=8) during focus groups; the infographics were then tested in a national online survey (n=998) to see when it had any effects on parents' understanding of antibiotic use. The researchers wanted parents to be involved in the design process so they could feedback on the novelty and potential use of the infographics for parents (Van Hecke et al., 2020). They also wanted to ensure that the final evidence-based infographics resonated with parents, that the information was relevant for them, and that it focused on outcomes that parents could relate to (Van Hecke et al., 2020). The researchers concluded that future campaigns should be co-developed with its target audience, and it was important to evolve beyond traditional public health campaigns

The interventions reviewed in this section often did not report a theoretical basis informed by any behavioural change theory, which could have affected their outcomes (King et al., 2016; McParland et al., 2018; Price et al., 2018; Lim et al., 2020). Only five studies, out of 12, made use of behaviour change models or theories; three used the COM-B model (Alison et al., 2020; Hayes et al., 2021b; Wilding et al., 2021) and two used the Theoretical Domains Framework (TDF) (Hayes et al., 2021a; Hall et al., 2020). There is consensus that interventions aimed at improving knowledge, understanding, attitudes, and perceptions on ABR and the use of antibiotics should ideally be informed by behavioural change theories to improve intervention outcomes (McParland et al., 2018; Price et al., 2018; Atkins et al., 2020; Fletcher-Miles et al., 2020; Van Katwyk et al., 2020).

2.8 Knowledge and behaviour

The term education can be described as the process of gaining or receiving systematic instructions, whereas knowledge embodies facts, information, and skills, that a person may possesses or accumulates, in a particular topic, through experience of education (Surbhi, 2021). Therefore, knowledge is the desired outcome of education, and is comprised of general knowledge, knowledge that increases personal awareness, and knowledge that increases skills (Arlinghaus & Johnston, 2018).

Often public health interventions promoting behaviour change focus on providing information to the public, with the goal of teaching people to change their behaviour (Brown, 2018). These health promotion interventions assume that knowledge/information alone may create sustainable behaviour change, without considering the broader context in which behaviour changes and is sustained, particularly as human behaviour is complex (Kelly et al., 2016; La Guardia, 2022).

Although education and knowledge are essential components for behaviour change, there is debate as to whether knowledge alone can influence behaviour (Kelly et al., 2016; Arlinghaus & Johnston, 2018; Brown, 2018). The premise of knowledge and information as a driver of behaviour is influenced by the information deficit model (IDM) (Abunyewah, 2020). Also known as the deficit model, knowledge deficit model, deficit theory, knowledge gap model, and information deficit theory, the IDM suggests that providing information about an issue can result in people changing their perceptions, beliefs, attitudes, and eventually behaviour (Abunyewah, 2020). However, critiques of the model argue that while providing adequate information to improve knowledge is necessary, it is insufficient in itself to motivate people to change behaviours (Kelly et al., 2016; Abunyewah, 2020). IDM privileges a top-down approach, whereby experts are seen as sources of information. This borrows from traditional medical models of the doctor-patient relationship, where patients receive information from medical practitioners, i.e., doctors pass on their expertise and thereby remedy to the information deficit (Abunyewah, 2020). Although this model may work for patients with acute conditions, it is not always effective for complex behaviours, such as exercising and dieting, and other public health challenges, such as prevention by way of behaviour change (Kelly et al., 2016; Abunyewah, 2020).

Many researchers believe that improving knowledge is not enough to change behaviour; in fact, if knowledge did change behaviours, nobody would smoke, everyone would exercise, eat healthily, and wear seatbelts (Xu et al., 2015; Stevely et al., 2018; Beck et al., 2019; Sun et al., 2023). However, one could argue that it is critical to explain to people why certain behaviour changes are necessary (Kelly et al., 2016; Arlinghaus & Johnston, 2018). For example, explaining the risks associated with not attending cancer screening could improve awareness on the importance of screening; or understanding the health risks involved with smoking is critical to make a decision to stop smoking. Behaviour change is more likely to occur if education and knowledge increases an individual's awareness of a particular issue (Kuzniar et al., 2021); for example, a person may make the decision to stop smoking if they are aware of the consequences of smoking and are currently experiencing some of these consequences. Therefore, for education and knowledge to increase awareness, an individual must be provided with a better understanding of the personal relevance of the information provided, by adapting this information to increase or highlight consequences and relevance to the individual (Arlinghaus & Johnston, 2018; Kuzniar et al., 2021).

Furthermore, it can be argued that knowledge is the first step towards behaviour, by changing attitudes regarding the behaviour that needs to be changed; knowledge can influence perceptions, which can in turn change attitudes, and eventually change behaviours (La Guardia, 2022). By providing information and adapting it to the individual or groups of individuals receiving it, explanations as to why the information is specifically pertinent to them would also be provided with the goal of changing attitudes around this issue, and eventually changing the behaviour (Arlinghaus & Johnston, 2018; Abunyewah, 2020). In the 'theory of reasoned action' behaviour change model, attitude can be described as the feeling and perception towards a subject, and includes cognitive, affective, and conative/behavioural components (Schrader et al., 2004). The cognitive component is the belief associated with a subject or action; the affective component represents the emotion and feelings associated with a particular subject or action; and the cognitive component is the overt action of direct predisposition towards the subject or action (Schrader et al., 2004). Motivation to change behaviour often requires more than simply providing information about an issue and improving participant engagement is necessary to ensure sustained behaviour change (Ienna et al., 2022). When an individual feels deeply connected to a behaviour they are attempting to change, they may be more likely to persevere through the potential hardship of changing this behaviour and sustain the behaviour in the long run (Arlinghaus & Johnston, 2018; Abunyewah, 2020; Ienna et al., 2022). In simpler terms, what an individual knows may inform their attitude about a subject, which in turn may influence behaviour (Ienna et al., 2022). Interestingly, behaviours can also inform attitudes, which can impact perception and therefore may impact knowledge gains. Therefore, the relationship between knowledge, attitudes, and behaviour, is complex, dynamic, and sometimes reciprocal (Schrader et al., 2004; Arlinghaus & Johnston, 2018; Abunyewah, 2020; Ienna et al., 2022).

Although the IDM may be construed as experts being in charge of what people know, which may lessen individual empowerment in making decisions about their own health, it can be argued that providing information and educating people may in fact encourage them to be in control of their behaviour, and also allows them to be more empowered and responsible for their health and their health-related behaviours (Brown, 2018; Barbosa et al., 2021). However, this assumes that people having an unhealthy lifestyle will change their behaviour, if they are shown that they are unhealthy. This argument can be problematic, particularly as behaviour occurs in social environments, and therefore behaviour change should take into account the social context as well as the political and economic factors which directly influence people's health, regardless of the individual's behaviours (Brown, 2018; Mendelsohn, 2019; Verplanken & Orbell, 2022). For example, informing people about eating more fruit and vegetables, will not necessarily make them do so daily, particularly if there are other aspects that may influence this behaviour, such as the lack of access to produce, the cost of buying produce daily, and the ability to prepare/cook vegetables, etc. Looking at the social determinants of health, people's capacity to change behaviours may be significantly limited, even if educational strategies successfully raise awareness, due to the environments they live in (Marmot et al., 2010).

Many behaviours are significantly dependent on environments and engrained habits, and there are various factors that are more likely to be more important than the provision of information, in determining behaviour (Brown, 2018; Mendelsohn, 2019; Verplanken & Orbell, 2022). Having said that, proponents of the social cognitive theory, which includes self-efficacy as an important factor in behaviour change, believe that education plays an important role in self-efficacy (Schunk et al., 2020). Self-efficacy involves the perception that outcomes will result from engaging in a behaviour and perceiving one's own ability to successfully execute these behaviours (Schunk et al., 2020). Firstly, educating people increases their awareness as to why a behaviour change is necessary, including providing knowledge on how the behaviour change will result in a desirable health outcome (Schunk et al., 2020; Al-Salmi et al., 2022); for example, interventions aimed at improving diets, will have an educational component showing that healthy changes to everyday meals could positively influence health outcomes, (i.e., being healthier and/or losing weight). Secondly, self-efficacy will also come from individuals' perceptions that they are able to make these changes (Al-Salmi et al., 2022). Therefore, education incorporating skills training is required for people to understand how to make changes to their behaviours (Al-Salmi et al., 2022); for example, awareness about the benefits of eating healthier is important, but knowing how to make dietary changes to make meals healthier is necessary before individuals can properly engage in changing their diets. A randomised intervention trial (n=260; intervention group n=130; control group n=130), informed by the social cognitive theory, found that awareness and general knowledge of rational antibiotic use was better in the intervention group (received self-care educational intervention) ($p<0.001$) compared to the control group ($p>0.05$); they also reported that an intervention based on social cognitive theory was efficient to improve awareness and general beliefs about safe and responsible use of antibiotics (Mohebbi et al., 2018).

Protection motivation theory (PMT), which provides a conceptual framework to explain factors predicting risk preventative behaviours, also focuses on the provision of information to create a change in attitudes (Rogers, 1983; Shillair, 2020; Marikyan & Papagiannidis, 2023). PMT is usually used to explain people's decision to participate in health risk mitigation behaviours and disaster prevention (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023). The premise of PMT is that an individual's motivation to protect themselves from threats will influence their decision to participate in risk preventative behaviours (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023). With PMT, decisions are made based on results of threat appraisal or coping appraisal. During threat appraisal people estimate the level of threat, by assessing the perceived severity of the threat (i.e., perceptions of the degree of seriousness of the possible harms brought by the threat) and their perceived vulnerability to the threat (i.e., perceptions of their susceptibility to the harms brought by the threat) (Rogers, 1983). Threat appraisal also involves assessing the perceived benefits or rewards of maintaining the current risky behaviours (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023). Coping appraisal also involves the evaluation of the individual's capacity to perform risk preventative behaviours, which also influences motivation (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023).

In PMT the perceptions severity, vulnerability, and reward, can motivate and individual to perform adaptive responses (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023). For example, looking at air pollution, an individual may assess the severity of the issue (i.e., air pollution caused by cars), the vulnerability to the issue (i.e., increased pollutants in the air causing respiratory problems), and the rewards (i.e., cars provide fast transport), and may decide to perform adaptive pro-environmental behaviours (e.g., cycling to work, avoiding using the car for short errands, or using public transport instead of driving). However, higher perceptions of severity and vulnerability are much more likely to increase motivation to perform risk preventative behaviours, while higher perceptions of rewards from current behaviours will inhibit adaptive risk preventative behaviours (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023). Self-efficacy (i.e., and individual's perception of their ability to perform the recommended behaviour), response efficacy (i.e., perception of effectiveness of the recommended behaviour), and response cost (i.e., the cost of performing the recommended behaviour) are important components in coping appraisal, which will also influence whether individual choose to change their behaviour (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023). Consequently, high costs in performing preventative behaviours could inhibit individuals from changing their behaviour (Janmaimool, 2017; Shillair, 2020; Marikyan & Papagiannidis, 2023). In their Japanese study (n=1980), Okuhara et al. (2020) found that the perceived severity of COVID-19 (standardized $\beta = 0.11$, $p < 0.001$) and self-efficacy (standardized $\beta = 0.32$, $p < 0.001$) significantly predicted greater levels of staying at home; however, perceived vulnerability and response efficacy did not predict staying at home. Therefore, they concluded that increasing awareness regarding the perceived severity of infection and self-efficacy in terms of not going out, could encourage people to respect social lockdown restrictions (Okuhara et al., 2020). In their cross-sectional study (Singapore; n=1002), looking at threat perceptions associated with patient adherence to antibiotics, Lee et al. (2023) reported that adherence to antibiotics was associated with four of the five PMT constructs: perceived response cost ($\beta = 0.61$, $p < 0.01$), perceived response efficacy of adherence to antibiotics ($\beta = 0.096$, $p < 0.01$), perceived susceptibility to ABR ($\beta = 0.097$, $p < 0.01$), and perceived severity of ABR. Interestingly, they found that patient's adherence to antibiotics seemed to be strongly correlated to the cost (response cost) of visiting the doctor to get antibiotics ($r = -0.69$, $p < .001$), and to a lesser extent the perception of ABR as a threat ($r = 0.08$, $p = 0.01$) (Lee et al., 2023).

2.9 Summary of key findings from the literature review and key gaps in the literature

Various studies have been conducted to evaluate parents' knowledge and understanding on antibiotic use and antibiotic resistance (Kotwani et al., 2010; Vazquez-Lago et al., 2011; Gaarslev et al., 2016; Lum et al., 2018; Cabral et al., 2015; Zhang et al., 2018; Biezen et al., 2019; Bosley et al., 2021). However, the current knowledge and understanding of parents in GM has not previously been explored. The culture of antibiotic use, antibiotic prescribing, and antibiotic expectations during GP consultations remains unknown in GM. Furthermore, whilst a link between education level as a predictor of good knowledge and understanding about ABR and antibiotic use has been established (Anderson, 2018; Salm et al., 2018; McNulty et al., 2019; Bianco et al., 2020; Mallah et al., 2021), high levels of education have been also found to be associated with the paradoxical behaviour of not following health promotion guidance, as previously explained with vaccinations. For example, Mallah et al. (2022) found that high levels of education were associated with higher odds of storing antibiotics for future use, and Shebehe et al. (2022) found that high knowledge scores on infection rates and ABR were associated with higher odds of antibiotic use. Therefore, understanding whether and how education levels influence knowledge and understanding of antibiotic use and ABR, is important, particularly in a diverse setting like GM with low health literacy levels, and high levels of deprivation.

Many studies in the UK, have reported parental expectation for antibiotics (Rooshenas et al., 2014; Bosley et al., 2018; O'Doherty et al., 2019; Van de zande et al., 2019; Borek et al., 2020; Bosley et al., 2021), and that there is an increased expectation for antibiotics, particularly in deprived areas and among ethnic minority groups (Van der Zande et al., 2019; Borek et al., 2020; Miller et al., 2022). However, these studies have looked at drivers of increased antibiotic prescribing from a GP perspective, rather than from a patient perspective. In previous studies, parental expectations varied depending on the circumstances, with factors such as communication challenges, time pressure during consultations, pressure from day-care and employers, being suggested as reason for increased antibiotic prescribing for children (Rooshenas et al., 2014; Bosley et al., 2018; Kockow et al., 2019; Van der Zande et al., 2019; Borek et al., 2020; Rose et al., 2021; Allen et al., 2022; Miller et al., 2022). However, most of these studies were explored from the GP perspective, while parents' voices were lost. Parents' potential expectation for antibiotics has not been explored in a setting like GM; neither has their expectations of GPs or the outcome of medical consultations. These issues are important to explore given that parents have been reported as simply wanting reassurance, which has often been interpreted as antibiotic expectation by GPs. Therefore, understanding challenges experienced by parents, in a setting like GM is important, particularly post-COVID-19.

It has been found that deprivation is a determinant of antibiotic prescribing where inequalities can be seen in the prescribing and use of antibiotics (Mölter et al., 2018; PHE, 2020; McCloskey et al., 2023). Although there have been studies showing the heterogenous distribution of antibiotic prescribing in the UK (Covvey et al., 2013; Mölter et al., 2018; Thomson et al., 2020; Allen et al., 2022; Devine et al., 2022; McCloskey et al., 2023), parental drivers of antibiotic prescribing in different areas of GM (including those that are deprived) have not yet been investigated.

Many studies have linked deprivation to poor knowledge, awareness, and behaviours with regards to antibiotics and ABR. Many of these studies look at area deprivation, ethnicity, and education etc. as separate and isolated variables that do not influence each other (Mason et al., 2018; 2019; Adekanmbi et al., 2020; Shebehe et al., 2021; Tyrell et al., 2022; McNulty et al., 2022). Participants in these studies were selected based on postcodes determining areas of deprivation (see Table 8), or by using Index of Multiple Deprivation (IMD) (Mason et al., 2018; Adekanmbi et al., 2020; Tyrell et al., 2023). However, the concordance between personal deprivation that individuals experience in a deprived area and area-deprivation measures is poorly understood (Ingleby et al., 2020). Furthermore, although IMD may provide an understanding of relative deprivation in an area, i.e., poverty compared to others in society, it is not a suitable measure for targeting individuals, as within any area, there will be individuals who are deprived and those who are not (MoHCLG, 2015; Clelland & Hill, 2019). The indices are also limited in sensitivity and specificity, as they exclude many individuals experiencing deprivation, and include many who despite living in a deprived area are not deprived (i.e., ecological fallacy) (Lancaster et al., 2002; Doodman et al., 2008; Lokar et al., 2019). Therefore, when discussing deprivation, the over-reliance of area-based deprivation measures such as the IMD, can hide complexities related to deprivation and exclude a significant number of individuals experiencing deprivations who do not lived in a deprived area whilst including a significant number of people who are not experiencing deprivation, although live in deprived areas (Clelland & Hill, 2019; Dymond-Green, 2020). For example, in Mason et al.'s (2018) study looking at the general public's knowledge and awareness of ABR, it was reported that respondents in affluent areas possessed better understanding of ABR and antibiotics than those who resided in deprived areas, however nuances regarding factors such as education and health literacy were not discussed in the study.

Table 8: How deprivation was identified in studies on ABR and/or antibiotic use in the UK

Studies	How deprivation was identified
Knowledge and awareness of the general public and perception of pharmacists about antibiotic resistance. (Mason et al., 2018)	Researchers identified affluent public areas of London (Wimbledon, Richmond and Kingston upon Thames) and deprived public areas and areas with diverse ethnicities (Hackney, Waltham Forest, City of Westminster, Haringey, Newham, Islington, Enfield). Affluent and deprived areas were determined based on IMD scores and were chosen due to convenience based on proximity to the researchers. Area deprivation, rather than individual characteristics associated with deprivation
Antibiotic use and deprivation: an analysis of Welsh primary care antibiotic prescribing data by socioeconomic status. (Adekanmbi et al., 2020)	SES as defined by the Welsh Index of Multiple Deprivation (WIMD). Participants were categorised into WIMD quintiles (with 1 representing the most deprived quintile and 5 the least deprived). Area deprivation, rather than individual characteristics associated with deprivation
Knowledge about infections is associated with antibiotic use: cross-sectional evidence from the health survey Northern Ireland. (Shebehe et al., 2021)	The Northern Ireland Multiple Deprivation Measure (NIMDM) was used to estimate socioeconomic and sociodemographic disparities. Quintiles of NIMDM rankings based on a participant's home address made up the deprivation index. Area deprivation, rather than individual characteristics associated with deprivation

What the public in England know about antibiotic use and resistance in 2020: a face-to-face questionnaire survey. (McNulty et al., 2022)	Participants were asked demographic questions including their age, gender, ethnicity, education, employment, income, number and age of any children. Participants were categorised by the social grade of their household, which was determined by the occupation of the chief income earner. Social grades were as follows: AB: high or intermediate managerial, administrative or professional workers; C1: Supervisory, clerical and junior managerial, administrative or professional workers; C2: skilled manual workers; D: semi and unskilled manual workers; E: state pensioners, casual or lowest grade workers, unemployed with state benefits only. The socio-economic status of participants, based on their employment, was used here rather than area deprivation.
'Superbugs': raising public awareness of antimicrobial resistance through a pop-up science shop. (Tyrell et al., 2022)	Schools were mapped by the Welsh Index of Multiple Deprivation (WIMD) of their geographical locations. They considered 'overall deprivation' in their analysis. Area deprivation, rather than individual characteristics associated with deprivation.

There may be nuances in demographic characteristics that are atypical to what is expected from a deprived sample; therefore, simply looking at area deprivation (area deprivation or IMD) with regards to knowledge and awareness about ABR can be misleading and may lack critical depth. Looking at demographic characteristics, such as education, alongside area level deprivation, among parents in GM could provide some insight into how these characteristics may affect knowledge, attitudes, perceptions, and behaviours regarding antibiotic use and ABR.

Chapter 3: Methodology

This chapter critically discusses the research design, methodology, tools used for data collection, participant recruitment, and data analysis to address the aims and objectives of this PhD study, i.e.:

Aim: to obtain an in-depth understanding of the current knowledge, attitudes, and practices of parents living in GM, regarding antibiotic use, prescription advice, and antibiotic resistance, based on a mixed methods explanatory study.

Objectives:

- To investigate parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance, in GM (phase 1 - using questionnaires).
- To explore the factors that influence parents' perceptions, experiences, and practices, in the context of their young child being prescribed antibiotics (phase 2 & 4 – via telephone and face-to-face interviews).
- To provide recommendations for future research and interventions aimed at improving antibiotic awareness among parents (phase 3 – online creative workshops).

3.1 The research design

Mixed method research involves utilising both qualitative and quantitative methodologies in a single study, often described as blending research paradigms, while combining different methodologies (Ghiara, 2020). With a combination of both quantitative and qualitative approaches, a mixed methodology is an effective way of exploring a phenomenon and corroborating the results obtained by the different methods (Castro et al., 2010; Hughes, 2016). This can provide a more holistic view of the research problem, along with diversity and depth to the findings (Hafsa, 2019). Many researchers would agree that another advantage of using this methodology is the potential triangulation, by investigating the phenomena from different vantage points using diverse methods and techniques (Ivankova et al., 2006; Dhanapati, 2016; Hafsa, 2019; Maarouf, 2019). While using this approach requires a longer time frame to conduct all phases of the study (Castro et al., 2010; Namey & Trotter, 2015), it offers the advantage of obtaining well-defined confirmatory results from quantitative analysis, along with rich descriptive accounts and explanations drawn from qualitative analysis (Sandelowski, 2000; Driscoll et al., 2007; Guest & Fleming, 2015).

Ontology is the study of the nature of reality, whereas epistemology focuses on how valid knowledge is gained (Weed, 1999). Some researchers would argue that quantitative and qualitative methodologies cannot be combined due to their epistemological and ontological differences. Quantitative research is grounded in positivism (Moon & Blackman, 2014), and posits that research should be objective (Maarouf, 2019). Positivism is based on the premise that reality exists independent of the researcher, and that the researcher and participants exist as independent entities (Allison & Pomeroy, 2000; Scotland, 2012; Ghiara, 2020). Qualitative research, on the other hand, is embedded in interpretivism (Moon & Blackman, 2014) and proposes that research is subjective (Maarouf, 2019). In this type of research reality is individually constructed and varies from one individual to another (Allison & Pomeroy, 2000; Scotland, 2012; Ghiara, 2020).

Mixed methods research is considered to be based on pragmatism, rather than either positivism or interpretivism (Feilzer, 2010). Pragmatism is a research paradigm that permits researchers to focus on the methodology that will allow the research problem/question to be answered (Kaushik & Walsh, 2019; Maarouf, 2019). Pragmatism proposes that reality is not static and is based on practicality rather than underlying philosophy (Kaushik & Walsh, 2019; Maarouf, 2019). Although this approach draws criticism among proponents of positivism and interpretivism (Feilzer, 2010; Kaushik & Walsh, 2019), pragmatists would argue that reality and knowledge both originate from beliefs and habits, and that meaning is dependent on the human experience and influenced by context (Kaushik & Walsh, 2019). Pragmatists query the dichotomy of positivism and interpretivism, advocating for a mix of both approaches, as they share commonalities in the research process, such as accuracy and thoroughness (Feilzer, 2010).

This study used a mixed methods approach with the aim of clarifying and understanding participants' views on antibiotic use and ABR while allowing the results obtained to be more reflective of the parent population in GM (Wisdom & Creswell, 2013; Hageman et al., 2015). Therefore, a combination of elements from both quantitative and qualitative approaches have been used to obtain more informative results (Castro et al., 2010; Almeida, 2018). This should provide clearer inferences for the study, as well as minimise biases and shortcomings that could arise if only a single method was used (Ivankova et al., 2006; Dhanapati, 2016).

An imbalance of data, from either the quantitative or qualitative phase, can occur using this approach (Leech & Onwuegbuzie, 2009; Almeida, 2018). Moreover, this approach increases the complexity of data analysis, is more labour intensive, and requires greater resources (Leech & Onwuegbuzie, 2009; Almeida, 2018). Notwithstanding these challenges, understanding a complex public health phenomenon such ABR requires the integration of different perspectives in the research design, to allow continual interpretation and flexibility during all phases of the research process, and provide a more comprehensive understanding of the research problem (Leech & Onwuegbuzie, 2009; Almeida, 2018). Using a mixed methods approach enables questions regarding parents' knowledge and understanding of antibiotic use and ABR to be answered, while capturing participants' attitudes, perceptions, and misconceptions on the topic being studied, thus providing a more combined transfer of evidence (Hageman et al., 2015; Namey & Trotter, 2015).

3.1.1 Reflexive statement

In qualitative research, reflexivity has been established as a practice that enhances credibility and quality of findings obtained with this type of methodology (Attia & Edge, 2017; Dodgson, 2019). Owing to the researcher's role as an instrument of inquiry, where their subjectivity and background may influence the research process, it is considered crucial that the researcher self-consciously evaluates and reflects on how they could have influenced the participants or topic discussed during the research (Probst, 2015; Zienkowski, 2017; Olmos-Vega et al., 2022).

Due to how the research process was developed for this study, it is important to reflect on how my background and philosophical stance has influenced the rationale for this study, and the adoption of a mixed methodology. The motivation behind this research stems from my medical and public health experience, which has sparked my interest in infectious diseases, particularly ABR. While completing my medical degree, I was involved in research on *Clostridium difficile* diarrhoea in patients in secondary care. During this period, I learned about hospital-acquired antibiotic resistant infections caused by the prolonged use of antibiotics, and the damaging effects of antibiotics on the human microbiota. With my background in medicine and public health, I understand our heavy reliance on antibiotics, and strongly believe in the importance of antibiotic stewardship in healthcare and community settings. However, I am also aware that healthcare professionals may be exposed to antibiotic-seeking behaviours from patients, especially parents; that there may be various factors that could influence these behaviours; and that the culture of antibiotic use, antibiotic prescribing, and antibiotic expectations is unknown in GM. This felt like a significant gap in existing knowledge that needed to be explored. My medical training, and working as a healthcare professional, has also made me more aware about the various challenges that may come up during medical consultations with patients, particularly with parents, such as communication challenges that may be construed as pressure from patients to obtain a treatment that may not be necessary for them. Therefore, this study provided the opportunity to get better insight into how patients, particularly parents, experience medical consultations, and how communication between patients and healthcare providers can be improved.

My philosophical stance and personal values align with pragmatism, with an inclination towards positivism. Coming from a medical and public health background, I always aligned with positivism. Positivists use objective statistics and facts to identify causes which influence outcomes, through a deductive approach (Maarouf, 2019). Finding solutions that could benefit society has always been central to my research. However, during the course of my PhD I have adopted a more pragmatic stance, as I have come to the realisation that while quantitative approaches may provide important information regarding the "what" of the issue, they cannot provide in-depth information regarding the "why" of the issue.

It was my view that by adopting a mixed methodology, an in-depth understanding of the findings, via the qualitative process, would provide more depth to the descriptive and/or inferential statistics from the quantitative process. Allowing participants to have a voice and a chance to share their views and perceptions underpinning the facts and statistics, and by enabling them to inform the development of an intervention, would enable me to provide a more holistic view of the research phenomenon being studied.

Although it is argued that quantitative and qualitative methodologies are too different to be integrated in one methodology, I believe that both objective and subjective approaches can be used complementarily, in the study of complex phenomena. As a pragmatist, I chose to use a mixed methodology, as the strengths of one methodology could compensate for the weaknesses of the other (Hafsa, 2019). This also allowed for a more flexible process, whereby I could choose the method that worked best and was most practical for the particular objectives I was trying to achieve. This flexibility in the research process was very useful, particularly during the COVID-19 pandemic, as it allowed me to adapt to changes that were very influential on my research.

After completion of the literature review, it was established that knowledge on ABR and antibiotic use is lacking to some extent in many countries, including the UK. There have been many interventions, conducted in the UK, to increase awareness on the ABR issue and educating the public on the appropriate use of antibiotics; however, I realised that parents' voices had been lost in the majority of the research that was being done, which was a gap identified in the literature. It was my view that adopting a purely quantitative approach to evaluate parents' knowledge and understanding of ABR, antibiotic use, and prescription advice, would limit the findings that could potentially inform future ABR interventions targeting parents. Therefore, a mixed methodology would not only allow me to evaluate knowledge, awareness, and self-reported practices among parents in GM, but it would also provide an understanding of their beliefs and perceptions relating to ABR, antibiotic use, and antibiotics prescribing.

3.2 The research phases

There are 3 main research designs associated with mixed methodology research. The first is the "convergent parallel mixed method", where both quantitative and qualitative data are collected and analysed simultaneously (Maarouf, 2019; Draucker et al., 2020). The second is the "explanatory sequential mixed method", where quantitative data is collected prior to qualitative data, as the qualitative findings are used to provide further explanation on the quantitative findings (Maarouf, 2019; Draucker et al., 2020). The third and final design is the "exploratory sequential mixed method", where the researcher collects qualitative data in the first instance and then collects quantitative data, as the qualitative data is used to inform the quantitative research phase (Maarouf, 2019; Draucker et al., 2020).

A sequential explanatory design was used for this research, which involved collecting and analysing quantitative data prior to qualitative data collection and analysis (Ivankova et al., 2006; Dhanapati, 2016). The rationale for this design is that it offers an over-all understanding of the research problem, with in-depth narrative data being used to provide a more thorough understanding of the numeric findings (Ivankova et al., 2006; Draucker et al., 2020). This allowed the first phase of the study to be utilised to develop research questions that were useful to explore further in the phases 2 and 3.

Although executing this design can be a lengthy process, given that data collection and analysis has to be carried out thrice and in three separate phases (Dhanapati, 2016; Hafsa, 2019; Maarouf, 2019), the main aim was to use the qualitative data from phase 2 to further aid in the explanation and interpretation of the quantitative findings, as well as to inform the last phase of the study. Therefore, using a sequential explanatory design aided in the expansion of the findings derived from the first phase of the study, thus providing a more holistic view of the phenomenon being studied (Hafsa, 2019).

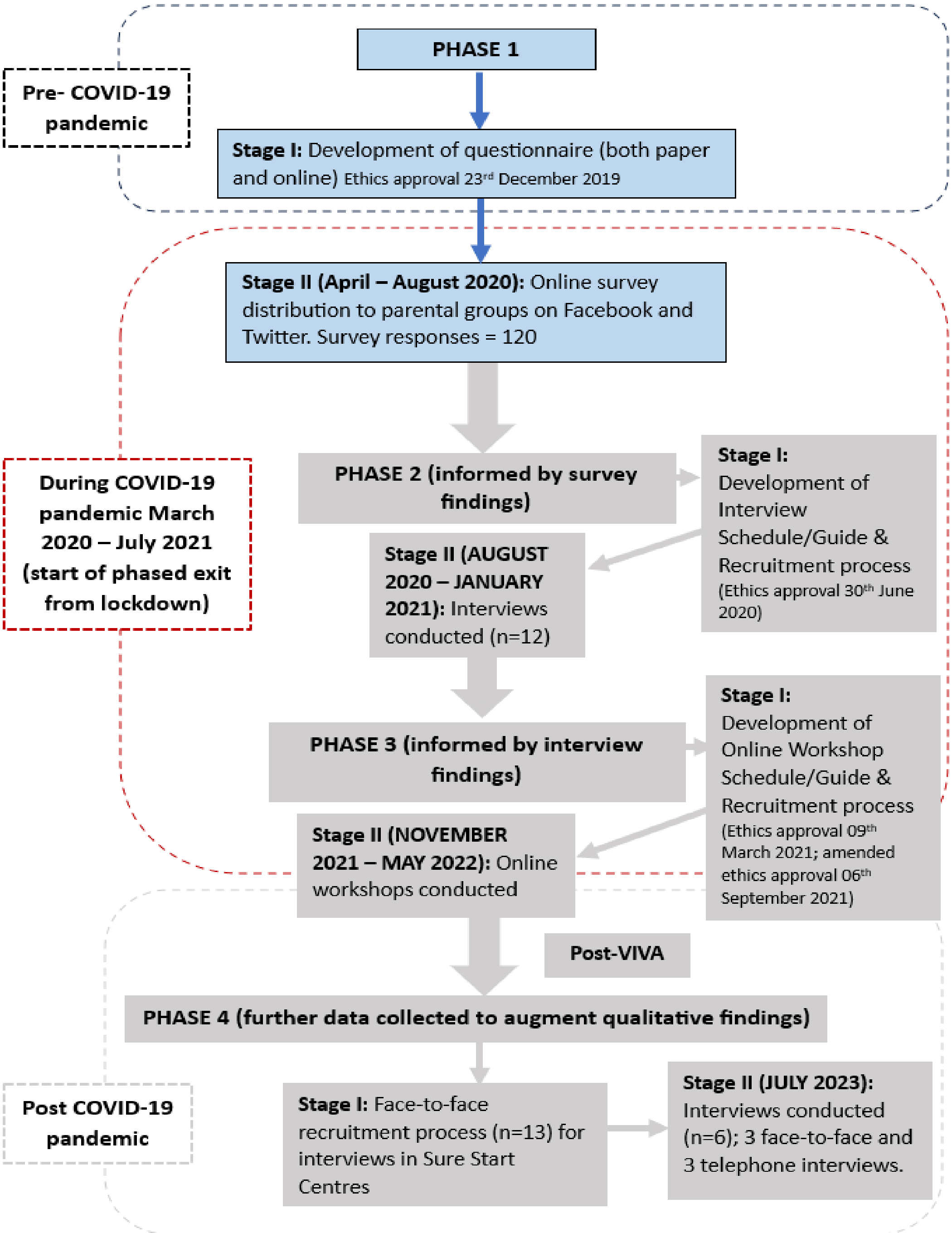
This PhD aimed to obtain an in-depth understanding of the current knowledge, attitudes, and practices of parents living in GM, regarding antibiotic use, prescription advice, and antibiotic resistance. Four phases were carried out to achieve this: the quantitative phase (phase 1) involving online surveys; the qualitative phase (phase 2) involving semi-structured telephone interview; online creative workshops (phase 3) involving suggestions and recommendations from parents to design and develop an intervention/tool using a participatory approach; and a final qualitative phase (phase 4) involving further interviews with parents from deprived areas, to obtain a more representative view of the parent population in GM.

It is important to note that the first 3 phases of this study were conducted during the COVID-19 pandemic. Due to the strict regulations on public gatherings and social distancing that were in place (WHO, 2020a) all 3 phases of data collection were conducted remotely to ensure researcher and participant safety and comply with government social distancing guidelines.

3.2.1 Phase 1:

This phase aimed to investigate parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and ABR. By starting with this quantitative phase statistical associations between variables could be explored during data analysis (Addissie, 2014; Snelson, 2016). There were 2 stages involved, Stage I, the development of a questionnaire, and Stage II, conducting the survey (see Figure 15).

Figure 15: Research timeline and flowchart for Phase 1 (highlighted in colour)



3.2.1.1 Questionnaire development (Phase 1, Stage I)

To answer objective 1, a cross-sectional survey was developed (Stage I) (see Figure 15) to provide a snapshot of parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance, in GM. This understanding was needed as a baseline to inform the subsequent phases of the study, i.e. the qualitative phases (interviews and online workshops).

Questionnaires have been used in many of the large-scale studies used to inform this one (André et al., 2010; Khan et al., 2013; European Commission [EC], 2018) (discussed further in section 3.2.1.1). Strengths of using questionnaires are that they are cost-effective, quick, and a standardised way of gathering data from a large sample of participants (Patton, 2005; Wright, 2006). Analysis of questionnaires can be carried out more objectively compared to other data collection methods, such as interviews (DiCicco-Bloom & Crabtree, 2006). Moreover, the data obtained can be quantified and compared during data analysis (Castro et al., 2010). However, some limitations of using questionnaires include low response rates (Bryman, 2006) as well as the possibility of gathering data that may not be very accurate or truthful (Patton, 2005; Wright, 2006). As this method has been found to be inadequate in obtaining information regarding participants' experiences and feelings (Bryman, 2006; Castro et al., 2010) the qualitative phase of the study was designed to explore these topics in more depth, and to provide greater insights into participants' perceptions, experiences, and feelings regarding antibiotic use for their children and ABR.

During the original design of the study, it was anticipated that paper, alongside online questionnaires would be distributed to participants (as shown in Figure 15). Non-NHS day-care centres and community centres in various boroughs in GM were the target, to include boroughs of various deprivation levels for a more representative sample. It was anticipated that using both types of distribution would have ensured a more reflective sample of parents in GM, including those with less digital engagement. However, online surveys were the only feasible method of quantitative data collection that could be used, due to COVID-19 restrictions enforced at the time of the study.

The first stage of the questionnaire design process involved searching the literature to explore the range of questionnaires that had previously been used to explore the public's knowledge and understanding of ABR, antibiotic use, and prescription advice, so that the findings from this study would be comparable with published norms. These studies were appraised for their methodology and results, and the questionnaires that had been used were evaluated. Questionnaires that were trying to measure similar variables (André et al., 2010; Khan et al., 2013; Rousounidis et al. 2011; EC, 2018) were appraised for their utility, and to select the questions that were suitable for this PhD research. Once the questionnaires were selected, the research teams who designed and developed these questionnaires were contacted to request their permission to use them in this PhD research.

Questionnaires that had been previously used in other studies, were utilised in this study to enable the findings obtained to be compared with published norms; thus, adding to the literature/evidence base (Mather et al., 2009; Mazumdar, 2021). Having comparable data can highlight whether the results confirm or contradict existing conclusions from previous studies (Schmidt & Pardo, 2014; Hanel et al., 2019; Mazumdar, 2021). Also, if the findings are found to be different from the published norms, a certain amount of interpretation as to why this may be so can also be done, regarding how the methodologies used could have affected the results, and how relevant the results are in the context of the existing literature, i.e. filling an existing knowledge gap in the literature (Schmidt & Pardo, 2014; Hanel et al., 2019; Mazumdar, 2021).

The main source for the questions used in this study, was the Special Eurobarometer Report on Antimicrobial Resistance 478 (EC, 2018). This survey (see Appendix 4) has been repeatedly used by the European Commission, in 2009, 2013, 2016, 2018, and most recently in 2022, to track and monitor the general public's knowledge and use of antibiotics in countries of the European Union (including the UK, prior to Brexit) (EC, 2018). The questionnaire covers various topics relating to ABR, including antibiotic use, ABR awareness, risks associated with unnecessary antibiotic usage, ABR information and awareness, policy response to ABR, and use of antibiotics in animal husbandry and agriculture (EC, 2018).

Eurobarometer data are available to the public from the Leibniz Institute for the Social Sciences website (GEISIS); however, limited information is given regarding the validation processes undertaken during the development of the survey. Having contacted the EC, their technical report (EC, 2018) was signposted as having information pertaining to the validation process. However, it only provides information on the extensive set of weighting variables used in the Eurobarometer technical report. The sparse details regarding the validation process could be due to the survey being developed by a third party. Notwithstanding that the Eurobarometer survey has been used in multiple high-profile studies (discussed below), and provides comparable data, which was the aim of using questionnaires that had been previously used in other studies.

Regarding the weighting variables provided in the technical report, this was done to ensure that the sample is appropriate for comparative analysis (EC, 2018). Statistics provided by the Eurostat (statistical office of the European Union) inform the EC of the true distribution and demographic characteristics of the population in each country involved in the study (Fahey et al., 2019; EC, 2016; EC, 2018; EC, 2022). Post-stratification sample weighting is then used to ensure that the Eurobarometer participant samples will approximate these distributions, to reduce survey bias (Fahey et al., 2019; EC, 2016; EC, 2018; EC, 2022). Therefore, population size weighting makes sure that the national sample size is similar across countries despite the major variations in population sizes (Fahey et al., 2019; EC, 2016; EC, 2018; EC, 2022).

The Eurobarometer survey on AMR was developed for various population samples from countries in the European Union (including the UK, prior to Brexit) (EC, 2016; EC, 2018; EC, 2022). In this regard, the Eurobarometer survey was designed to collect data from countries like the UK and was developed to obtain data from the general public, which includes people from different socio-economic backgrounds and with various literacy levels (EC, 2016; EC, 2018; EC, 2022). Findings reported by the EC contain socio-demographic comparisons with regards to employment, education, age, gender, income deprivation (using the variable "difficulty in paying house bills") (EC, 2016; EC, 2018; EC, 2022).

Furthermore, questions from the Eurobarometer survey have been used in multiple studies that sought to evaluate the public's knowledge and understanding of ABR and antibiotic use (Kamata et al., 2017; Mazinska et al., 2017; Chanvatik et al., 2019; Gajdács et al., 2020; Tangcharoensathien et al., 2021; Belamarić et al., 2023; Singh-Phulgenda et al., 2023). Both Chanvatik et al. (2019) and Tangcharoensathien et al. (2021) describe modifying the Eurobarometer survey on AMR with additional questions, to evaluate knowledge and antibiotic use in a Thai population; the new questionnaire was then assessed for logic and clarity, before being piloted. Similarly, Belamarić et al. (2023) utilised the Eurobarometer survey to conduct an online cross-sectional survey among the population of the Republic of Serbia. As their study was conducted during the COVID-19 pandemic, they also included questions relating to antibiotic use during the pandemic (Belamarić et al., 2023). Despite not providing any information regarding its validation process, the Eurobarometer survey has been used and is still being used and described as a validated questionnaire ("a validated questionnaire from the AMR Eurobarometer survey was used to collect data on antibiotic use and knowledge, access to antibiotics, and understanding of policy responses" Singh-Phulgenda et al., 2023; p. 11), including most recently a study conducted by the WHO Regional Office for Europe (Singh-Phulgenda et al., 2023; WHO, 2023b). In this study the Eurobarometer survey was adapted and used with the aim of evaluating knowledge, attitudes, and behaviours regarding antibiotic use and AMR, in 14 WHO European Region Member States (Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, Montenegro, North Macedonia, Republic of Moldova, and Tajikistan) (Singh-Phulgenda et al., 2023; WHO, 2023b). Singh-Phulgenda et al. (2023) described that the translated versions of the survey were validated by leads and data collectors in each country through a pilot run of the survey ("the translated version of the survey was validated by the leads and data collectors in each country through a pilot run" Singh-Phulgenda et al., 2023; p. 11).

Gjersing et al. (2010) suggests that there is no universal agreement on how to adapt a validated questionnaire in another cultural setting; whereas Sousa et al., (2017) propose that due to the time and cost constraints involved in developing and validating new questionnaires, researchers often adapt existing validated questionnaires to fit their study, even though this may introduce bias in the findings. Adapting questionnaires that have been previously validated is common practice among researchers, although these studies lack transparency regarding how the questionnaire was adapted (Gjersing et al., 2010; Stewart et al., 2012; Sousa et al., 2017).

As previously stated, the questionnaire used in this study was largely based on the questionnaire used in the Eurobarometer 478 (EC, 2018), with certain questions being adapted to also include data on children's use of antibiotics (e.g., Q23). It is noteworthy that even though certain questions were adapted for better clarity, or to provide more data, none of the scales or answer options were changed (i.e., if the original question used a 5-point Likert scale, the adapted question used the same unchanged scale).

For the purpose of this study (looking at parents' knowledge, understanding, attitudes, and perceptions on ABR, antibiotic use, and prescription advice), the following components from the Antimicrobial Resistance Questionnaire (Appendix 4) from the Eurobarometer Report (2018) were incorporated into the questionnaire used in this cross-sectional survey:

- Antibiotic use among the general public; more specifically whether they have used antibiotics in the last year, how these antibiotics were obtained, the reason for taking them, and whether adequate tests were conducted to confirm diagnosis of the illness.
- The public's knowledge on ABR, the use of antibiotics, and the risks associated with using antibiotics unnecessarily.
- Awareness and information on ABR and antibiotic use; more specifically the impact of ABR information and awareness on their behaviour, their interest in receiving more information on ABR, and the sources of information they would consider trustworthy.

Three questions from the Eurobarometer survey were excluded (the last 3 questions). One question (question 13) discussed tackling ABR at the EU level (which was considered a sensitive topic, given that Phase 1 was going to be conducted in the midst of Brexit); and two questions (question 14 and 15) related to the use of antibiotics as treatment for sick farm animals and to stimulate growth in farm animals within the EU, which was considered beyond the scope of this study.

Khan et al.'s (2013) study also informed the questionnaire used in this PhD study. This cross-sectional study sought to evaluate medical students' knowledge, attitudes, perceptions, and practices with regards to antibiotic and ABR (Khan et al., 2013). Although this study was conducted in a teaching hospital in Kerala, with second year undergraduate students, many of the questions used in their survey were of interest for this PhD study, particularly the questions that related to attitudes and self-reported practices (e.g., Q34 with a scenario where the doctor prescribed a course of antibiotics, see Table 10). Some questions from Khan et al.'s (2013) study were excluded, as they were variations of questions in the Eurobarometer survey (e.g., "Do you consult a doctor before starting an antibiotic?"); or were excluded as they were not of interest for this study (e.g., "Do you check the expiry date of the antibiotic before using it?"). Furthermore, Khan et al.'s (2013) study and survey has been utilised in other studies (in various countries, such as Nepal, Malaysia, Rwanda, and Saudi Arabia) to inform the development of questionnaires looking at ABR knowledge, attitudes, and practices (Rajiah et al., 2015; Pizutto et al., 2016; Shrestha, 2019; Kandasamy et al., 2020; Nisabwe et al., 2020; Nair et al., 2023).

As Khan et al.'s (2010) and EC (2018) did not fully meet the objective of the PhD questionnaires, some further questions were taken from different questionnaires used in other studies (André et al., 2010; Rousounidis et al. 2011; and Vallin et al., 2016). These questions were selected as either they would provide further data on parents' knowledge, understanding, and attitudes, or they provided questions pertinent to children. Further information on why these questions were selected are provided in Table 10.

The questionnaire for this PhD study (Appendix 9) was divided into 5 parts, to provide sufficient information to achieve objective 1, i.e., to investigate parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance:

- Part 1 involved assessing parents' knowledge on antibiotics and ABR with True or False questions. Questions for this section was taken from the following sources: André et al. (2010), Khan et al. (2013), and EC (2018).
- Part 2 involved evaluating parents' attitudes towards ABR, antibiotic prescribing, antibiotic prescription advice, and the likelihood to ask GPs for antibiotics. Participants were asked about their opinions regarding certain statements on ABR and to choose from answers ranging from strongly agree to strongly disagree. Questions for this section was taken from the following sources: Rousounidis et al. (2011), Khan et al. (2013), and Vallin et al. (2016).
- Part 3 investigated participants' self-reported practices regarding antibiotics, such as whether they use prescriptions to obtain the antibiotics, completed the antibiotic treatment, asked for antibiotics for their children during GP consultations, complied with the antibiotic treatment regimen, kept leftover antibiotics, or gave leftover antibiotics to their children. Questions for this section was taken from the following sources: Khan et al., (2013), and EC, (2018).
- Part 4 comprised of questions designed to collect demographic information such as gender, age, education attainment, ethnicity, country of origin, number of children, and area they live in (first part of postcode was requested). Questions for this section was taken from the following source: ONS Census (2011).

- Part 5, the final part, asked whether the respondents would be willing to participate in a telephone interview. If participants were willing, they were asked to provide their contact details (phone number or email address). Questions for this section was taken from the following sources: Khan et al., (2013), and EC (2018).

Table 9 below provides examples of the questions used for each section.

Table 9: Example of questions used in the online questionnaire and the objectives behind using them.

Objective (Question number)	Example of question
To evaluate parents' knowledge on antibiotics and ABR (Q1-4)	The improper use of antibiotics can lead to the emergence of bacterial resistance ☐ True ☐ False
To understand parents' attitudes towards ABR and antibiotic prescribing (Q5-21)	Whenever I take antibiotics, I contribute to the development of ABR ☐ Strongly agree ☐ Somewhat agree ☐ Undecided ☐ Somewhat disagree ☐ Strongly disagree
To assess parents' self-reported practices regarding antibiotic use for them or their child (Q22-35)	Do follow the full course of treatment for your child? ☐ Always ☐ Usually ☐ Sometimes ☐ Seldom ☐ Never
To obtain parents' socio-demographic information (Q36-43)	What gender are you? ☐Female ☐Male ☐Other
Invitation to participate in a focus group/interview (Q44)	We would like to invite you to take part in focus group/interview. If you are willing to participate in this next phase of our study, please leave your contact information below.
To understand on which topics participants would want to receive more information in the future (Q45-46)	On which topics, if any, would you like to receive more information? (Multiple answers possible)

As shown in Table 10 below, follow-up questions were also added to the questionnaire by the researcher, to provide further detail to participants' answers (examples are given below). Most of the questions were single-answer multiple-choice questions, while others had a follow-up, open-ended question (e.g., question 24 and 25).

Open-ended follow-up questions included:

- If you have chosen other, please give examples of which other symptoms.
- If you have chosen “without prescription from elsewhere” please can you provide more information on how and from where you obtained the antibiotics.
- If no, what country were you born in?

Open-ended questions were included, to enable additional qualitative data to support illuminate quantitative data being gathered with the survey (O’Cathain & Thomas, 2004; Chang & Vowles, 2013; Jones et al., 2013). Open-ended questions allow respondents to provide more nuanced responses to certain questions without being limited in their responses (O’Cathain & Thomas, 2004; Chang & Vowles, 2013; Jones et al., 2013). They also allowed participants to freely explain certain behaviours, attitudes, and opinions, that may not come across correctly via close-ended questions alone (O’Cathain & Thomas, 2004; Jones et al., 2013).

In the questionnaires used to inform the survey for this study, Likert scales were used for the questions that assessed respondents’ attitudes, perception, and beliefs (Khan et al., 2013; EC, 2018) (see Table 10). Using 5-point or 7-point Likert scales is a common method used in questionnaires designed to understand the respondents’ attitudes and opinions on a specific topic (Kazi & Khalid, 2012; Chang & Vowles, 2013; Regmi et al., 2016). Including Likert scale questions in a questionnaire is an effective method of measuring the strength of particular belief, attitude or opinion (Kazi & Khalid, 2012; Chang & Vowles, 2013; Regmi et al., 2016). Therefore, 5-point Likert scale questions were included in the questionnaire, as all of the questions taken from other studies originally used 5-point Likert scales wherever relevant; the scales were not altered for this PhD study.

Table 10: Sources of the questions used in the survey.

Question	Question from:	Validation	Setting and participant sample
Q1. For each of the following statements, please tell me whether you think it is true or false. (Answer options: True/ False/ Don't know) (a) Antibiotics kill viruses (b) Antibiotics are effective against colds (c) Unnecessary use of antibiotics makes them become ineffective (d) Taking antibiotics often has side-effects such as diarrhoea	European Commission (2018). Special Eurobarometer 478 —November 2018 Antimicrobial Resistance. European Union.	Details on validation process is sparse, weightage is provided in the Eurobarometer technical report However, survey was undertaken 4 times by the European Commission, Directorate-General for Health and Food Safety. First survey conducted in 2009; two further surveys conducted in 2013 and 2016. Eurobarometer 478 is the fourth in the series	Conducted in 28 EU Member States (n=27474) Looked at knowledge, attitudes and behaviour of the European public regarding ABR and antibiotic use. Aimed at the general public to include people from different socio-economic backgrounds.
Q2. When do you think you should stop taking antibiotics once you have begun a course of treatment? When you feel better When you have taken all of the antibiotics as directed by your doctor Other Do not know	European Commission (2018). Special Eurobarometer 478 —November 2018 Antimicrobial Resistance. European Union.		
Q3. The improper use of antibiotics can lead to: (Answer options: True/ False/Don't know) (a) Ineffective treatment (b) Worsening of illness (c) Emergence of bacterial resistance (d) Additional medical cost to the patient	Khan et al. (2013). Antibiotic Resistance and Usage-A Survey on the Knowledge, Attitude, Perceptions and Practices among the Medical Students of a Southern Indian Teaching Hospital.	Questionnaire was adapted from validated questionnaires from various studies. Prior to the study, questionnaire was validated by subject experts for its content and relevance.	Conducted in teaching hospital in Kerala, among second year MBBS undergraduate students (n=97)
Q4. Which statements do you agree with (a) Bacteria are germs that cause common cold and flu True/False/Don't know	Khan et al. (2013)		
(b) Antibiotics are effective against bacteria True/False/Don't know	André et al. (2010). A survey of public knowledge and awareness related to antibiotic use and resistance in Sweden.	Adapted from validated questionnaire from other studies. Questionnaire was pre-tested before the study.	Swedish population (n=747; aged 21-80 years), randomly selected using the official government registry (SPAR).

Question	Question from:	Validation	Setting and participant sample
	This question was added to assess if respondents knew what antibiotics are used for.		
(c) Antibiotics resistance can spread from animals to humans True/False/Don't know (d) Antibiotic resistance can spread from human to human True/False/Don't know	Vallin et al. (2016) Knowledge and Attitudes towards Antibiotic Use and Resistance - A Latent Class Analysis of a Swedish Population-Based Sample. These questions were added from the above study to assess whether respondents understood how ABR can spread and be transmitted to others.	Questionnaire adapted from André et al.'s (2010) study. Questionnaire was tested for face validity with 17 individuals of different age, gender, and professional background	Swedish population (n=1426; aged 18-74 years), randomly selected using SPAR.
Q5. Antibiotic resistance is an important and serious public health issue worldwide (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Khan et al. (2013) Adapted from original question. The original question was "Antibiotic Resistance is an important and serious public health issue facing the World" and was changed to "Antibiotic resistance is an important and serious public health issue worldwide"		
Q6. Antibiotic resistance is an important and serious public health issue in this country. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Khan et al. (2013)		
Q7. When I have a cold, I should take antibiotics to prevent getting a more serious illness. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Khan et al. (2013)		
Q8. When I get fever, antibiotics help me to get better more quickly. (Strongly agree/Somewhat	Khan et al. (2013)		

Question	Question from:	Validation	Setting and participant sample
agree/Undecided/Somewhat disagree/Strongly disagree)			
Q9. Whenever I take antibiotics, I contribute to the development of antibiotic resistance. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Khan et al. (2013)		
Q10. Skipping one or two doses does not contribute to the development of antibiotic resistance. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Khan et al. (2013)		
Q11. Antibiotics are safe drugs; hence they can be commonly used. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Khan et al. (2013)		
Q12. If a child suffers from a cold or flu, it will be cured faster if they are given antibiotics. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Rousounidis et al. (2011). Descriptive study on parents' knowledge, attitudes and practices on antibiotic use and misuse in children with upper respiratory tract infections in Cyprus. The questions from Rousounidis et al.'s (2011) study were utilised to add questions pertaining to children and parents' expectation for antibiotics for self-limiting infections	Pre-tested questionnaire was developed by the research. No further information provided on validation. Approved by ethics committee of the Cypriot Ministry of Education	Conducted in Cyprus using convenient sampling. Participants were parents (n=1494) of children attending kindergartens and elementary schools
Q13. If the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Rousounidis et al. (2011). This question from Rousounidis et al. (2011) was needed to assess respondents' attitudes in a scenario where the were not given antibiotics for their child when they expected them. This question was necessary		

Question	Question from:	Validation	Setting and participant sample
	based on finding from the literature review. Adapted from original question as a result of piloting. The original question was "Would you change your pediatrician because according to your opinion he/she does not prescribe antibiotics often enough for your child?" and was changed to "If the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional."		
Q14. You would re-use an antibiotic which you had used in the past if your child presents the same symptoms. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Rousounidis et al. (2011). The questions taken from Rousounidis et al.'s (2000) study were added as they pertained to antibiotic use for children, and were necessary to evaluate parents' attitudes towards antibiotic use. Adapted from original question as a result of piloting. The original question was: "Would you reuse an antibiotic which you had used in the past if your child presents similar symptoms?" and was changed to "You would re-use an antibiotic which you had used in the past if your child presents the same symptoms."		
Q15. Most of the Upper Respiratory Infections (e.g. common cold, sinusitis, tonsillitis, or	Question added by researcher.		

Question	Question from:	Validation	Setting and participant sample
laryngitis) will be self-cured even without the use of antibiotics? (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Based on findings from the literature, this question was added to identify whether respondents knew that self-limited infections are cured without the need for antibiotics. Question was assessed for logic and clarity, before being piloted.		
Q16. You expect your doctor to prescribe antibiotics if your child was suffering from an Upper Respiratory Tract Infection (e.g. common cold, sinusitis, tonsillitis, or laryngitis). (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Rousounidis et al. (2011). This question was added to identify parents expectation for antibiotics for self-limiting infections. Adapted from original question as a result of piloting. The original question was: "Do you agree that you will be dissatisfied if your paediatrician does not prescribe antibiotics for Upper Respiratory Tract Infections (i.e. cold, ear infection, cough)?" and was changed to "You expect your doctor to prescribe antibiotics if your child was suffering from an Upper Respiratory Tract Infection (e.g. common cold, sinusitis, tonsillitis, or laryngitis)."		
Q17. You would ask your doctor for antibiotic therapy if your child suffers from recurrent Upper Respiratory Tract Infections (e.g. common cold, sinusitis, tonsillitis, or laryngitis). (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Rousounidis et al. (2011). This question was added to evaluate respondents expectation for antibiotics, and their attitude towards management of self-limiting infections. Adapted from original question as a result of piloting. The original question was:		

Question	Question from:	Validation	Setting and participant sample
	"Would you request an antibiotic prescription if your child suffers from frequent Upper Respiratory Tract Infections?" and was changed to "You would ask your doctor for antibiotic therapy if your child suffers from recurrent Upper Respiratory Tract Infections (e.g. common cold, sinusitis, tonsillitis, or laryngitis)."		
Q18. Which of the following symptoms would make you visit a doctor for your child? Cough Fever Runny nose Ear pain Sore throat Hoarseness Other	Rousounidis et al. (2011). This question was added as it pertained to symptoms experienced by children that would worry parent to cause them to seek medical advice. Adapted from original question as a result of piloting. The original question was: "Which ones of the following symptoms would make you visit a pediatrician for your child? Cough, Fever, Nose drainage, Ear pain, Sore throat, Hoarseness, Change of behavior, Other" and was changed to "Which of the following symptoms would make you visit a doctor for your child? Cough, Fever Runny nose, Ear pain, Sore throat, Hoarseness, Other"		
If you have chosen other, please give examples of which other symptoms	Question added by researcher. This question was added to obtain further clarifications regarding other symptoms that parents would want medical advice on.		

Question	Question from:	Validation	Setting and participant sample
	Question was assessed for logic and clarity, before being piloted.		
Q19. When antibiotics are prescribed for you or your child, you are given enough information regarding how to take the antibiotics, how long to take it for, and the possible side effects that could occur while taking it? (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	André et al. (2010). This question utilised to evaluate whether respondents were given enough information on the antibiotics being prescribed. Adapted from original question as a result of piloting. The original question was: "When antibiotics are prescribed, the doctor takes time to provide information on how they should be used, in an understandable manner." And was changed to "When antibiotics are prescribed for you or your child, you are given enough information regarding how to take the antibiotics, how long to take it for, and the possible side effects that could occur while taking it?"		
Q20. During consultations with a healthcare professional (e.g.: nurse, GP, paediatrician, pharmacist), you are given time to inquire about the antibiotics prescribed to you. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	Question added by researcher This question was added to see whether respondents were given the opportunity to ask questions about antibiotics. This question was added based on the literature review about short consultations. Question was assessed for logic and clarity, before being piloted.		
Q21. During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing antibiotics and are	Question added by researcher		

Question	Question from:	Validation	Setting and participant sample
given enough information on how to treat the symptoms that you or your child are presenting. (Strongly agree/Somewhat agree/Undecided/Somewhat disagree/Strongly disagree)	This question was added based on the literature on parental expectation for antibiotics. Question was assessed for logic and clarity, before being piloted.		
Q22. Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months? (Answer options: Yes/No/Do not know /Do not wish to answer)	European Commission (2018). Special Eurobarometer 478		
Q23. Have you given any antibiotics to your child in the last 12 months? (Answer options: Yes/No/Do not know /Do not wish to answer)	European Commission (2018). Special Eurobarometer 478. Adapted from original question. The original question was "Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?" (see Q22 above) and was changed to "Have you given any antibiotics to your child in the last 12 months?"		
Q24. How did you obtain the last course of antibiotics that you used? From a medical prescription Administered by a medical practitioner You had some left over from a previous course Without prescription from a pharmacy Without prescription from elsewhere Don't remember Do not know Do not wish to answer	European Commission (2018). Special Eurobarometer 478		
If you have chosen "without prescription from elsewhere" please can you provide more	Question added by researcher		

Question	Question from:	Validation	Setting and participant sample
information on how and from where you obtained the antibiotics.	Based on the literature that shows that antibiotics are sometimes taken without a prescription; this question was added to evaluate how respondents obtained antibiotics for themselves without a prescription, as antibiotics can only be prescribed in UK due to prescribing regulations. Question was assessed for logic and clarity, before being piloted.		
Q25. How did you obtain the last course of antibiotics for your child? From a medical prescription Administered by a medical practitioner You had some left over from a previous course of antibiotics for your child You had some left over from a previous course of antibiotics for you Without prescription from a pharmacy Without prescription from elsewhere Don't remember Do not know Do not wish to answer	European Commission (2018). Special Eurobarometer 478. Adapted from original question. The original question was: "How did you obtain the last course of antibiotics that you used?" (see Q24 above) and was changed to "Have you given any antibiotics to your child in the last 12 months?"		
If you have chosen "without prescription from elsewhere" please can you provide more information on how and from where you obtained the antibiotics.	Question added by researcher Based on the literature that shows that antibiotics are sometimes taken without a prescription; this question was added to evaluate how respondents obtained antibiotics for their child without a prescription, as antibiotics can only be prescribed in UK due to prescribing regulations.		

Question	Question from:	Validation	Setting and participant sample
	Question was assessed for logic and clarity, before being piloted.		
Q26. What was the reason for last taking the antibiotics that you used? Pneumonia (an infection causing an inflammation of one or both lungs) Bronchitis (inflammation and swelling of the bronchi, the airways that carry airflow from the trachea into the lungs) Rhino pharyngitis (inflammation of the mucous membrane of the nose and pharynx) Flu Cold Sore throat Cough Fever Headache Diarrhoea Urinary tract infection Skin or wound infection Other Do not know Do not wish to answer	European Commission (2018). Special Eurobarometer 478		
Q27. What was the reason for last giving your child antibiotics? Pneumonia (an infection causing an inflammation of one or both lungs) Bronchitis (inflammation and swelling of the bronchi, the airways that carry airflow from the trachea into the lungs) Rhino pharyngitis (inflammation of the mucous membrane of the nose and pharynx) Flu Cold Sore throat	European Commission (2018). Special Eurobarometer 478. Adapted from original question. The original question was: “What was the reason for last taking the antibiotics that you used?” (see Q26 above) and was changed to “What was the reason for last giving your child antibiotics?”		

Question	Question from:	Validation	Setting and participant sample
Cough Fever Headache Diarrhoea Urinary tract infection Skin or wound infection Other Do not know Do not wish to answer			
Q28. Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics? Yes No Do not remember Do not know Do not wish to answer	European Commission (2018). Special Eurobarometer 478		
Q29. Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics? Yes No Do not remember Do not know Do not wish to answer	European Commission (2018). Special Eurobarometer 478. Adapted from original question. The original question was: “Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?” (see Q28 above) and was changed to “Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?”		
Q30. In the last 12 months, do you remember getting any information about not taking	European Commission (2018). Special Eurobarometer 478		

Question	Question from:	Validation	Setting and participant sample
antibiotics unnecessarily, for example for a cold? (one answer only) Yes No Do not know			
Q31. If you have ever been given information about not taking antibiotics unnecessarily or giving your child unnecessary antibiotics, where did you get this information from? From a doctor From a pharmacist From another health professional (e.g. nurse or physio-therapist) From a family member or friend From a TV advertisement On the Internet or in online social networks In a leaflet or on a poster In a newspaper On the TV news or other programmes On the radio Other Do not know	European Commission (2018). Special Eurobarometer 478. Adapted from original question. The original question was: "If you have ever been given information about not taking antibiotics unnecessarily, where did you get this information from?" and was changed to "If you have ever been given information about not taking antibiotics unnecessarily or giving your child unnecessary antibiotics, where did you get this information from?"		
Q32. Did the information that you received change your views on using antibiotics or giving antibiotics to your child? Yes No Do not know	European Commission (2018). Special Eurobarometer 478. Adapted from original question. The original question was: "Did the information that you received change your views on using antibiotics?" and was changed to "Did the information that you received change your views on using antibiotics or giving antibiotics to your child?"		

Question	Question from:	Validation	Setting and participant sample
Q33. On the basis of the information you received, how do you now plan to use antibiotics? You will always consult a doctor when you think you need antibiotics You will no longer self-medicate with antibiotics You will no longer take antibiotics without a prescription from a doctor You will no longer keep left over antibiotics for next time you are ill You will give left-over antibiotics to your relatives or friends when they are ill Other None Do not know Do not wish to answer	European Commission (2018). Special Eurobarometer 478		
Q34. The doctor prescribes a course of antibiotics for you. After taking 2–3 doses you start feeling better. (Answer options: Always, Usually, Sometimes, Seldom, Never) (a) Do you stop taking the further treatment? (b) Do you save the remaining antibiotics for the next time you get sick? (c) Do you discard the remaining, leftover medication? (d) Do you give the leftover antibiotics to your child or children if they get (e) Do you complete the full course of treatment?	Khan et al. (2013)		
Q35. The Doctor prescribes a course of antibiotic for your child. After taking 2–3 doses your child starts feeling better. (Always, Usually, Sometimes, Seldom, Never) (a) Do you stop giving them further treatment? (b) Do you save the remaining antibiotics for the next time they get sick?	Khan et al. (2013) Adapted from original question. The original question was: "The doctor prescribes a course of antibiotics for you. After taking 2–3 doses you start feeling better." (see Q34 above) and		

Question	Question from:	Validation	Setting and participant sample
(c) Do you discard the remaining, leftover medication? (d) Do you give the leftover antibiotics to your other children or family members if they get sick? (e) Do you follow the full course of treatment for your child?	was changed to "The Doctor prescribes a course of antibiotics for your child. After taking 2–3 doses your child starts feeling better."		
Q36. What gender are you? Male Female Other	Adapted from ONS Census (2011), question on gender		
Q37. What is your age: 16-19 20-29 30-39 40-49 50-59 60-69 70+	Question added by researcher This question was added to evaluate whether age could be associated with knowledge, understanding, and attitudes towards antibiotics, antibiotic prescribing, and ABR. Question was assessed for logic and clarity, before being piloted.		
Q38. What is your ethnicity? White British Black/African/Caribbean/Black British Asian/Asian British Mixed/Multiple ethic groups Other ethnic group Prefer not to say	Adapted from ONS Census (2011), question on ethnicity		
Q39. Were you born in the UK? Yes No Do not wish to answer	Question added by researcher Based on the literature that certain countries have antibiotic practices that do not comply to UK prescribing regulations (e.g., over the counter purchase of antibiotics); this question was added to evaluate whether		

Question	Question from:	Validation	Setting and participant sample
	respondents country of origin could be associated with their knowledge, understanding, and attitudes towards antibiotics, antibiotic prescribing, and ABR. Question was assessed for logic and clarity, before being piloted.		
If no, what country were you born in?	Question added by researcher This question was added to provide further information on which specific country the respondent was born in, to evaluate whether respondents country of origin could be associated with their knowledge, understanding, and attitudes towards antibiotics, antibiotic prescribing, and ABR. Question was assessed for logic and clarity, before being piloted.		
Q40. What is the highest qualification you have? If your UK qualification is not listed, tick the box that contains the nearest equivalent. If you have a qualification gained outside the UK, tick the 'Foreign qualifications' box or the nearest UK equivalent (if known). O-Levels/CSEs/GCSEs Apprenticeship A-Levels/Higher School Certificate/Advanced Diploma Certificate of higher education Diploma of higher education Undergraduate degree (e.g. BA, BSc) Master's degree (e.g. MA, MSC)	Adapted from ONS Census (2011), question on qualifications		

Question	Question from:	Validation	Setting and participant sample
Doctorate (e.g. PhD) Professional qualification (e.g. teaching, nursing, accountancy) Other vocational/work-related qualifications Foreign qualifications No qualifications			
Q41. How many children do you have that live at home with you or who you have regular responsibility for? None 1 2 3 4 5 or more	Question added by researcher This question was added to evaluate how many children respondents were responsible for and potentially administering antibiotics to. Question was assessed for logic and clarity, before being piloted.		
Q42. How many of these children are aged between 3 month and 6 years old? None 1 2 3 4 5 or more	Question added by researcher This question was added based on the literature that this age group is often prone to infections. Question was assessed for logic and clarity, before being piloted.		
Q43. What is the first part of your postcode? (Open question)	Question added by researcher This question was added to map areas where respondents lived onto IMD maps, to evaluate a potential association between deprivation and knowledge, understanding, and attitudes. Question was assessed for logic and clarity, before being piloted.		

Question	Question from:	Validation	Setting and participant sample
Q44. We would like to invite you to take part in a focus group/interview. If you are willing to participate in this next phase of our study, please leave your contact information (e.g. email address or phone number) below.	Question added by researcher. This question was added to facilitate participant recruitment for Phase 2. Question was assessed for logic and clarity, before being piloted.		
Q45. On which topics, if any, would you like to receive more information? Resistance to antibiotics How to use antibiotics Medical conditions for which antibiotics are used Prescription of antibiotics Links between the health of humans, animals and the environment Other None I don't want to receive more information on these issues Don't know	European Commission (2018). Special Eurobarometer 478		
Q46. Which of the following sources of information would you use in order to get trustworthy information on antibiotics? A doctor A nurse A pharmacy A hospital Another health care facility Family or friends An official health-related website (e.g. a website set up by the national government/ public health body/ European Union) A health-related personal blog Another health-related website Online social networks	European Commission (2018). Special Eurobarometer 478		

Question	Question from:	Validation	Setting and participant sample
TV Newspapers or magazines The radio Other You are not interested in finding information on antibiotics Do not know			

During the design of the survey each section had a title to inform the participants about the topic on which they would be questioned. None of the questionnaires used in the development of this survey made use of section titles in their surveys, however using signposting was suggested by the volunteers involved in piloting the survey (discussed further in section 3.2.1.1.2), to make it more user-friendly.

A progression bar was also included in the online questionnaire, to allow the respondents to see how far they had reached in the survey. There is mixed evidence regarding the effectiveness of using progression bars in online surveys to reduce drop-off rates (Tukibayeva & Sarraf, 2012; Villar et al., 2013; Snijders et al., 2020), with some authors reporting that utilising progress bars has no effect on survey completion (Conrad et al., 2011; Snijders et al., 2020), and others suggesting an increase in participant enjoyment of the survey experience and a decrease in drop-offs when progress bars were included (Yentes et al., 2012; Villar et al., 2013). Socio-demographic questions were placed at the end of the survey, rather than at the very beginning, as they involved more personal questions regarding gender, age, ethnicity, post-code, place of birth, and educational attainment (Teclaw et al., 2012; Lor et al., 2017). This was done so that participants were not discouraged by answering these questions from the beginning of the questionnaire, which could lead to increased drop-off rates (Jones et al., 2013; Stevenson, 2017; Miles, 2018).

3.2.1.2 Questionnaire piloting (Phase 1, Stage I)

Following the questionnaire development, it was assessed for logic and clarity within the supervisory team, before being piloted with a group of volunteers (n=10). Piloting was carried out to ensure clarity of content, that the questions were understandable, and that there was a logical flow to the questions. The group of volunteers comprised of parents from the general public, of mixed ethnicity and gender, who were not involved in the research project, were not health professionals, and had various levels of educational attainment. This was done to ensure that the survey was clear and easy to complete by participants who did not have specific knowledge on ABR. Piloting ensures that potential questionnaire faults and problems can be dealt with before data collection begins (Boynton & Greenhalgh, 2004; Ritter & Sue, 2007; Kazi & Khalid, 2012), and that the questions are comprehensive and adequate for the respondents (Norman et al., 2001; van Gelder et al., 2010). It also allows the researcher to confirm that the questions are in the right order, flow well, and that answering the questionnaire online is feasible (Ritter & Sue, 2007; Kazi & Khalid, 2012; Regmi et al., 2016). Piloting is an important step during questionnaire design and development, as it helps detect flaws and errors in formatting, contents, and grammar (Kazi & Khalid, 2012; Regmi et al., 2016).

The volunteers involved in the piloting process were asked to provide feedback to the researcher upon questionnaire completion. As the piloting process occurred prior to the COVID-19 pandemic, both paper and online questionnaires were piloted, as these were the tools that were anticipated to be used for quantitative data collection. Therefore, some of the volunteers were given a paper questionnaire to complete, while the others were asked to complete the online version. Piloting of the online survey was important to ensure sure that the formatting on the JISC (Joint Information Systems Committee) online website was adequate, and that completing the paper and online questionnaire was feasible and easy for the potential respondents. While the volunteers completed the questionnaire, they were timed by the researcher, to ensure it took on average 15 to 20 minutes to complete, as various studies suggest that participants are more likely to respond to the short questionnaires compared to long ones, and higher completion rates are observed with short questionnaires (Sahlqvist et al., 2011; Kost et al., 2018; Sharma et al., 2022).

Volunteers were asked to give feedback on the structure, length, and feasibility of the questionnaire, as well as the language, clarity, and flow of questions, so that errors in formatting, contents, and grammar were detected (Kazi & Khalid, 2012; Regmi et al., 2016). Feedback showed that most of the questions were comprehensible with the exception of a small number that had ambiguous phrasing that could potentially confuse participants completing the survey. For example, the question "Would you change your pediatrician because according to your opinion he/she does not prescribe antibiotics often enough for your child?" was changed to "If the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional", for better understanding.

The volunteers also recommended adding links to online resources on ABR and ABR awareness, at the end of the questionnaire, to encourage respondents to get more information on the issues mentioned in the questionnaire. Although this had not been done in the previous questionnaires used to inform the development of the survey for this study, it was considered a good opportunity to share ABR information from trustworthy sources, with participants. Therefore, links to ABR awareness messages and campaigns from the NHS, PHE, and the WHO, were added to the last page of the questionnaire, along with the researcher's contact information in case participants wanted more information or had questions on the subject or the study.

3.2.1.3 Recruitment/Sampling:

As no previous similar study has been conducted in GM, that could inform the sample size used for this study, a Sample Size Calculator was used to determine the minimum sample size required for the results to be of significance (https://www.surveysystem.com/sscalc.html). The calculation was based on a response distribution of 50%, with a confidence interval of 5%, and a 95% confidence level. The calculated sample size was estimated to be 385 participants; however, to guarantee accuracy and account for any missing data or non-responses the participant sample size was increased to 400.

Facebook and Twitter were the platforms chosen, as they both have a very large following, with Facebook having approximately 2.93 billion (as of 1st quarter of 2022) and Twitter having 206 million users (as of 2nd quarter of 2021) (Dixon, 2022). Using these types of social media platforms for research is becoming increasingly popular among researchers, particularly for recruitment (Snelson, 2016; Dol et al., 2019; Chang & Wang, 2021). Recruiting participants through social media may be more practical and cost-effective compared to traditional recruiting methods (Snelson, 2016; Dol et al., 2019; Chang & Wang, 2021), which were not an option in this study. Although social media is a promising tool for participant recruitment, there are still gaps in the literature regarding certain ethical concerns that may arise while using social media for health research recruitment, such as privacy issues, informed consent, anonymity, and risk of harm (Townsend & Wallace, 2016; Dol et al., 2019; Cheng & Wang, 2021). However, as Facebook and Twitter were only used to distribute the online questionnaire, these issues were circumvented by including a disclaimer for participants in the questionnaire, regarding their anonymity, privacy, and consent.

A preliminary search of both social media platforms found over a thousand online international and national communities, groups, and pages dedicated to parenting, parents and children, and parents and carers. This was narrowed to parents living in GM and having children aged between 3 months and 6 years old. To achieve this, a systematic search for these groups on Facebook and Twitter was conducted, using the following keywords: parent(s), parenting, parent(s) and child/children, father(s)/dad(s), mother(s)/mum(s), carer(s), parent(s) and carer(s). These keywords were systematically paired with the name of each borough in GM: Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford, and Wigan. The search was also widened to include other GM online groups and pages, affiliated to the ones selected from the systematic search. All the relevant GM parental groups and pages were included in this study, irrespective of the number of followers they had, to ensure that the questionnaire was shared as many times as possible, to improve response rates (see Table 11).

Table 11: GM Facebook and Twitter groups (n=222) selected for the online questionnaire distribution

GM Borough	Facebook and Twitter Groups/Pages
Bolton	Bolton Parent Carers Page CalmFamily Bolton and Chorley Bolton Children's Asthma Page Water Babies Manchester Parents and Carers Group Daytrippers-Bolton family and fundraising Families and Babies Bolton Reach Family Project, Bolton Child Disability Living Allowance Parent to Parents help, advice & moans Parent Squad The Savvy Swim Parent Mummy Social Bolton Children's Opportunity Group Autism in Bolton Mini Giants Bolton Funtime Activities Sports for Kids Lagan's Foundation Fluff is the Future NCT Cloth Nappy Library Bolton Maternity Voices Partnership Bolton Toy Library COG Parent's and Carer's Group
Bury	BURY2GETHER – Parent/Carer Group Chat Single Mums Den Parenting on a Budget Parent Carers Lancashire Parents of scoliosis children UK Parents of Children with ASD/Asperger's (UK only) Attachment Disorder UK (parents'/carers of children with AD) The Career Mum. Inclusive & empowering (men & women, parents or not) Weight loss management group for parents with children and teens Family fund support for parents to advise/moan to each other Bury SEN Parents Strong Mums Emma's Diary Sleepless Army New Parents Bury Community Parents of children with mental health issues UK autism spectrum parents support group UK parents of children with asthma support group What's on Bury Bury Young Carers Sling & Meet – Salford, Swinton, Walkden, Bury Bury West & North Children's Centre Hub Dream Big Little One Day Nursery – Bury

GM Borough	Facebook and Twitter Groups/Pages
	Mumsnet Bolton Bury Bury East Children's Centres Bright Starts Nursery – Bury Parents and toddlers group Bury Baptist Church Twinkle parents group Radcliffe Parents & Carers (Bury)
Manchester	Manchester Mums Little Peacock – Home ParentHub Baby and Children's Market – Greater Manchester Manchester Plays On What to Do with The Kids in Manchester TinyTalk South Manchester Baby Signing and Toddler Talking Spoons Charity Mini First Aid Manchester North, Salford & Bury Baby Boogie – Manchester Culturekidsmanchester South Manchester Twins and Multiples Home-Start South Manchester Manchester First Steps-Parents as Teachers Manchester Home Birth Conference Prestwich and North Manchester Sling Library Flexi-Minder Manchester Little Learners Manchester North Adventure Babies South Manchester Manchester Parents Group Manchester with Kids – Family Friendly Event + Activity Guide Greater Manchester Homebirth ASGMA – Autistic Society Greater Manchester Area Greater Manchester Neonatal Parent Advisory Group Families Manchester Magazine Manchester Band Parents Association Support for parents fighting social services in Manchester Home-Start Manchester Manchester SB & Hydro Parents South Manchester Down Syndrome Support Group Single parents Manchester South Manchester Natural Parenting Group & Sling Library Manchester Family Toddler Sense Manchester Central Gentle Parenting South Manchester Manchester Essex Parents Advocacy Connection University of Manchester Student Parents and Carers Manchester Parents Group Manchester Parent Carer Forum Manchester Mums
Oldham	Puddleducks Childminding Oldham School's Out – Oldham Positive Steps Precious Glimpse – Burnely, Saltaire & Oldham – Manchester Magical Milestone – Parent Hub Parent Champion Project Oldham Brighter Beginnings

GM Borough	Facebook and Twitter Groups/Pages
	Baby Sensory & Hello Baby Massage Oldham BabyBallet Oldham Made in Oldham Friends of Bright Futures School Oldham Deaf Children's Society – ODCS Oldham and Rochdale NCT Home-Start Oldham, Stockport & Tameside Oldham SEND Information, Advice & Support Service Oldham Parent Carer Forum
Rochdale	Baby sensory Rochdale, Ramsbottom and Rossendale Rochdale Parent Carers Voice Chat UK Parents Work from Home Jobs Kids Casting Calls Parents of Child Actors & Models UK Parents of Preemies Support UK Therapeutic Parenting Rochdale Community Little Stars, Parent and toddler group Parents Protecting Children UK Home-Start Rochdale Borough Boutique Baby Sale – Rochdale & Middleton Rochdale Parent Carers Oldham and Rochdale Sling Library
Salford	Families Greater Manchester Salford Foundation Trust Together H & H Family Centre Family on The Go Salford Sayf Salford Kidzrus Salford Family Food Bank Salford Summer Family Fete Salford Partnership Family Hubs – Early Help Service Salford Young Parents Project Salford Young Parents Network South Salford Sure Start Children's Centre Home-Start Trafford, Salford & Wigan Salford parents PND support group North Salford Sure Start Children's Centre Salford Parent Voice
Stockport	Parenting Additional Needs Warrington Parents and Carers – Warrpac Parents Together Baby Sensory Stockport Stockport Tadpoles Support Group for Children and Families with Diabetes Headstart Phonics More Play More Often Baby Choices Little Learners Stockport Proud 2 b Parents Adoption Counts Start Well Stockport TinyTalk Stockport East ParentPreneur Bramhall Stockport Maternity Voices Partnership Cheeki Monkeys Stockport

GM Borough	Facebook and Twitter Groups/Pages
	Signpost Stockport for Carers Stockport Sling Library Stockport Mumbler News Page SPACE Stockport ADHD Parent Support Group PACTStockport Toddler Sense Stockport TJA Stockport parents and students 2021 Godley Parents Chat Little stars Stockport parents and carers Stockport Apex Parents & Members page Stockport SEND Families Stockport What's on in Stockport TinyTalk Stockport East Parents SPACE – Stockport Parents of ADHD Children in Education Stockport school (mile end) parents Everything Stockport
Tameside	The grown up's parent network Tameside Parenting Network Tameside Children's Centres Talk of Tameside | Facebook North Tyneside Parent Carer Forum Tameside Peer to Peer Support Group for Baby Reflux and Baby Allergies Parenting Journey Events Relax Kids Tameside Family Nurse Partnership Tameside Inclusability Hub Tameside Eggs for Education Raring2go Tameside Tameside 30 hours childcare OKE – Our Kids Eyes Lushtums Manchester, Cheshire and Tameside Babease Massage – Hypnobirthing & Pregnancy Yoga, Tameside Tameside Positive Birth Group TASCA – Tameside Action for Social Communication & Autism Support group Peek-A-Boo Daycare Tameside Grow in Tameside Baby Sensory Tameside
Trafford	Childminders in Trafford Special parents in Trafford – Trafford Parents Forum Trafford Prime parents Trafford Parents Against Cuts: SEN Elmscot Group of Day Nurseries, Nursery Schools & Kids Collective Clubs Little Kickers UK The Park Playgroup In the Night Garden Live Parents' First Aid Training C.I.C Friends of Little Bundles High-Functioning Trafford Play Factor Trafford PDA Parents and Carers Transitions Project at Trafford Parents Forum Trafford Childcare Providers

GM Borough	Facebook and Twitter Groups/Pages
	Special Parents in Trafford -Trafford Parents Forum Home-Start Trafford, Salford & Wigan
Wigan	Kids United Wigan Raring2go Wigan Bargains for Parents Wigan Joxytales Little Ravers Littliees childminding Little Angels Toddler Group Worsley Hall Wigan Community Resource Centre – Bramble House Baby Sensory Wigan and St Helens Mini Giants Wigan Boutique Baby Sale – Wigan Premier – Bolton, Leigh, Warrington & Wigan Wow Group West Lancs, Wigan, St Helens, Southport and Ormskirk CalmFamily Warrington and Wigan Westfield Start Well Centre Mitchy Titch Yoga Fun & Fitness Classes for babies, children and parents Wigan & Leigh T1 Parent Support Group Hop Skip & Jump Wigan Wigan Parent Carer Forum

Once the groups were identified, an invitation message was sent to the administrators of the Facebook groups (Appendix 7). The recruitment message included introductory information regarding the researcher (name, email address, university contact details), title of the PhD research, aim of the study, brief information on the study, information on consent, confidentiality and anonymity, and information on the right to withdraw from the study at any time. The recruitment message also contained some brief instructions on how the administrators could help distribution. Once the administrators agreed (n=9) to participate in the distribution, they were sent the link to the questionnaire.

For the Twitter questionnaire distribution, a link was shared on the researcher's page, followed by a brief tweet (Appendix 6) explaining the purpose of the study, and encouraging parents in GM to complete the questionnaire and share the tweet and link. The online questionnaire distributed via Twitter relied on 'retweets', as it has been found that tweets that include a link are more likely to be retweeted (i.e., shared by other twitter users) (O'Connor et al., 2013; Snelson, 2016; Townsend & Wallace, 2016; Arigo et al., 2018). The tweet recruiting participants for the online survey generated 27 retweets.

To ensure that parents completing the online survey were living in GM, the administrators were asked to attach a short message to the post containing the link to the survey, stating that it only applied to parents living in GM. This was also done for the questionnaire distribution via Twitter.

The first part of the questionnaire comprised a short paragraph explaining the aim and purpose of the study, crucial information regarding participant involvement, confidentiality, and the right to withdraw from the study at any time. Participants were informed that the questionnaires were used to generate anonymous responses and that their participation was completely voluntary. They were reassured that no identifiers were used during data collection, analysis, and presentation, and were encouraged to answer the questions to the best of their ability.

3.2.1.4 Procedure/distribution (Phase 1, Stage II)

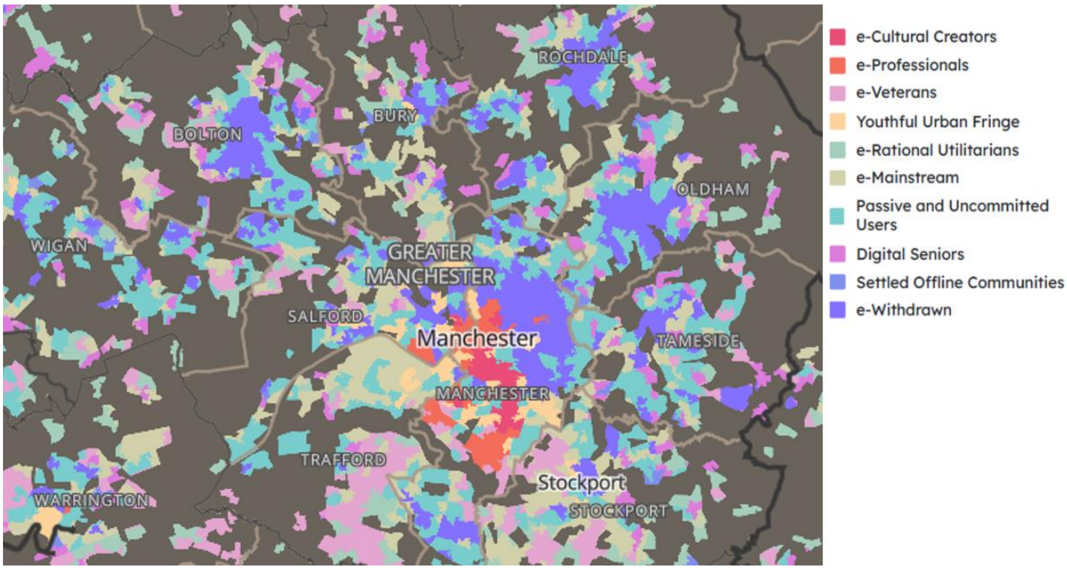
After survey development and piloting, cross-sectional survey was conducted (Stage II) (see Figure 15) to gain an overview of parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance, in GM. Online questionnaires were distributed via the Joint Information Systems Committee (JISC) online website (https://www.jisc.ac.uk). Online surveys have been used successfully in numerous studies on ABR and antibiotic stewardship, including studies mentioned in section 2.6 (Hall et al., 2020; Roope et al., 2020; Van Hecke et al., 2020; Hayes(b) et al., 2021).

Online questionnaires are a quick and cost-effective way of reaching a big population sample, with participants having similar characteristics from diverse geographical areas, in a short time frame (Jenn, 2006; Wright, 2006; Chang & Vowles, 2013). Using an online questionnaire is also convenient for some respondents, as they can take their time to answer the questionnaire, complete it in multiple sessions, and at a time that is convenient for them (Boyton & Greenhalgh, 2004; Ornstein, 2013; Regmi et al., 2016). Online surveys can have diverse questions, such as multiple-choice questions, dichotomous questions, scales, and open-ended questions, which are similar features seen in paper questionnaires (Evans & Mathur, 2005; Hunter, 2012; Kazi & Khalid, 2012). However, unlike paper questionnaires, questionnaires distributed via online platforms such as the JISC online website, provide convenient and consistent data management, which makes the data collection process more efficient (Hoonakker & Carayon, 2009; Van Gelder et al., 2010; Ward, Clark, Zabriskie & Morris, 2012; Ball, 2019). Using online questionnaires also facilitates data transfer into a database such as excel or SPSS (Statistical Package for the Social Sciences), for data analysis. Having the facility to export the data collected into a convenient database helps reduce transcription errors and prevents survey modification by respondents (Ward et al., 2012; Ornstein, 2013; Regmi et al., 2016).

Although the use of online questionnaires has many advantages that could appeal to researchers and respondents, using this tool could lead to issues such as participants not providing accurate information and answers to the questions in the survey (Evans & Mathur, 2005; Hunter, 2012; Kazi & Khalid, 2012; Regmi et al., 2016). However, this could also occur with other types of surveys as well (Kazi & Khalid, 2012; Regmi et al., 2016). Using online questionnaires to collect data can also lead to sampling issues (Van Gelder et al., 2010; Ward et al., 2012; Ball, 2019). This is particularly so when using online communities to distribute the questionnaire, as accurate sampling frames can be difficult to establish due to sporadic participation of individuals in various online communities (Ward et al., 2012; Ornstein, 2013; Regmi et al., 2016). Another disadvantage of online questionnaires is self-selection bias, as some individuals from internet communities are more likely than others to complete online surveys (Regmi et al., 2016; Ball, 2019). Studies have shown that young people are more likely than older people to complete online surveys (Helsper & Residorf, 2017; Mulder & de Bruijner, 2019; Kelfve et al., 2020), and that people with higher education levels are more willing to respond to online surveys (Helsper & Residorf, 2017; Corness & Bosnjak, 2018; Mulder & de Bruijner, 2019; Andrade, 2020). Socio-economically deprived people are also less likely to respond to online surveys (Helsper & Residorf, 2017; Kelfve et al., 2020). These factors could all lead to skewed results once the data collected is analysed, which could inhibit the estimation of population parameters, as well as any generalisations that could be made regarding the findings obtained from the study (Regmi et al., 2016; Ball, 2019; Andrade, 2020).

As online questionnaires were used to collect data for this study phase, digital literacy and engagement are important factors that need to be addressed. According to the ONS, in February 2020, 96% of households in the UK had access to the internet (ONS, 2020c). Digital accessibility and engagement offer people more accessibility to information, as well as more choice and control over their health (Stone, 2021). Approximately 6% of the UK population (approximately 1.5 million households) did not have internet access in their homes in March 2021 (Ofcom, 2021). In GM, level of engagement with the internet is heterogeneously distributed as shown in the map below (see Figure 16) (Consumer Data Research Centre [CDRC], 2022).

Figure 16: Internet user classification; how people in different parts of GM interact with the internet.



(Source: CDRC Mapmaker, 2022)

Highest levels of engagement are seen among students (e-Cultural Creators), and urban professionals (e-Professionals & e-Veterans), accounting for 15.8% of the GM population (CDRC, 2022). Average levels of engagement are noted among GM populations that live at the edge of urban areas (e-Mainstream group), in the periphery of materially deprived areas (Youthful Urban Fringe), and among ageing and retired members of the population (Digital Seniors) (CDRC, 2022). These groups with average engagement with the internet, comprise of 29% 0f the GM population (CDRC, 2022). Below average engagement is observed among those living in rural and semi-rural areas (e-Rational Utilitarians) and outside city centres (Passive and Uncommitted Users), who have low engagement with the internet due to poor infrastructure or well below average access to broadband; and among the elderly living in semi-rural areas (Settled Offline Communities) (CDRC, 2022). People with below average engagement with the internet make up 38.1% of the GM population, whilst the least engaged make up 17.1% (CDRC, 2022). This group of people rarely engage with the internet (e-Withdrawn group,) and includes the highest number of people with no or very limited internet access (CDRC, 2022). E-Withdrawn groups in GM are generally located in deprived areas of urban regions, areas of high ethnic diversity, and have the highest rate of unemployment and social housing compared to the other groups (CDRC, 2022). Characteristics of the different groups of internet users in GM, depicted in the map (Figure 16), are described further in Table 12 below.

Table 12: Characteristics of internet user groups in GM

Internet User Groups (percentage of GM population)	**Characteristics of people living in different parts of GM and how they interact with the Internet.**
e-Cultural Creators (1.7%)	• High levels of daily internet engagement (social networks, communication, streaming, and gaming). • Very active users, aged between 18 to24 (big multicultural and student populations. • Well-above average ownership of laptop devices among users. • Above average internet access (via mobile and at public places). • Mainly living close to the city centre or near Higher Education Institutes, with good infrastructure like broadband.
e-Professionals (3%)	• High levels of daily internet engagement (social networks, communication, streaming, and gaming). • Experienced users comprised of fairly young populations of urban professionals (aged between 25 and 34). • Use variety of devices and methods to access the internet. • Ethnically diverse, with strong representation of white non-British populations. • Well-qualified and have very high availability of internet at work. • Mainly residing in residential areas neighbouring city centres or in affluent suburbs.
e-Veterans (11.1%)	• Usually from affluent families, typically living in low-density suburbs (mainly middle-aged and highly qualified professionals). • Frequent and experienced internet users (2nd highest levels of internet access at work after the e-Professionals users). • Use multiple devices and a variety of ways to engage with the internet. • Fairly mature users, with high levels of engagement for information seeking, online services, and shopping. • Lower levels of internet engagement for communication and entertainment.
Youthful Urban Fringe (2.5%)	• Students and other young urbanites (from ethnic minorities) living at the edge of city centres, in informal households that often border materially deprived communities. • Average access to broadband. • Average levels of engagement with the internet engagement over-all (mainly high levels of social media usage).
e-Rational Utilitarians (10.7%)	• Late middle-aged or elderly (including a high proportion of retired home owners). • Reside mainly in rural and semi-rural areas on the outskirt of cities. • High demand for internet services by these users, but supply is low due to poor infrastructure. • Engagement with the internet via in house personal computers (low levels of mobile access). • Internet use mainly for finding information or access to online banking (internet used as a utility rather than for entertainment purposes).
e-Mainstream (18.7%)	• Comprised of people from a wide range of socioeconomic backgrounds and from represent heterogeneous neighbourhoods.

Internet User Groups (percentage of GM population)	Characteristics of people living in different parts of GM and how they interact with the Internet.
	• Reside at the periphery of urban areas or in transitional neighbourhoods. • Typical user has average level of engagement.
Passive and Uncommitted (26.1%)	• Comprised mainly of people with limited or no interaction with the internet. • Reside outside city centres and close to semi-rural areas, with below average access to broadband • High levels of employment in semi-skilled and blue-collar occupations. • Individuals are rarely online (internet is typically used once a week or less). • Users typically prefer accessing the internet via smartphones (social networks, gaming, and some online shopping).
Digital Seniors (7.8%)	• Predominantly retired White British, relatively affluent. • Average internet usage (typically using a personal computer at home). • Infrequent users but are able to use the internet to seek information, use online financial services, for and online shopping (less able to use the internet for social networks, streaming or gaming). • Typically reside in semi-rural or coastal regions, with limited internet service.
Settled Offline Communities (1.3%)	• Elderly and retired White British, who tend to reside in semi-rural areas. • Limited engagement with the internet (limited or no internet access). • Typically use home computers rather than mobile devices to find information rather than social networking, gaming or media streaming.
e-Withdrawn (17.1%)	• Mostly comprised on individuals who are the least engaged with the internet. • Reside in areas located in deprived neighbourhoods of urban regions. • Characterised by less affluent White British individuals or areas of high ethnic diversity. • Has the highest rate of unemployment and social housing compared to other groups. • Highest proportion of people having no internet access, or those having access but never engaging with the internet. • Lowest rates of internet engagement, especially for information seeking and financial services. Lowest rates of online access via a mobile device. • Higher than average access to cable broadband by TV Provider, suggesting that some individuals may have opted into broadband mainly for the TV-associated benefits. • It is possible that many people within this e-Withdrawn group have opted out of online engagement, either because it is considered unnecessary or because of economic reasons.

(Adapted from: CDRC, 2022)

People in households that have no access to internet services, those aged over 65 years old, and people who are financially vulnerable, are more at risk of digital exclusion (Ofcom, 2021; Stone, 2021). As shown in Figure 16 and Table 12, digital exclusion is a problem that could be affecting more than 17% of the GM population. As GM is an area of multiple deprivation levels and has an aging population, there are multiple pockets of digitally excluded areas and communities across GM (Figure 16). However, given the demographic characteristics of the parents who participated in the PhD study, they would most likely fit in the e-Cultural Creators (1.7%) or e-Professionals (3%) internet user groups, as they were all mostly well qualified, using a variety of devices and methods to access the internet, ethnically diverse, having high levels of daily internet engagement, and above average internet access (CDRC, 2022). Therefore, the sample most likely missed are those who would be considered e-withdrawn.

Considering that participant recruitment can be a slow process (Crawford et al., 2001; Kaplowitz et al., 2004), links to the online questionnaire for this study were distributed on social media sites (Facebook & Twitter). Using social media platforms such as Facebook and Twitter offered the potential to reach large and/or specific participant groups, and increase participant recruitment cost-effectively (O'Connor et al., 2013; Snelson, 2016; Townsend & Wallace, 2016; Arigo et al., 2018). Previous studies on recruiting participants via social media reported that using accessible and influential social media groups for the target population helped in participant recruitment (O'Connor et al., 2013; Arigo et al., 2018; Zucco et al., 2018). Therefore, using online communities, such as those on Facebook and Twitter, offer an effective way to gain access to demographically similar groups of people, with specific interests, characteristics, attitudes, beliefs, goals, and values (Regmi et al., 2016; Ball et al., 2018; Zucco et al., 2018; Jones et al., 2020; Leighton et al., 2021; Darko et al., 2022).

It can be argued, that using a questionnaire distributed and promoted via social media may not capture the authentic views of the sample population (Regmi et al., 2016; Ball, 2018), i.e., the survey may not capture the views of those in the target population who do not use social media, particularly those considered e-withdrawn. However, given the pandemic situation and the COVID-19 regulations, recruiting parents from online communities was the only feasible option for data collection. Furthermore, many of the groups of internet users in GM use social media to a certain extent; and parents from this PhD study are most likely to be classified as e-Cultural Creators and e-Professionals (Table 12) (CDRC, 2022), making it a suitable way of targeting various parent populations across GM, to allow for a greater sample size, during a pandemic, when paper-based questionnaires were not feasible. Additionally various studies on ABR that have been mentioned in this thesis have utilised online tools to collect data (Roope et al., 2020; Wilding et al., 2021; Ashiru-Oredope et al., 2022; EC, 2022). For example, the fourth and most recent survey in the Eurobarometer survey series on AMR (using the same survey that informed the development of the questionnaire used in this PhD study) was conducted during the pandemic and utilised an online platform, as well as a Random Digit Dialling design to conduct the survey via telephone (mobile and landline) (EC, 2022). In Wilding et al.'s (2021) RCT, one of the phases of their study was recruiting participants via an online platform, who followed a link to an online survey. Ashiru-Oredope et al.'s (2022) cross-sectional study, also utilised an online survey that was disseminated to healthcare workers, via email, national AMR groups, and Twitter. In Roope et al.'s (2020) randomised experiment, an online survey was used, prior to COVID-19, as it was a way of targeting a big sample of the UK general public (see Appendix 9). However, it is important to note that as these studies were conducted online, they did not capture e-withdrawn communities.

3.2.1.5 Data analysis:

Quantitative data collection began in April 2020 (Phase 1, Stage II), and the online questionnaire remained open until 1st August 2020. Data extraction, cleaning, and analysis began in August 2020. The objective of the quantitative phase was to investigate parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance, in GM. Therefore, the study population was parents of children aged 3 months to 6 years old, living in GM. Based on the fulfilling objective of this phase, the research questions were as follows:

- How are parents' knowledge and understanding of antibiotics (i.e., is knowledge and understanding lacking and/or are there misconceptions and misunderstandings)?
- Do parents know what antibiotics are used for (i.e., antibiotics should only be used to treat bacterial infections)?
- Do parents know that using antibiotics can lead to side-effects?
- What do parents know about ABR and how ABR occurs?
- Do parents think ABR is a serious problem?
- Do they have good self-reported practices when they use antibiotics?
- Do they follow antibiotic prescription advice?

Inclusion criteria for this phase of the study included parents: living in GM with a child/children aged 3 months to 6 years old at the time of data collection; speaking/reading

English; who had access to a computer (due to changes brought by COVID-19 restrictions); and who had access to social media.

Exclusion criteria included parents: living outside of GM; who were not computer literate; had no access to social media; had children younger than 3 months old or older than 6 years at the time of data collection; and who did not speak/read English. Members of the public who were not parents were also excluded.

Data cleaning was conducted using Microsoft Excel, and SPSS 25.0 to conduct further analysis of the cleaned data. Answers were coded, and the variables and questions given labels to facilitate data analysis. Non-responses were coded as missing, and the rest of the data were coded using numbers to facilitate data analysis (Appendix 10). To facilitate data analysis, particularly due to the small sample size obtained (n=120), the 5-point Likert scale used in the questionnaire was reduced to 3 points (agree/undecided/disagree and usually/sometimes/never). Certain demographic categories were also collapsed into fewer groups; for example, for the ethnicity variable, as most respondents (95%) were of white ethnicity, the ethnicity variable was grouped into 'white' and 'other ethnicities', which comprised of the following ethnicities: Asian (including Asian British), Black (including African, Caribbean, and Black British), Mixed (including multiple ethnic groups), and other ethnic groups. The variables were then labelled to facilitate the analysis.

Many researchers choose to collapse categories, as it may be considered advantageous for the analysis of sparse data (Grondin & Blais, 2010; Calvin et al., 2020; Van Dusen et al., 2020); however, the effects of doing so have not been systematically evaluated (DiStefano et al., 2021). Usually collapsing categories, such as a Likert scale, is performed when one or more items being measured with the scale has a low frequency of response (Calvin et al., 2020; Van Dusen et al., 2020; DiStefano et al., 2021). Therefore, existing scales are recoded into fewer categories to allow better clarity of the data obtained, and easier identification of patterns (Grondin & Blais, 2010; Calvin et al., 2020; Van Dusen et al., 2020). This can also help reduce the amount of skewedness observed with item-level data, and improve results (Calvin et al., 2020; DiStefano et al., 2021). However, a limitation of this procedure is that information from the data being analysed may be lost; resulting in a reduction in power to detect misspecification or false-positive evidence, which may introduce bias in the data and affect findings obtained from chi-square tests (Hayashi et al., 2007; Grondin & Blais, 2010; DiStefano et al., 2021). The decision to collapse categories, rather than analyse sparse data, is quite common among researchers; hence, this practice can be seen in many peer-reviewed studies, including studies that informed this quantitative phase (McNulty et al., 2007; Khan et al., 2013; Bert et al., 2016), and other national and international studies on ABR and antibiotic use (Saha et al., 2020; Khumra et al., 2021; Moore et al., 2021; Scarborough et al., 2021; Almeida-Costa et al., 2023; Teague et al., 2023).

Two levels of measurement were identified from the data obtained: nominal (e.g., gender and ethnicity) and ordinal (e.g., level of education and age range). The exposure variables were the questions on knowledge and understanding, attitudes, and self-reported practices with regards to antibiotics. The covariates/potential confounding factors were gender, age, ethnicity, level of education, deprivation level, and number of children.

Univariate data analysis was selected to better understand the data set obtained. In Univariate analysis each variable in the data set is explored separately, to summarise and find patterns in the data (Arbogast & VanderWeele, 2013; Pallant, 2016; DeCarlo et al., 2020; Kinney et al., 2023). With this method of analysis, variables are not analysed in relation to each other, but rather in isolation and is considered the best method for descriptive research questions (Arbogast & VanderWeele, 2013; Pallant, 2016; DeCarlo et al., 2020; Kinney et al., 2023). Using this method also allows a better understanding of what each variable looks like, i.e., if certain categories have not been selected by participants or if one of the variables has lot of missing data (Arbogast & VanderWeele, 2013; Pallant, 2016; DeCarlo et al., 2020; Kinney et al., 2023). Additionally univariate analysis can be used to identify associations between covariates and the exposure variables, despite the increased risk of obtaining an inflated Type 1 error (discussed further below) as more analysis is conducted (Arbogast & VanderWeele, 2013; Pallant, 2016; DeCarlo et al., 2020; Kinney et al., 2023). Although one could argue that using multivariate analysis (a type of analysis of variance used to evaluate the relationship between two or more dependent variables) would be useful to consider the variables together and would adjust for the increased risk of Type 1 error, this type of analysis requires a large sample size (Pallant, 2016). To use multivariate analysis, there has to be more cases in each category than there are dependent variables (Pallant, 2016). However, given the small sample size achieved for this study (n=120), with many categories not selected by participants (see Appendix 1) multivariate analysis was not possible.

After data collection and data cleaning, variables obtained for each question were analysed using descriptive statistics, i.e., frequencies and percentages, which are presented in tables. Cross tabulations were then carried out to observe the response frequencies and percentages for each question, compared to demographic category; chi-square tests (X^2) were performed to compare frequency data between genders, levels of education, deprivation, age groups, and ethnicities. Fisher's exact test was used whenever the expected count in chosen cells was less than 5 (Pallant, 2016).

The chi-square test of independence is an inferential statistical test that allows conclusions to be made regarding a population sample, i.e., comparisons between 2 variables can be made to understand whether they are related to the sample population (Pallant, 2016; Turney, 2023). This test evaluates a null and alternative hypothesis. The null hypothesis (H_0) assumes that there is no association between the two variables being tested (Flechner & Tseng, 2011; Pallant, 2016; Turney, 2023), for example "there is no association/relationship between knowledge on antibiotics being inefficient on viruses (variable 1) and gender (variable 2)". Whereas the alternative hypothesis (H_1) indicates that there is an association between the two variables (Flechner & Tseng, 2011; Pallant, 2016; Turney, 2023), for example "there is a positive association/relationship between knowledge on antibiotics being ineffective to treat colds (variable 1) and level of education (variable 2)".

P-value is usually set at 0.05, showing that there is a 5% (α=0.05) chance that the result is a false positive; meaning that although there is a statistically significant result, there is in fact no association between the variables (Pallant, 2016; Thies et al 2016; Turney, 2023). P-value is the probability that the difference between the variables is due to random chance when the null hypothesis is true (Type I error/random error/false positive) (Flechner & Tseng, 2011; Thies et al., 2016; Corbin, 2020). Type II error/systematic error/false negative occurs when the null hypothesis is accepted, but is actually false (Flechner & Tseng, 2011; Thies et al., 2016; Corbin, 2020). Thus, the null hypothesis is rejected if the probability of Type I error is <5% ($p<0.05$). Results that had a p-value less than 0.05 ($p<0.05$) were considered statistically significant; therefore, the null hypothesis is rejected and shows that the variables are related (Pallant, 2016; Turney, 2023). Results that had a p-value more than 0.05 ($p>0.05$) were considered statistically non-significant; therefore, the null hypothesis cannot be rejected and shows that the variables are unrelated (Pallant, 2016; Turney, 2023). It is important to note that a larger sample will generally reduce the probability of a Type I error and would consequently decrease the p-value (Flechner & Tseng, 2011; Corbin, 2020). In the case of a small sample size (such as the one obtained for this study, n=120), getting a false negative could be highly likely (Corbin, 2020; Indrayan & Mishra, 2021).

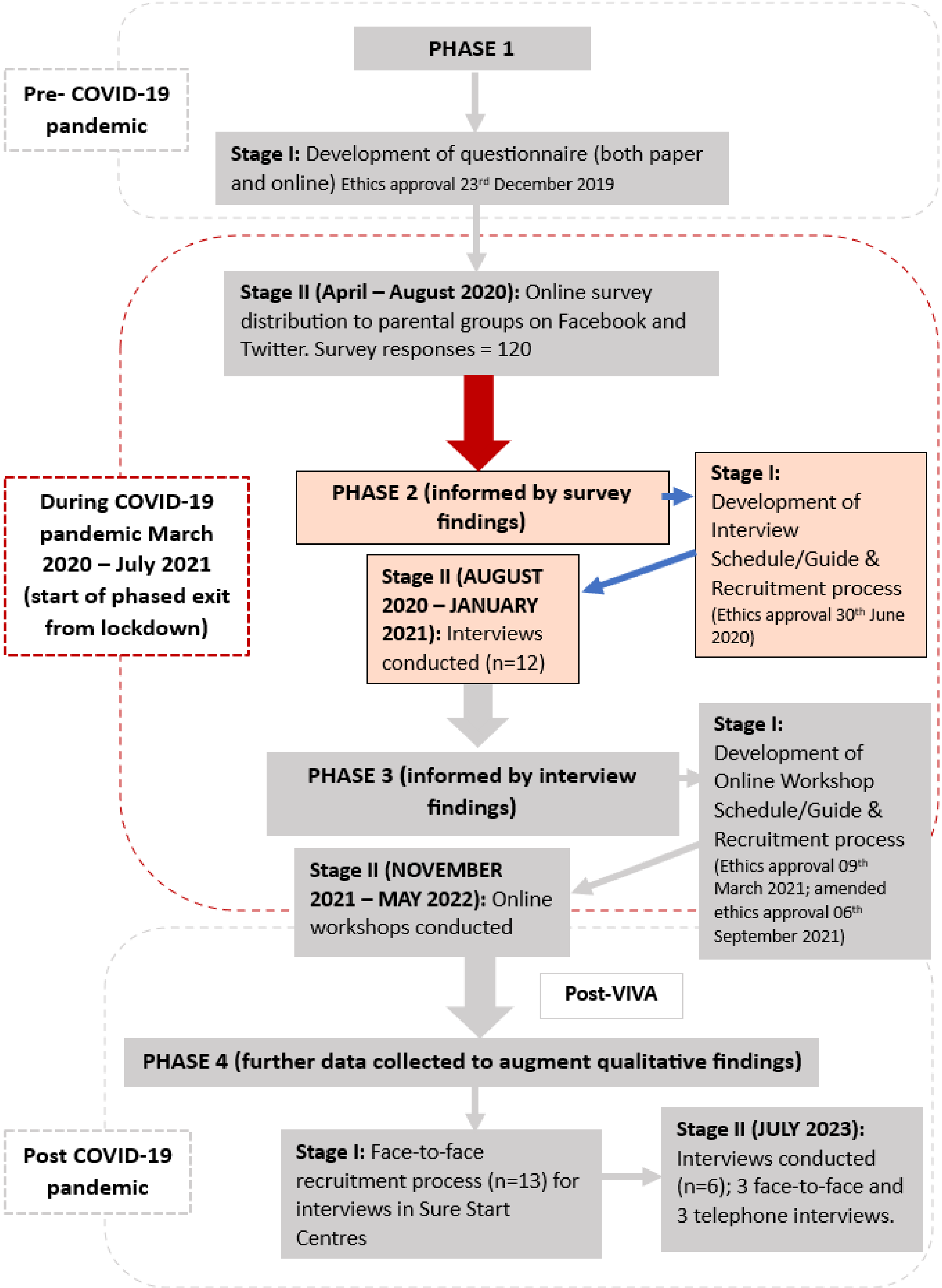
Levels of deprivation were identified based on the 2019 Index of Multiple Deprivation (see Chapter 1) obtained from respondents' home postcodes, which were categorised based on high or low deprivation. In the survey, participants were asked to provide the first part of their postcode, to identify whether they lived in an affluent or less affluent area of GM. Participants' postcodes were mapped using the Ministry of Housing, Communities & Local Government (MoHCLG) 2019 Indices of Deprivation Interactive Dashboard (MoHCLG, 2024). This method has been utilised in other studies such as Thomson et al.'s (2020) study examining trends in antibiotic prescribing in primary care, where the address of GP surgeries in England were matched with deprivation data derived from the 2015 IMD, to then rank the GP surgeries from most deprived to least deprived. Boiko et al.'s (2020) study looking at patient expectation and experiences of antibiotics, also utilised a similar method, where participants were categorised into high, medium, or low deprivation, based on the 2015 IMD. In this PhD study, once the postcodes were matched on the 2019 IMD, the category for deprivation was collapsed into 2 categories 'more deprived' and 'less deprived' for further data analysis. It is important to note that this method, although useful for providing information on the level of deprivation of an area, does not provide details on deprivation experienced by the individual, i.e., an individual may live in an area that is considered as deprived based IMD data, but is not in fact experiencing deprivation (MoHCLG, 2019). This will be addressed further in the strengths and limitations of this study (Chapter 5).

Responses from the open-ended questions, were used to enhance and/or confirm the findings obtained from the quantitative data (Rouder et al., 2021). The raw data obtained from these questions were first reviewed and coded using a combination of deductive and inductive codes (Rouder et al., 2021). The codes were then grouped into categories and finalised, to obtain themes that have been discussed in the results. Relevant quotes were chosen to illuminate the quantitative results obtained with the online survey (Rouder et al., 2021).

3.2.2 Phase 2:

For this phase of the study focus groups were originally planned to get a more in-depth understanding of parents' perceptions, experiences, practices and behaviour towards antibiotic use, prescribing for their child/children, including their understanding of ABR. These focus groups would have potentially been carried out in community centres and Sure Start Centres in the selected boroughs where the paper questionnaires would have been distributed, to capture differences socio-economic status (SES) in responses. Although conducting focus groups would have been a more cost-effective way of obtaining more personal and detailed data compared to interviews (DiCicco-Bloom & Crabtree, 2006), due to the unprecedented consequences of the COVID-19 pandemic and the social distancing restrictions advised by the UK government, telephone interviews were the only method used to gather the qualitative data for the second phase of the study.

Figure 17: Research timeline and flowchart for phase 2 (highlighted in colour)



3.2.2.1 Recruitment/Sampling (Phase 2, Stage I):

Following Phase 1, 30 parents, who had volunteered to participate in the interviews (via the online questionnaire), were contacted via email (Phase 2, Stage I) (see Figure 17). This way of recruiting participants, based on availability and accessibility, is convenience sampling, a type of non-probability sampling method that is widely used in research (Elfil & Negida, 2017; Jager et al., 2017; Dudovskiy, 2018). Although using convenience sampling can lead to systematic bias and inhibits generalisations about the population being studied, this method is quick, inexpensive, and an uncomplicated way of recruiting participants (Elfil & Negida, 2017; Jager et al., 2017; Dudovskiy, 2018).

After contacting the 30 parents, those who were happy to take part in the interviews were sent a consent form (Appendix 13), and an information sheet (Appendix 12) detailing the nature of the study and how the interview would be conducted. In line with the ethics requirements, participants were given at least 24 hours to consider whether they still wanted to participate in the interview, which was organised and scheduled based on their availability.

The researcher reiterated important information from the documentation sent to the participants, prior to scheduling the interview, e.g. providing a brief introduction of the study, the process of the interview and that the interview would be recorded to facilitate transcription and data analysis. Participants were also given the opportunity to ask the researcher any questions. Following this, the consent form (Appendix 13) was read to each participant and verbal consent from each participant was clearly recorded to ensure they were comfortable with the interview procedure, and with being audio recorded.

3.2.2.2 Procedure (Phase 2, Stage II):

Telephone interviews were chosen as the method of data collection for Phase 2 as they have many advantages, including being relatively cheap, compared to other qualitative data collection methods (Opdenakker, 2006; Oltmann, 2016). They also allow the researcher to have wide geographical access to participants, which saves time and travel costs (Opdenakker, 2006; Oltmann, 2016). Telephone interviews are also practical for participants who may not be able or have the time to travel to research settings, for example shift workers, people with disabilities, parents who do not have childcare (Opdenakker, 2006; Oltmann, 2016).

Interviews are a common data collection tool, useful in various methodological approaches (Frances & Coughlan, 2009; Jamshed, 2014; McGrath et al., 2019). Although they can be quite time-consuming, they are a flexible and an efficient way of gaining a deeper understanding of participants' perspective, motivations, experiences, thoughts, beliefs, and opinions, on a particular topic or social phenomenon (Knapik, 2006; Gill et al., 2008; Jamshed, 2014; Oltmann, 2016). They also allow participants to be easily reached, and the collection of relevant supplementary information that may have come up during the interview process, and add further depth to the findings obtained Knapik, 2006; Gill et al., 2008; Jamshed, 2014; Oltmann, 2016).

Inaccuracies and inconsistencies in the responses obtained are a risk, as interviewees could lie about certain socially undesirable traits and responses, misunderstand certain questions, or may not be able to remember certain details (DiCicco-Bloom & Crabtree, 2006; Oltmann, 2016, McGrath et al., 2019). Errors could also be caused by the interviewer, such as omitting or changing the wording of certain questions, biased or unnecessary probing, or recording errors (Novick, 2008; King, Horrocks & Brooks, 2018). However, to circumvent errors that could be caused by the interviewer, an interview script/guide (Appendix 2) was used (Knox & Burkard, 2009; Jacob & Furgerson, 2012; Robinson, 2014; King et al., 2018).

Three types of interviews can be used to generate qualitative data: structured, semi-structured, and unstructured (Frances & Coughlan, 2009; Jamshed, 2014; McGrath et al., 2019). Structured interviews involve the use of a questionnaire, consisting of predetermined questions, with little to no variation in the questions set (Jamshed, 2014; King, Horrocks & Brooks, 2018). Although easier and quick to conduct, they do not allow for follow-up questions, and limit participant responses. Therefore, collection of in-depth information is limited using this method (DiCicco-Bloom & Crabtree, 2006; Oltmann, 2016, McGrath et al., 2019).

Unstructured interviews, on the other hand, do not require a prepared questionnaire, and involve the interviewer starting the interview with an opening question and the interview then progressing based on the initial response provided for that question (Baker & Edwards, 2012; Peters & Halcomb, 2015; Rosenthal, 2016; Hawkins, 2018). This type of interview is used when significant insight from the interviewees is needed, and where little is known about the subject area (DiCicco-Bloom & Crabtree, 2006; Oltmann, 2016, McGrath et al., 2019). However, this method is very time-consuming and can be quite confusing and difficult to participate in, as there are no predetermined questions to guide the interview (Baker & Edwards, 2012; Rosenthal, 2016; Majid et al., 2017; Hawkins, 2018).

The third type is semi-structured interviews, which was the method chosen for the qualitative phase of this study. During this process, several key questions are used to guide the interview and define the topics that will be explored (Nehls et al., 2015; Rosenthal, 2016; Hawkins, 2018). This type of interview has a more flexible approach and allows for follow-up questions, which helps participants elaborate and provide more detailed responses (Opdenakker, 2006; Kyale & Brinkmann, 2009; Jacob & Furgerson, 2012; Oltmann, 2016).

The interview questions for this study were developed from emerging data obtained from phase 1 (Table 13), and an amended ethics application was submitted before the beginning of phase 2, with detailed information regarding the proposed questions to be used.

Table 13: Interview topics/questions developed from the emerging quantitative data

Topics used in the interview guide	Quantitative findings that informed the questions
Questions were developed to explore parents' past use of antibiotics for them and/or their child; how they feel when antibiotics and not prescribed when they feel they are needed; how they take/administer the antibiotics.	Lack of understanding regarding responsible antibiotic use e.g., skipping antibiotic doses
Questions were developed to explore parents' views on ABR and whether they understood what it means; their concerns about ABR; whether they believed it could affect them or their child; and whether there was a need for more awareness on ABR.	Lack of understanding regarding ABR and individual's contribution to ABR
Questions were developed to explore parents' experiences during GP consultations, particularly regarding antibiotic prescribing, i.e., are they given enough information, do they understand the prescription advice, are they given enough time to enquire about it, do they feel informed about their child's illness when leaving the consultation.	More than half of the respondents felt they were not given enough time in medical consultations to enquire about the antibiotics prescribed.
Questions were developed to explore when they had last heard about ABR and responsible antibiotic usage; whether there was a need for more information on responsible antibiotic use; types of media they would be interested in to deliver health promotion messages on antibiotics and ABR.	Participants remembered getting information about responsible antibiotic usage, but it had not changed their minds about the unnecessary use of these drugs

The interview guide and interview questions were piloted on volunteer parents, to explore the clarity and language used, question flow, and to ensure jargon, that may confuse or intimidate the interviewees, was avoided (Knox & Burkard, 2009; Oltmann, 2016; Rosenthal, 2016; King et al., 2018; McGrath et al., 2019). Piloting helped fine-tune the interview guide and allowed the questions to be adjusted to avoid any misunderstanding and encourage participants to elaborate on their answers, by adding potential follow-up questions and probes.

3.2.2.3 Data analysis:

The interviews conducted in phase 2 were transcribed verbatim by the researcher. After transcription, framework analysis was used for the systematic analysis of the data. As framework analysis is primarily focused on analysing the contents of the interviews (Barbara, 2004; Gale et al., 2013; Bhatia, 2018; Warren, 2020), conventional dialogue transcribing, which include pauses, laughter, sight, etc. made by the participants, will not be included in the transcriptions.

Framework analysis was the chosen method of data analysis as it enabled in-depth investigation of the data, while maintaining a clear and rigorous examination that would aid the analytical processes (Smith & Firth, 2011; Gale et al., 2013; Parkinson et al., 2016; Bhatia, 2018; Warren, 2020). The framework analysis of the data is generative, systematic, and comprehensive, as it is primarily based on and driven by the observations and accounts of the participants and allows the full review of the data collected in a methodical way (see Table 14) (Srivastava & Thomson, 2009; Furber, 2013; Kiernan & Hill, 2018; Roshaidai et al., 2019).

Table 14: The framework analysis process, involving 5 steps

Framework Analysis		
Step 1	Familiarisation	Process during which the researcher gains an overview of the data collected, by familiarising themself with the transcripts of the interviews conducted. During this process the researcher discovers the key concepts, ideas, and recurrent themes, by studying the transcripts and listening to the recordings of the interviews
Step 2	Identification of thematic framework	Determining the emerging themes and concepts from the responses given by the participants during the interview. These themes, concepts, and key issues are noted and form the foundation of a thematic framework that can then be used to filter and categorise the data set. By analysing the meaning, relevance, and importance of the issues and themes that arise from the participants' responses, the researcher can further develop and refine the thematic framework
Step 3	Indexing	Identification of the segments of data that correspond to a specific theme, and this process in conducted for all the transcripts. For convenience, a numerical system involving codes can be utilised during indexing and can be annotated alongside the text.

Step 4	Charting	Specific indexed sections of data are organised in charts based on themes. The relevant sections of data are moved from the original textual context and arranged in charts that were informed by the thematic framework in step 2. Even though the data is moved from their original context, each pertinent piece of data will be annotated to keep track of where they came from
Step 5	Mapping and Interpretation	Comprises of the analysis of the key characteristics organised in the charts. This analysis will provide a schematic diagram, that will aid and guide the researcher during the interpretation of the data. Through this process, the researcher will be able to outline concepts that have been raised during analysis, map the nature of the phenomena, find associations, provide clarifications, and develop strategies or recommendations, which are all reflective of the participants and would echo their attitudes, insights, and beliefs.

(Adapted from: Gale et al., 2013)

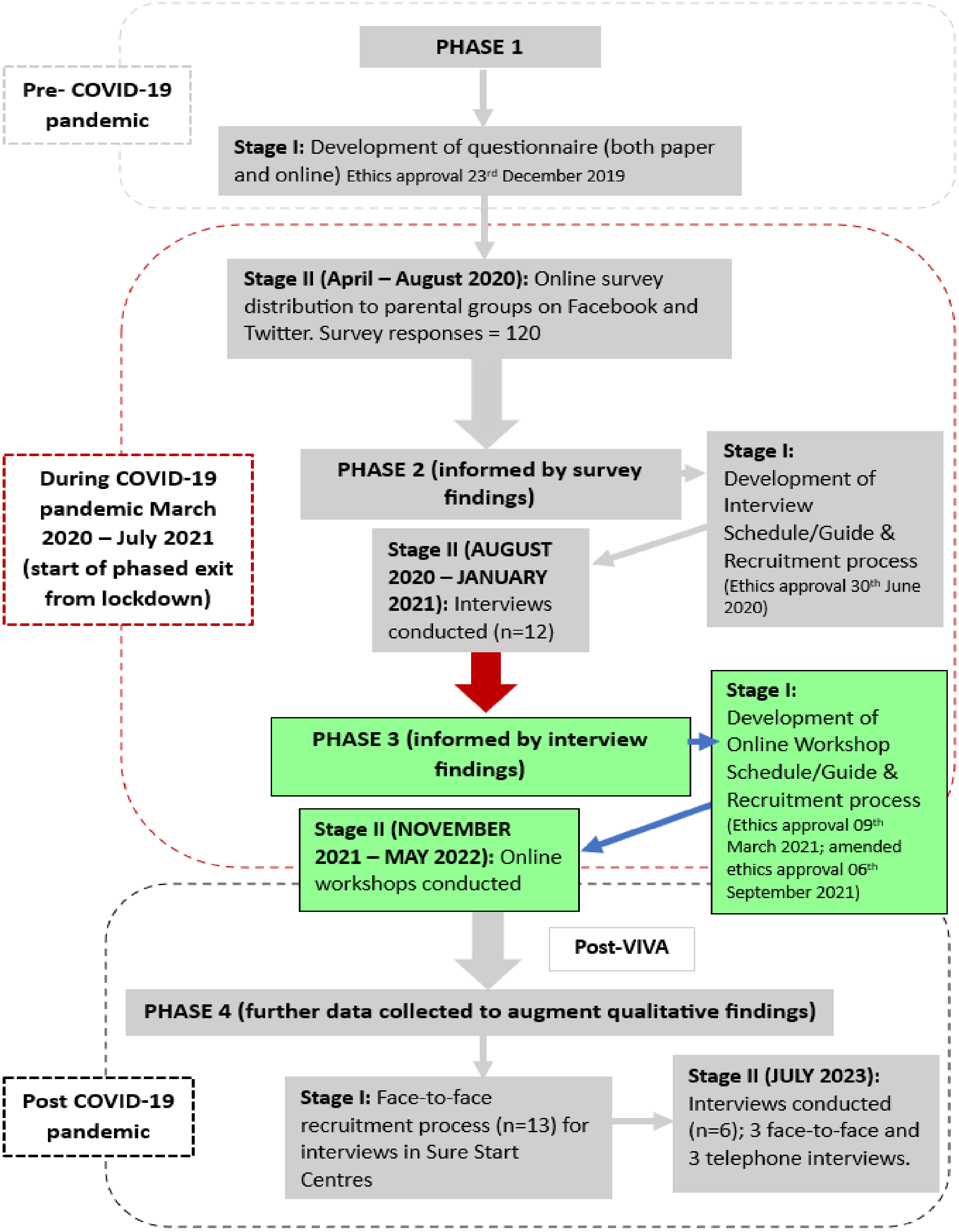
Framework analysis can be considered a flexible method of qualitative data analysis, and it allows the researcher to either start data analysis during the data collection process or start data analysis after all qualitative data has been collected (Gale et al., 2013; Parkinson et al., 2016; Warren, 2020).

Although framework analysis is resource-intensive and time-consuming, the original textual data, analytical process, and interpretations developed using this method, can be reviewed by other researchers and demonstrates transparency (Sutton & Austin, 2015; Vogl et al., 2018). The sampling method used in qualitative research is not intended to be representative of a wider population and analysing heterogenous data using framework analysis is not possible (Erlingssona & Brysiewiczb, 2017; Collins & Stockton, 2018). However, similar topics and issues were discussed in the telephone interviews conducted for this PhD study; therefore, framework analysis was a good method for the thematic analysis of the responses generated by the interviews, and to capture diversity around the topics discussed in the interviews (Gale et al., 2013; Sutton & Austin, 2015; Kiernan & Hill, 2018; Warren, 2020).

3.2.3 Phase 3:

The third of phase of this study involved engaging with parents to inform recommendations for the future development of an intervention, using a participatory approach, that could help raise awareness on ABR among parents. Workshops topics and questions were developed based on emerging findings from the phase 2 interviews (see Figure 18).

Figure 18: Research timeline and flowchart for phase 3 (highlighted in colour)



3.2.3.1 Recruitment/Sampling (Phase 3, Stage I):

For phase 3, parents who had previously participated in phase 2 of the study (telephone interviews) were invited to participate in the online workshops, using the contact details they provided (phase 3, Stage I). New participants were also recruited via Twitter. University of

Salford students, who were parents of children aged between 3 months and 6 years living within the GM region, were also invited to participate in the workshops. It was anticipated that having multiple recruitment methods would help increase participation rates (which were low, following contact with parents who had participated in phase 2 of the study). Module leaders from non-health-related programmes at the University of Salford were contacted to share an invitation email (Appendix 17) with their students. Recruiting students using a 3rd party ensured that GDPR regulations were followed, and that students' personal information, such as name and email address, were not shared without the students' consent. Using a third party ensured that no potential participant felt pressured or coerced into taking part in the study, that participants were given enough time to consider whether they were interested intaking part in the study, and to minimise bias that could occur during recruitment (Black et al., 2013; Vat et al., 2017). Due to poor response rate during the recruitment process, other recruitment strategies had to be adopted, such as contacting a day-care organisation (BusyBees) with several branches in the UK, including branches in GM; and posting a recruitment message in a newsletter operated by a health and social care organisation (Healthwatch Salford). Therefore, convenience sampling was also used for participant recruitment for phase 3 of the study.

As previously mentioned, all participants were sent a consent form and information sheet detailing the nature of the study and how the online workshops would be conducted. Participants were given at least 24 hours to consider whether they wanted to participate in the online workshops. The online workshops were organised based on the availability of each participant. Although a series of workshops were conducted in phase 3, each participant was requested to participate in one workshop only. At the beginning of each online workshop the researcher briefly explained the workshop procedure, and the participants were informed that they would be recorded in order to facilitate analysis of the data obtained from each session.

3.2.3.2 Procedure (Phase 3, Stage II):

A participatory approach involves the inclusion and involvement of people in a collaborative framework, to create and develop policies, programmes, and interventions that would affect and benefit them as stakeholders (Nastasi et al., 2000; Dinbabo, 2003; Appel et al., 2012; South et al., 2019). Empowering people to analyse their own reality and problems, set their own goals and targets, and share their knowledge and experiences should enable participants to have more control over their lives, and in the case of this study, empower parents to take control of their health and make better decisions concerning their own and their children's health (McLeroy et al., 2003; Holkup et al., 2004; PHE, 2015a; South et al., 2019). Although participatory research can be time-consuming and may involve complex techniques to enable communication and negotiation, it is an inclusive community-led approach that involves a wide range of people taking part (PHE, 2015a; Maya-Jariego & Holgado, 2019). To ensure inclusivity for the participatory development of the intervention, pro-active efforts were made to include parents from various boroughs in GM, to give a good representation of parents across GM.

Participatory research is a low-cost method of gathering qualitative data on participants' beliefs, behaviours, perceptions, and views on a certain issue through dialogue and debate and is also an effective method of discussing sensitive or controversial topics while including a heterogenous group of people that may have various levels of health literacy (Dinbabo, 2003; Holkup et al., 2004; Appel et al., 2012; South & Stansfield, 2018).

Using participatory methods to design and develop an intervention depends on volunteers giving up a substantial amount of their time to participate in the process (Corbie-Smith et al., 2010; Flor et al., 2020). However, having specific communities as an integral part of the participatory development process should build a strong base for the intervention in that community, and improve intervention credibility as the intervention itself has been designed and developed by a group of participants, ideally representing all segments of that community (Corbie-Smith et al., 2010; Stansfield et al., 2020). For example, if parents in GM are aware that other parents, with similar experiences and views, were instrumental in the development of the intervention, they could assume that their interests were attended to and would be more open to trying out the intervention.

Phase 3 also began during the COVID-19 pandemic. After searching the literature for feasible participatory methods for the final phase of the study, online creative workshops were chosen as the most efficient way of involving parents in the process. Due to social distancing restrictions in place due to the pandemic, this method was chosen for its practicality and to ensure COVID-19 guidance was followed.

Workshops are increasingly being used in research as a qualitative tool for data collection (Storvang et al., 2018). The main aim of a workshop is to encourage various stakeholders to participate in collaborative discussions to solve or clarify identified problems, provide constructive feedback, and develop new ideas and solutions, within a short period of time (Storvang et al., 2018; Sufi et al., 2018). Compared to meetings or conferences, workshops can be more intense, with deeper discussions to stimulate creativity, resulting in stronger collaborations (Pavelin et al., 2014; McInerny, 2016). They can also produce a sense of shared purpose among participants and allow collaboration to find ideas and solutions (Koloski, 2012). Workshops also have the advantage of producing in one day what could have potentially taken weeks or months of meetings to accomplish (Koloski, 2012).

There are three main types of workshops, namely exploratory, learning, and creating workshops (Sufi et al., 2018). During exploratory workshops, ideas are discussed and analysed to gain a better understanding of a particular matter and its associated challenges and solutions (Sufi et al., 2018). Learning workshops involve the teaching of a particular skill set or technique (Sufi et al., 2018). Creating workshops encourage participants with a common interest to collaborate in the development of something through a creative process (Sufi et al., 2018). Creating workshops were chosen for this study, as they would allow participants to generate new ideas and solutions and decide on priorities and strategies (Pavelin et al., 2014), which was essential for the development of the health promotion intervention/tool.

While conducting workshops, there is potential for certain biases to occur, for example social desirability bias, whereby participants may offer responses that they believe the interviewer or facilitator may want to hear, or responses that are socially acceptable (Sufi et al., 2018). To circumvent these, participants were reassured at the beginning to each workshop that there were no right or wrong answers and that all opinions and views were welcome, to encourage them to share genuine views and opinions.

The tools used in phase 3 included an invitation letter (Appendix 16) and social media message (Appendix 15) to recruit participants, a creative online workshop guide (Appendix 21) to facilitate the online sessions, a participant information sheet (Appendix 18), a consent form (Appendix 19), and a brainstorming brief (Appendix 20) that aimed to provide participants with more information on the activities that were to take place during the sessions.

To ensure participants were properly informed about the study and the phase they were involved in, each participant was sent a consent form, along with an information sheet detailing the nature of the study, how the online session would be conducted, their role in the study, and their right to withdraw from the study. Participants were also informed via these documents that the workshops would be recorded, and that no identifiers would be used when processing/analysing the recording and data obtained from each online workshop. The participants were asked to submit the signed consent form prior to taking part in the online workshops. For the participants who were unable to send the researcher a signed consent form prior to the online workshop session, verbal consent was taken before the start of a session and was recorded. After recruitment the workshops were organised according to participants' schedule. As the online workshops were hosted via Microsoft Teams, participants were sent a link to the meeting, prior to the session.

The brainstorming brief was sent to each participant, a couple of days before the scheduled online workshops, to outline the aim of the brainstorming activity, provide more information on the brainstorming process, explain the strategy involved in this activity, define the objectives of the activity, and provide an outline of the themes and topics that would come up during the session. The aim of the brainstorming brief was to avoid pressuring participants into coming up with ideas and solutions on the spot, which could inhibit creativity (Ramzipoor, 2020; Hatch, 2021). Therefore, with the brief, participants were encouraged to come to the workshop prepared with ideas, views, and opinions, which could allow the workshops to be more time-efficient and productive (Ramzipoor, 2020; Hatch, 2021).

During the workshops the researcher took the role of session facilitator (Phase 3, Stage II). They began with a short presentation (3-5 minutes) by the researcher, comprising of a short summary of the findings from phases 1 & 2, a brief explanation of the aim of phase 3, and how the online session would be proceeding. To facilitate the smooth running of the sessions, parents were asked to briefly introduce themselves (first name only) after the presentation. When participants are being encouraged to collaborate in a short time frame, introductions are recommended to ensure they are comfortable sharing ideas (Pavelin et al., 2014).

A short icebreaker activity called "chat-storm" was also conducted once all participants had introduced themselves. This activity involved each participating parent typing, in the chat box the first three words that came to mind when the facilitator/researcher called out a word or theme linked to the online session taking place, such as “ABR awareness”, “ABR knowledge”, “antibiotic prescription”, and “parents and antibiotic use”. Icebreakers can be an effective method to begin group sessions where individuals come together for a specific mutual purpose, and to engage with participants in the objectives of the session (Yeganehpour, 2017). These icebreakers are also helpful to motivate participants and encourage them to bond as a group before delving into the complex aspects of the group sessions (Pavelin et al., 2014; Yeganehpour, 2017).

Due to the limited time allocated for each online session (1 hour and 30 minutes), only 1 ice-breaker activity and 1 brainstorming session were conducted during each online workshop. The brainstorming session began with using the Whiteboard feature provided by Microsoft Teams. Brainstorming activities are often used to develop new perspectives, ideas, and solutions, by engaging with participants in a collaborative way and in a creative and supportive setting (Ramzipoor, 2020). Therefore, this creative technique was chosen to enable participants to freely explore a variety of perspectives and generate spontaneous ideas within a short time frame (Koloski, 2012; Ramzipoor, 2020). Although brainstorming activities can be very useful to generate new ideas and solutions (Ramzipoor, 2020), the main disadvantage of these activities is automatically accepting the first reasonable solution provided by the participant or accepting the solution proposed by the loudest participant or the highest-ranking person in the session (Koloski, 2012). However, to prevent this, the researcher encouraged all participants to share their opinions and views and also provided the opportunity for participants to agree or disagree with each other. All ideas generated during the brainstorming sessions for this study, were considered equally and thoroughly.

During the brainstorming sessions, mind-maps were created on the Whiteboard feature, using the ideas and opinions offered by parents during the workshop. Mind-maps are a type of visual map, that can be used to display complex information and encourage more effective and systematic thinking (Choudhari et al., 2021). With the graphical organisation and display of information, mind-maps can also help participants visualise relationships between various concepts, as ideas and concepts are organised around a main topic (Choudhari et al., 2021; Barbrook-Johnson & Penn, 2021). Ideas included can be encircled and/or differentiated from each other using colour codes, and links between components of the mind-map can be shown with the help of arrows (Choudhari et al., 2021). The main topic, for example “ABR intervention/tool" (see section 4..3), is placed in the middle of a page, and the arrows are added to illustrate the links and connections between the main topic and subtopics, forming main branches and sub-branches that evolve from the main topic (Choudhari et al., 2021; Barbrook-Johnson & Penn, 2021). Mind-maps are increasingly being used in research, particularly in research using participatory methods, as they provide a valuable method of collaborating and sharing information (Choudhari et al., 2021). Although mind-maps may be difficult to communicate to those who have not participated in the mapping process, this method of data collection can be an intuitive and flexible tool that could help workshop discussions (Barbrook-Johnson & Penn, 2021).

The ideas and opinions brought forward by parents during the workshop were used to inform recommendations for the design of a future intervention and fulfilled objective 3 of the PhD study (to provide recommendations for future research and interventions aimed at improving antibiotic awareness among parents).

3.2.3.3 Data analysis:

Each online workshop was recorded and transcribed verbatim by the researcher. The online workshop produced two distinct types of data that were used during the data analysis process; a mind-map generated from each brainstorming session illustrating the views, ideas, and suggestions put forward by the participants; and verbatim workshop transcripts. Although most workshops on ABR utilise pre- and post-workshop surveys to measure whether the goals set prior to conducting the workshop were achieved (Young et al., 2017; Hayes et al., 2021a), this study utilised a more pragmatic approach to achieve objective 3 of the study, which was to obtain ideas and suggestions from participating parents that would inform the development of the intervention/tool to improve ABR awareness and antibiotic stewardship. A similar method of data collection during workshops was used by other studies, where ideas and discussions were reported without the use of pre- and post-workshop surveys (Kurt et al., 2019; Liguori et al., 2021; Lambraki et al., 2022). In Lambraki et al.'s (2022) study, workshops were used to obtain participants perspectives on the factors influencing ABR and places to target interventions, and 5 sources of data were produced, including verbatim workshop transcripts and flip chart notes.

Thematic analysis was used for the analysis of the data obtained from the online creative workshops. Thematic analysis is an analytic method, where patterns and meaning are systematically identified, analysed, and interpreted to better understand experiences, thoughts, or behaviours across a qualitative data set (Braun & Clarke, 2006; Braun & Clarke, 2012). Thematic analysis provides a robust framework for the coding and analysis of qualitative data, while also allowing the results presented in a way that is accessible to academic and non-academic communities (Braun & Clarke, 2014). Thematic analysis often comprises a 6-stage framework for conducting analysis, and these phases are not linear, particularly when complex data is involved (Finlay, 2021). The 6 phases of thematic analysis are described in the table below.

Table 15: The 6 phases of Thematic analysis

Thematic Analysis		
Phase 1	Familiarisation	Transcripts are read and re-read to allow the researcher to familiarise themselves with the entire data set. During the familiarisation phase, notes are added to the transcripts, and can be in the form of questions, highlighting items of interest, or making connections between ideas and data items.
Phase 2	Coding the data	In this phase the data can be organised in a systematic way, and labels or codes are added to the data to identify key features in the data, as well as matching data extracts. Once the initial coding is conducted, all codes and data extracts are collated
Phase 3	Highlighting key themes	In this phase the collated codes and extracts are examined and patterns are found. The codes are analysed, combined, and compared to generate themes. The process of themes identification is an interpretive process.
Phase 4	Reviewing themes	Coded data within each them is reviewed to ensure that they have been categorised correctly. In this phase data extracts can be re-categorised and themes can be modified and developed to better illustrate the coded data. Themes can be collapsed together, separated, or discarded in this phase.
Phase 5	Defining and naming the themes	Once the themes are refined, definition and narrative descriptions are created for each theme. Here, detailed analysis of each theme is developed. In this phase, data extracts are selected, to be presented in the final reporting of the findings.
Phase 6	Writing the report	The findings from the thematic analysis are reported. The report should include the themes and informative data extracts, to provide a clear and concise account of the findings.

(Adapted from: Braun & Clarke, 2006)

Thematic analysis provides a flexible approach to analysis of qualitative data, by allowing researchers to collect data in various forms; it also provides an accessible framework for both experts and non-experts, as it is relatively easy to understand and apply (Barkley, 2021). This type of qualitative data analysis is also useful when large data sets are concerned, and the data can be analysed with an inductive approach (data-driven approach) or with a deductive approach (theory-driven approach) (Kiger & Varpio, 2020; Charlotte, 2021).

The flexibility that thematic analysis may provide may be seen as a disadvantage by some researchers who consider this type of qualitative data analysis to be lacking in rigor (Kiger & Varpio, 2020). Furthermore, the flexible nature of thematic analysis can be a challenge for some researchers, particularly when determining which features of the data to focus on (Kiger & Varpio, 2020; Barkley, 2021). Another disadvantage of thematic analysis is that it is more prone to discrepancies or improper use of terminology, compared to other analytic methods with less flexible frameworks (Kiger & Varpio, 2020; Charlotte, 2021).

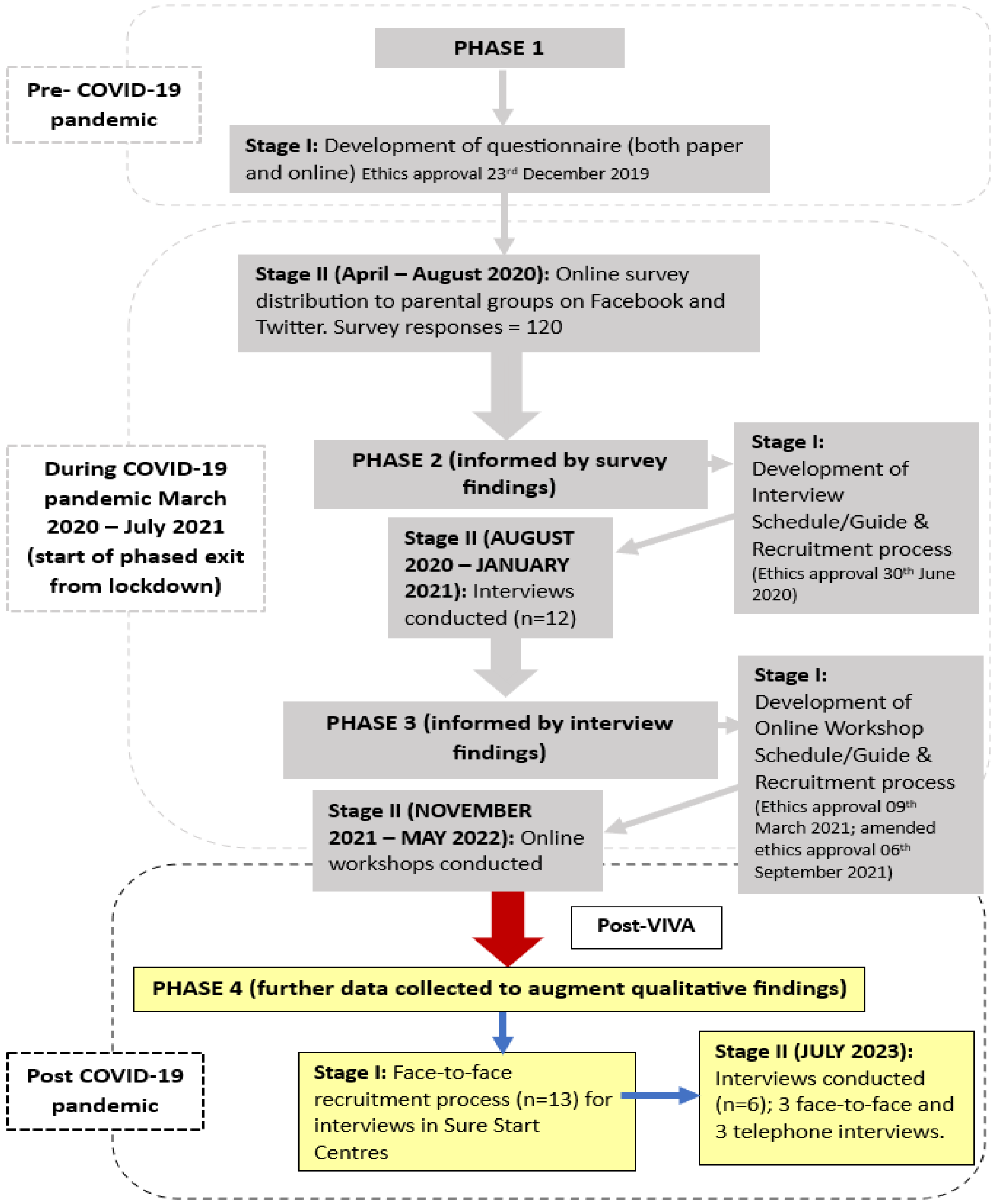
The results reported from this phase of the study focus on the main themes to have emerged from the study, with quotes to illustrate these themes. A similar method of data presentation was used in Wunderink et al.'s (2020) study on antibiotic stewardship in the Intensive Care Unit, where several main themes emerged from their workshop, and the researchers reported on these general themes with some illustrative examples.

The mind-maps obtained from the online workshops were combined to form a main mind-map (see section 4.3). A similar method of data analysis was used in Lambraki et al.'s study (2022), where data sources were combined to provide two final data sources that were used in the reporting of the findings. Main themes were noted on the mind-map, from which ideas, suggestions, concepts, and components emerged from the various workshop discussions (Lambraki et al., 2022). Therefore, a main mind-map was used to illustrate the findings from all the online workshops.

3.2.4 Phase 4 (Collection of further data post-viva):

Due to the small homogenous sample size obtained for phases 2 and 3 (due to the unforeseen circumstances brought about by the COVID-19 pandemic), and as per the examiner's requirements for the resubmission of this PhD thesis, more data was needed to obtain a more representative view of the parent population from a more deprived and ethnically diverse area (see Figure 19).

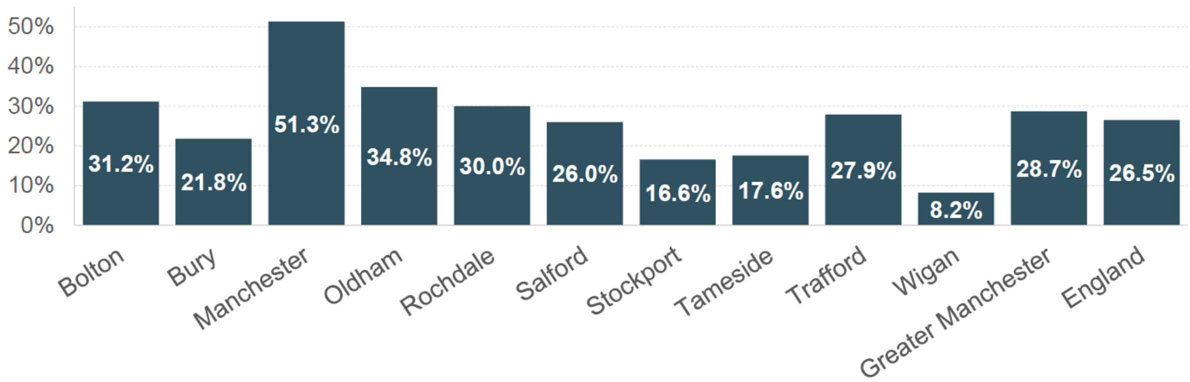
Figure 19: Research timeline and flowchart for phase 4 (highlighted in colour)



3.2.4.1 Recruitment/Sampling (Phase 4, Stage I):

As the sample obtained for phases 2 and 3 was not representative of the socio-economic and cultural diversity that can be seen among parents in GM (see Appendix 2), further research was conducted to better understand how to obtain a more diverse sample. The participant sample obtained for phases 2 & 3 were predominantly of White ethnicity; therefore, to obtain a more ethnically diverse sample for phase 4, demographic statistics of GM were assessed to gain a better understanding of which boroughs should be targeted for further participant recruitment. As mentioned in Chapter 1, Manchester is the most ethnically diverse borough in GM, with 51.3% of its population being from ethnic minority groups (see Figure 20 below).

Figure 20: Percentage of population from an ethnic minority group, in each GM borough in 2021



(Source: GMCA, 2023)

Although GM has multiple deprivation levels and large areas of deprivation, Manchester is the borough with the highest proportion of deprived areas within GM (Manchester City Council, 2019). Furthermore, based on 2019 IMD, Manchester is one of the most deprived areas in England (ranked 6th) (Manchester City Council, 2019; OHID, 2021). Based on these statistics Manchester was chosen as the most adequate borough to focus on participant recruitment. As the original plan for phase 2 (prior to the pandemic) was to recruit parents via Sure Start Centres, parents were recruited from these centres in the most deprived areas of Manchester.

Due to the limited time available for this new round of data collection, only the 10 most deprived areas in Manchester were targeted for further data collection. These areas have been ranked by Manchester City Council (2019), based on the Indices of Deprivation 2019 for Lower-layer Super Output Areas (LSOAs), with a decile ranking from 1 (most deprived 10%) to 10 (least deprived 10%). The areas identified as most deprived in Manchester were Miles Platting & Newton Heath, Harpurhey, Clayton and Openshaw, Gorton and Abbey Hey, Woodhouse Park, Higher Blackley, Charlestown, Sharston, Longsight, Baguley, Moss Side, Northenden, Cheetham, Crumpsall, Ardwick, Moston, Ancoats & Beswick, Levenshulme, Burnage, and Rusholme. Manchester City Council provides a list and contact details of Sure Start centres in these areas, which was used to contact the managers of these centres.

3.2.4.2 Procedure (Phase 4, Stage II):

Managers of Sure Start centres, in 10 most deprived areas of Manchester were contacted, to enquire about when parents of children aged between 3 and 6 months were more likely to attend the Sure Start Centre, and to gain permission to recruit and interview parents on the premises. Parents were approached at the centres, and the study was discussed with them. Interested parents were given a participant information sheet (see Appendix 23) detailing the nature of the study and how the interview would be conducted, and consent form (see Appendix 24). Parents were given the opportunity to ask further questions at each recruitment session and were encouraged to contact the researcher if they had further queries. They were given at least 24 hours to consider whether they still want to participate in the interviews. The researcher's contact information (e-mail and telephone number) was provided to interested participants, who were asked to contact the researcher to express their interest in being interviewed. Telephone and face-to-face interviews were organised based on the availability of each participant. At the beginning of the interview the researcher briefly explained the interview procedure, and the participants were informed that they were audio recorded with an audio recorder to facilitate transcription and analysis of the data obtained.

Participants were asked to bring their signed consent forms to the face-to-face interview. For those who had opted for a telephone interview, verbal consent was recorded prior to the start of the interviews. The interview questions used were the ones utilised in phase 2 of this PhD study; therefore, the same interview guide was used for both phases 2 and 4.

3.2.4.3 Data analysis:

The interviews conducted in this phase were transcribed verbatim by the researcher. Framework analysis was used for the analysis of the data obtained, previously discussed in section 3.2.3.

Chapter 4: Results

In this section, findings from all four phases are reported, comprising three sub-sections: findings from phase 1 the online survey; phase 2 the telephone interviews; phase 3 the online workshops; and phase 4 the Sure Start interviews.

The aim of the study was to obtain an in-depth understanding of the current knowledge, attitudes, and practices of parents living in GM, regarding antibiotic use, prescription advice, and antibiotic resistance, based on a mixed methods explanatory study.

Objectives:

- To investigate parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance, in GM.

- To explore the factors that influence parents' perceptions, experiences, and practices, in the context of their young child being prescribed antibiotics.

- To provide recommendations for future research and interventions aimed at improving antibiotic awareness among parents.

4.1 Findings, Phase 1; online surveys

This section of the thesis presents the results obtained from the online survey (April – August 2020), to investigate parents' knowledge, understanding, attitudes, and self-reported practices towards antibiotics, antibiotic use, ABR, antibiotic prescribing and advice. The significant results, that have further informed the rest of this PhD study, are presented in the following 4 subsections: demographic characteristics, knowledge on antibiotics and ABR, parents' attitudes towards ABR, antibiotic prescribing and prescription advice, self-reported practices regarding antibiotics. All chi-square test values, Fischer's exact test values, and p-values are reported in Appendix 1. A table is provided at the end of section 4.1., comparing the findings from this PhD study and those reported in the studies that informed the development of the questionnaire (Table 22).

4.1.1 Demographic characteristics of participants in Phase 1

120 participants completed the online survey; 95% were female (n=114) and 5% male (n=6) (see Table 16). Most were aged between 30 and 39 (n=71, 59.2%); 95% were of White ethnicity (n=114); and 90.8% were born in the UK (n=109).

Regarding educational attainment, the majority of the respondents had tertiary education qualifications, with 31.7% stating that their highest qualification was an undergraduate degree (n=38), followed by 24.2% choosing a master's degree (n=29), and 13.3% stating that they had a professional qualification (n=16), resulting in a highly educated sample (see Table 16).

Table 16: Demographic characteristics of the survey respondents.

Demographic Characteristics		Frequency	Percentage
Gender	Male	6	5.0
	Female	114	95.0
	18-29	10	8.3
	30-39	71	59.2
	40-49	34	28.3
	50+	5	4.2
Ethnicity	White	114	95.0
	Other ethnicities	6	5.0
Born in UK	Yes	109	90.8
	No	11	9.2
Educational Attainment	O-Level/CSEs/GCSEs	5	4.2
	Apprenticeship	1	0.8
	A-Levels/HSC/Advanced Diploma	7	5.8
	Certificate of higher education	4	3.3
	Diploma of higher education	6	5.0
	Undergraduate degree	38	31.7
	Master's degree	29	24.2
	Doctorate	10	8.3
	Professional qualification	16	13.3
	Other vocational qualifications	3	2.5
	Foreign qualifications	1	0.8
GM Borough	Bolton	15	12.5
	Bury	5	4.2
	Manchester	12	10.0
	Oldham	3	2.5
	Rochdale	11	9.2
	Salford	17	14.2
	Stockport	25	20.8
	Tameside	6	5.0
	Trafford	16	13.3
	Wigan	10	8.3
Deprivation	High deprivation level	49	40.8
	Low deprivation level	71	59.2

There was a heterogenous distribution of respondents from the different boroughs in GM. Most were from Stockport (n=25, 20.8%) (discussed in Chapter 5), followed by Salford (n=17, 14.2%), Trafford (n=16, 13.3%), and Bolton (n=15, 12.5%). Smaller numbers were from Oldham (n=3, 2.5%), Bury (n=5, 4.2%), and Tameside (n=6, 5.0%). Over half of the respondents had postcodes that corresponded to an area of low deprivation (n=71, 59.2%), with 40.8% of postcodes corresponding to areas of high deprivation (n=49). The majority of participants had one child aged between 3 months and 6 years old (n=76, 63.3%), with 31.7% (n=38) having two children, 3.3% (n=4) having 3, and 1.7% (n=2) having 4 or more.

4.1.2 Knowledge on antibiotics and ABR

In respect of knowledge, most parents demonstrated correct knowledge when stating that antibiotics do not kill viruses (n=110, 91.7%) and that antibiotics are not effective against colds (n=119, 99.2%) (see Table 17 below).

Table 17: Frequency distribution of answers regarding knowledge of ABR and antibiotic use.

Questions regarding knowledge of antibiotic resistance and antibiotic use		Frequency (Percentage)		
		True	False	Don't know
Q1 (a)	Antibiotics kill viruses	8 (6.7)	110 (91.7)	2 (1.7)
Q1 (b)	Antibiotics are effective against colds	1 (0.8)	119 (99.2)	0
Q1 (c)	Unnecessary use of antibiotics makes them become ineffective	113 (94.2)	7 (5.8)	0
Q1 (d)	Taking antibiotics often has side-effects such as diarrhoea	80 (66.7)	15 (12.5)	25 (20.8)
Q2 (a)	*(When do you think you should stop taking antibiotics once you have begun a course of treatment?)* When you feel better	1 (0.8)	119 (99.2)	0
Q2 (b)	*(When do you think you should stop taking antibiotics once you have begun a course of treatment?)* When you have taken all of the antibiotics as directed by your doctor	119 (99.2)	1 (0.8)	0
Q3 (a)	The improper use of antibiotics can lead to ineffective treatment	117 (97.5)	1 (0.8)	2 (1.7)
Q3 (b)	The improper use of antibiotics can lead to worsening of illness	76 (63.3)	17 (14.2)	27 (22.5)
Q3 (c)	The improper use of antibiotics can lead to emergence of bacterial resistance	103 (85.8)	0	17 (14.2)
Q3 (d)	The improper use of antibiotics can lead to additional medical cost to the patient	67 (55.8)	23 (19.2)	30 (25.0)
Q4 (a)	Bacteria are germs that cause common cold and flu	26 (21.7)	84 (70.0)	10 (8.3)
Q4 (b)	Antibiotics are effective against bacteria	92 (76.7)	24 (20.0)	4 (3.3)
Q4 (c)	Antibiotic resistance can spread from animals to humans	33 (27.5)	53 (44.2)	34 (28.3)
Q4 (d)	Antibiotic resistance can spread from human to human	42 (35.0)	47 (39.2)	31 (25.8)

Almost all participants correctly stated that they should stop taking antibiotics when they have completed the full course of drugs as instructed by their doctor (n=119, 99.2%), and that stopping treatment when they felt better was the incorrect thing to do (n=119, 99.2%).

However, a high percentage of participants were either unaware or misinformed about the consequences that could arise from improperly using antibiotics. For example, for the statement *'taking antibiotics often has side-effects such as diarrhoea'*, while 66.5% agreed with it (n=80), 20.8% (n=25) did not know whether it was true or not, and 12.5% (n=15) incorrectly stated that it was false.

For questions on the consequences of the improper use of antibiotics, 14.2% of the participants (n=17) chose ‘false’ for the statement ‘*the improper use of antibiotics can lead to worsening of illness’*, and 22% (n=27) chose ‘don’t know’. Regarding the improper use of antibiotics leading to additional medical cost to the patient, 19.2% said that this was false (n=23), and 25% said that they did not know whether this was true or not (n=30). The heterogenous results regarding knowledge on the improper use of antibiotics show that, although 97.5% (n=117) of the participants had correctly acknowledged that ‘*the improper use of antibiotics can lead to ineffective treatment*’, there are misconceptions among parents when it comes to the consequences that could arise with the improper use of antibiotics.

While 76.7% of the participants (n=92) correctly agreed that antibiotics were effective against bacteria, 20% (n=24) incorrectly stated that this statement was false. As mentioned previously most participants knew that antibiotics are ineffective against colds and viruses, however 21.7% (n=26) incorrectly agreed that *‘bacteria are germs that cause the common cold and flu’*, and 8.3% (n=10) did not know whether this was true or not. This demonstrates a lack of understanding or the presence of misinformation regarding bacteria, how they affect the body, and are treated.

Regarding the spread of ABR from animals to human and human to human, there was a mixed distribution in the responses provided by the participants. Only 27.5% of the participants agreed that ABR can spread from animals to humans (n=33), whereas 44.2% stated that this was false (n=53), and 34 participants did not know whether this was true or false (28.3%). Regarding ABR spreading from human to human, 35% stated that this was true (n=42), 39.2% chose ‘false’ (n=47), and 25.8% (n=31) did not know whether it was true or not. This shows a lack of knowledge and understanding on the drivers of ABR, as well as the various routes through which antibiotic resistant bacteria can spread.

There were no significant differences in responses to questions regarding knowledge of antibiotic resistance and antibiotic (see Appendix 1) use based on gender (Appendix 1, Table 26), place of birth (Appendix 1, Table 29), educational attainment (Appendix 1, Table 30), deprivation (Appendix 1, Table 33), number of children that the participants had (Appendix 1, Table 31).

Regarding age, there were no statistically significant associations in most responses provided by the four participant age groups (18-29, 30-39, 40-49, and 50+) (see Appendix 1, Table 27). However, 30 - 39-year-olds displayed better knowledge for the statement '*the improper use of antibiotics can lead to the emergence of bacterial resistance'* (X^2=13.1, p=0.02) (Appendix Table 27), with 100% identifying that this was true. Age was also associated with knowing that antibiotic resistance can spread from animals to humans (X^2=13.2, p=0.02) (Appendix 1, Table 27), where most of the participants, who correctly stated that antibiotic resistance can spread from animals to humans, were aged between 30 and 39. This suggests that age could be a significant predictor of knowledge on ABR, where younger participants (≤30 years old) and older participants (≥39 years old), may be more likely to be unaware or misinformed on certain aspects of ABR, such as how antibiotic resistance spreads.

There were no statistically significant differences (using chi-square tests) in most of the responses categorised by ethnicity (White and Other ethnicities) (Appendix 1, Table 28), with the exception of the statements *'antibiotic resistance can spread from animals to humans'* (X^2=11.0, p=0.03); 'Unnecessary use of antibiotics makes them become ineffective' (X^2=11.1, p=0.03); 'The improper use of antibiotics can lead to ineffective treatment' (X^2=21.4, p=0.05) (Appendix 1, Table 28). A higher percentage of White participants correctly stated that antibiotic resistance can spread from animals to humans, that the improper use of antibiotics would lead to ineffective treatment, and unnecessary antibiotics use would make them become ineffective. As univariate analysis was conducted for this phase of the study, it is difficult to see how other variables could have affected the findings here; for example, education could have been the predictor for better responses to these questions rather than ethnicity.

4.1.3 Parents' attitudes towards ABR, antibiotic prescribing, and prescription advice

Responses to the questions regarding parents' attitudes towards ABR, antibiotic prescribing, and prescription advice are provided in Table 18 below (excluding results from question 18, *'which of the following symptoms would make you visit a doctor for your child?'*, which was analysed differently and is presented at the end of this subsection).

For the statements on ABR being an important and serious public health issue worldwide, and in the UK, the majority of the participants agreed with the statements; 95% (n=114) agreed that it was an important public health issue worldwide and 93.3% agreed that it was a serious public health problem in this country (n=112) (Table 18).

Table 18: Frequency distribution of answers regarding parents' attitudes towards ABR, antibiotic prescribing, and prescription advice.

Questions regarding parents' attitudes towards, antibiotic resistance, antibiotic prescribing, and prescription advice		Frequency (Percentage)		
		Agree	Undeci-ded	Disagree
Q5	Antibiotic resistance is an important and serious public health issue worldwide	114 (95.0)	5 (4.2)	1 (0.8)
Q6	Antibiotic resistance is an important and serious public health issue in this country	112 (93.3)	7 (5.8)	1 (0.8)
Q7	When I have a cold, I should take antibiotics to prevent getting a more serious illness	4 (3.3)	0	116 (96.7)
Q8	When I get fever, antibiotics help me to get better more quickly	2 (1.7)	15 (12.5)	103 (85.8)
Q9	Whenever I take antibiotics, I contribute to the development of antibiotic resistance	62 (51.7)	25 (20.8)	33 (27.5)
Q 10	Skipping one or two doses does not contribute to the development of antibiotic resistance	19 (15.0)	33 (27.5)	68 (56.7)
Q 11	Antibiotics are safe drugs; hence they can be commonly used	48 (40.0)	15 (12.5)	57 (47.5)
Q 12	If a child suffers from a cold or flu, it will be cured faster if they are given antibiotics	2 (1.7)	2 (1.7)	116 (96.7)
Q 13	If the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional	4 (3.3)	7 (5.8)	109 (90.8)
Q 14	You would re-use an antibiotic which you had used in the past if your child presents the same symptoms	11 (9.2)	10 (8.3)	99 (82.5)
Q 15	Most of the URTIs (e.g., common cold, sinusitis, tonsillitis, or laryngitis) will be self-cured even without the use of antibiotics	108 (90.0)	6 (5.0)	6 (5.0)
Q 16	You expect your doctor to prescribe antibiotics if your child was suffering from an URTI (e.g., common cold, sinusitis, tonsillitis, or laryngitis)	23 (19.2)	15 (12.5)	82 (68.3)
Q 17	You would ask your doctor for antibiotic therapy if your child suffers from recurrent URTIs (e.g., common cold, sinusitis, tonsillitis, or laryngitis)	18 (15.0)	34 (28.3)	68 (56.7)
Q 19	When antibiotics are prescribed for you or your child, you are given enough information regarding how to take the antibiotics, how long to take it for, and the possible side effects that could occur while taking it?	96 (80.0)	11 (9.2)	13 (10.8)
Q 20	During consultations with a healthcare professional (e.g.: nurse, GP, paediatrician, pharmacist), you are given time to inquire about the antibiotics prescribed to you	57 (47.5)	19 (15.8)	44 (36.7)
Q 21	During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing antibiotics and are given enough information on how to treat the symptoms that you or your child are presenting	92 (76.7)	10 (8.3)	18 (15.0)

The heterogeneity in responses for certain statements relating to parents' attitudes towards antibiotic resistance and antibiotic use, show that participants know that antibiotic resistance is an important public health issue, and that antibiotics should not be taken for a cold (n=116, 96.7%). However, there are still misconceptions regarding an individual's contribution to antibiotic resistance. For example, although most (n=103, 85.8%) participants correctly disagreed that taking antibiotics for a fever would help them get better quicker, 12.5% (n=15) were undecided and 1.7% (n=2) agreed with the statement.

For the statement '*whenever I take antibiotics, I contribute to the development of antibiotic resistance'* the responses show a mixed understanding and attitudes among the participants; 51.7% (n=62) agreed that individuals contribute to the development of ABR, however 20.8% were undecided (n=25), and 27.5% (n=33) disagreed. For the statement *'skipping one or two doses does not contribute to the development of antibiotic resistance'* 15% (n=19) of the participants wrongly stated that skipping one or two doses did not contribute to the development of ABR, 27.5% were undecided (n=33), and 56.7% agreed. Regarding antibiotics being commonly used because they are safe drugs, 40% agreed (n=48), 12.5% were undecided (n=15), and 47.5% (n=57) disagreed.

For the statement *'you expect your doctor to prescribe antibiotics if your child was suffering from an URTI'* although most participants disagreed with this, 19.2% (n=23) agreed, and 12.5% (n=15) were undecided. Most participants disagreed that they would ask their doctor for antibiotics if their child suffered from recurrent URTIs, however 15% stated that they would request antibiotics for their child (n=18), with 28.3% remaining undecided (n=34). It is interesting to note that many participants stated that they were not usually given enough time to inquire about the antibiotics prescribed to them during consultations with a healthcare professional (36.7%, n=44), which could be an indication of why they disagreed or were unsure about certain statements in the questionnaire, such as antibiotics may cause side effects and that the improper use of antibiotics could lead to worsening of an illness and additional medical cost to the patient (see Table 17 in section 4.1.2).

There were no significant differences in responses to questions assessing parents' attitudes towards antibiotic resistance, antibiotic prescribing, and antibiotic prescribing advice (see Appendix 1), based on age (Appendix 1, Table 35), place of birth (Appendix 1, Table 37), and number of children participants cared for who were aged between 3 months and 6 years old (Appendix 1, table 39). However, it is important to note that as univariate analysis was conducted, potential relationships between the demographic variables and the statements could not have been made.

Regarding gender, there were no statistically significant associations in responses to questions assessing parents' attitudes towards antibiotic resistance, antibiotic prescribing, and antibiotic prescribing advice, in most of the responses provided by males and females. However, male participants displayed better knowledge for the statement 'w*henever I take antibiotics, I contribute to the development of antibiotic resistance'* (X^2=4.53, p=0.05) (Appendix 1, Table 34), with 100% correctly agreeing with this (Appendix 1, Table 34). Gender was also associated with better knowledge towards parents' expectation for antibiotics, where the majority of females disagreed that they would change doctor or go to another healthcare professional if their doctor did not prescribe antibiotics often enough for their child (X^2=6.07, p=0.05) (Appendix 1, Table 34). The results from the chi-square tests performed for these statements suggest that gender could be a significant predictor of attitude towards antibiotic resistance and antibiotic prescribing.

Comparisons between participant responses and ethnicity have shown no statistically significant associations in the majority of the responses categorised by ethnicity (White and Other) (Appendix 1, Table 36), with the exception of the statements *'if a child suffers from a cold or flu, it will be cured faster if they are given antibiotics'* (X^2=13.54, p=0.004) and '*if the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional'* (X^2=8.57, p=0.02) (Appendix 1, Table 36). The results show that a higher percentage of participants of White ethnicity displayed better attitudes towards antibiotic use for their child and antibiotic prescribing, compared to those of other ethnicities. Although this result shows a statistically significant association between ethnicity and the responses provided by the participants, the sample size obtained for this study does not illustrate a clear picture of how ethnicity can influence certain attitudes towards antibiotic use and antibiotic prescribing.

Regarding the association between educational attainment and attitude responses, those with degree level education displayed better attitudes towards antibiotic resistance (X^2=30.70, p=0.03), antibiotic prescribing (X^2=28.62, p=0.01), and prescribing advice

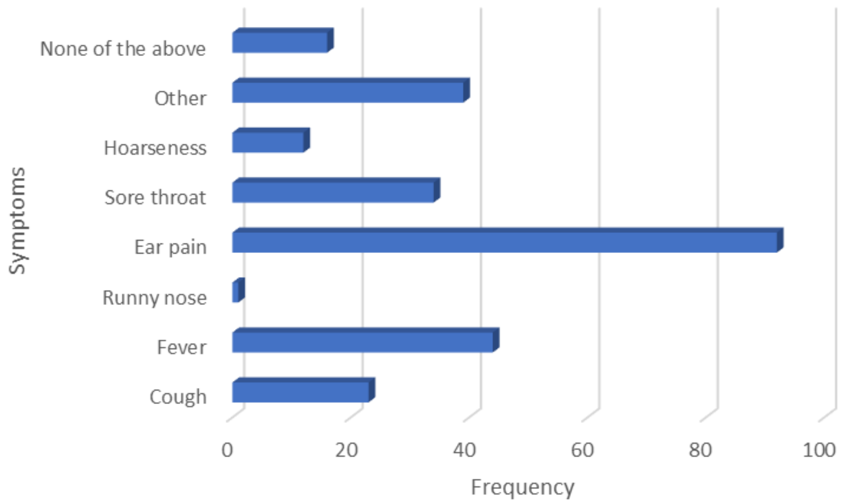
(X^2=26.30, p=0.03), compared to those other levels of educational attainment (Appendix 1, Table 38).

Comparisons between participant responses and deprivation have shown no statistically significant associations in most of the responses (Appendix 1, Table 41), with the exception of *‘whenever I take antibiotics, I contribute to the development of antibiotic resistance’* (X^2=6.88, p=0.03) and ‘s*kipping one or two doses does not contribute to the development of antibiotic resistance’* (X^2=5.95, p=0.05) (Appendix 1, Table 41). A significant association was also found between deprivation and the statements ‘*if a child suffers from a cold or flu, it will be cured faster if they are given antibiotics*’ (X^2=6.00, p=0.05) and ‘*if the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional*’ (X^2=6.44, p=0.04) (Appendix 1, Table 41). The results from the chi-square tests show that a higher percentage of participants in less deprived areas displayed better attitudes towards antibiotic use for their child and antibiotic prescribing, compared to those in more deprived areas.

Although the results previously mentioned suggest that gender and ethnicity may be variables that could influence parents’ attitudes, it is important to note that due to the systematic bias that could have occurred during data collection, with most of the participants being female (n=114, 95%) and of White ethnicity (n=114, 95%), the results obtained through data analysis may offer a skewed image of the population being studied in GM. Therefore, these findings can only be considered as indicative.

Question 18 (*‘which of the following symptoms would make you visit a doctor for your child?*) was a question that invited multiple responses from the participants. Therefore, the answers are presented differently from the other questions (above).

Figure 21: Frequency distribution for the responses for question 18; '*which of the following symptoms would make you visit a doctor for your child?*'



As shown in the bar chart above (Figure 21) most respondents chose ear pain (n=92; 77.3% of cases) as the symptom that would make them visit a doctor for their child, followed by fever (n=44; 37.0% of cases), other (n=39, 32.8% of cases), and sore throat (n=34, 28.6% of cases). There were no statistically significant associations (p≤0.05) between the answers chosen by the respondents and gender, age, ethnicity, place of birth, educational attainment, number of children participants were responsible for, and number of children that the participants cared for who were aged between 3 months and 6 years.

With a follow-up open-ended question, respondents were encouraged to give further details regarding what other symptoms would make them visit a doctor for their child. Out of the total responses (n=54) obtained, most of the clarifications provided by the participants suggests that they would only seek medical advice if their child had a symptom or combination of symptoms that persisted for one to two weeks, and had not abated by any treatment at home (n=28) such as persistent fever, cough, ear discharge, diarrhoea, vomiting, or rash. Parents clarified that they *"…would not expect abx* [antibiotics] *for all…*" and that they would "*…go seeking reassurance and not antibiotics*". One of the respondents also clarified that they would seek medical advice if "*anything of concern that sources like 111/NHS websites suggested contacting a doctor about…*".

Other symptoms mentioned were rash/non-blanching rash (n=12) and breathing difficulties (n=8) including croup. Parents also mentioned that they would seek advice if their child displayed a change in behaviour: "*if behaviour was different e.g., no energy, difficult to wake, no appetite, plus fever, pain, sickness, rash etc*".

4.1.4 Self-reported practices regarding antibiotics

The questions in this section, pertaining to parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, were a combination of single-answer multiple choice questions, multiple answer, and open-ended questions.

Table 19: Frequency distribution of responses for questions 22 & 23; regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice.

Questions regarding participants' and their child's use of antibiotics in the last 12 months		Frequency (Percentage)		
		Yes	**No**	**Do not know[1]**
Q 22	Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?	40 (33.3)	76 (63.3)	4 (3.3)
Q 23	Have you given any antibiotics to your child in the last 12 months?	46 (38.3)	74 (61.7)	0

[1] Including 'Do not wish to answer'

Table 19 indicates that in the last 12 months most of the participants reported that they had not used antibiotics for themselves (n=76, 63.3%) or their child (n=74, 61.7%). There were no statistically significant variations in the answers, based on gender, age, ethnicity, place of birth, educational attainment, deprivation, and number of children that the participants cared for who were aged between 3 months and 6 years.

Figure 22: Percentage of responses for question 24; regarding how participants obtained the last course of antibiotics they had used

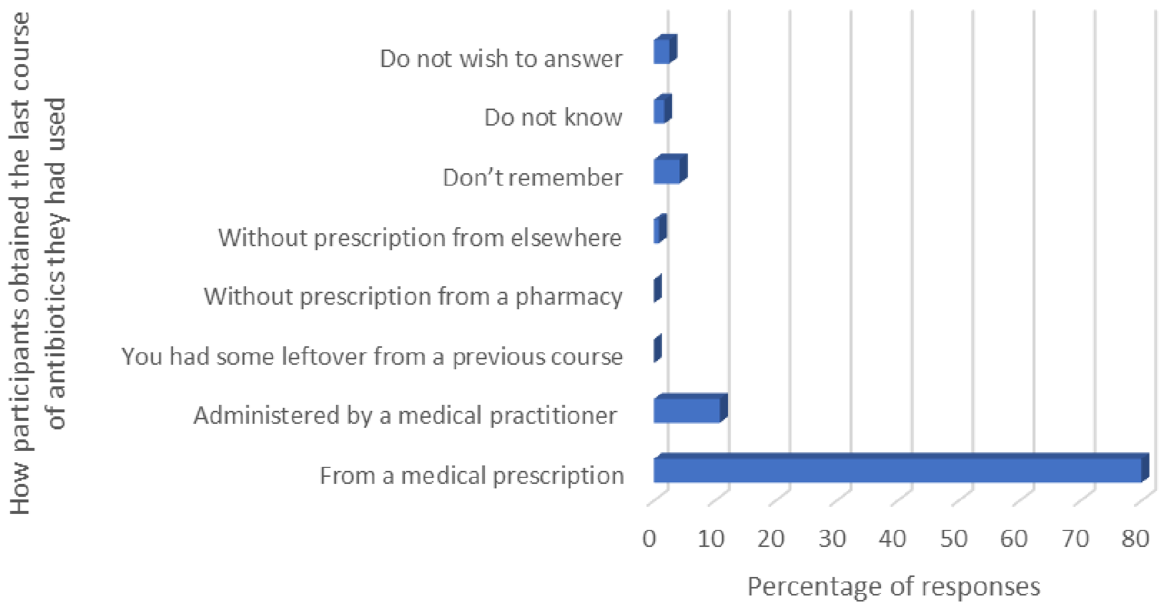


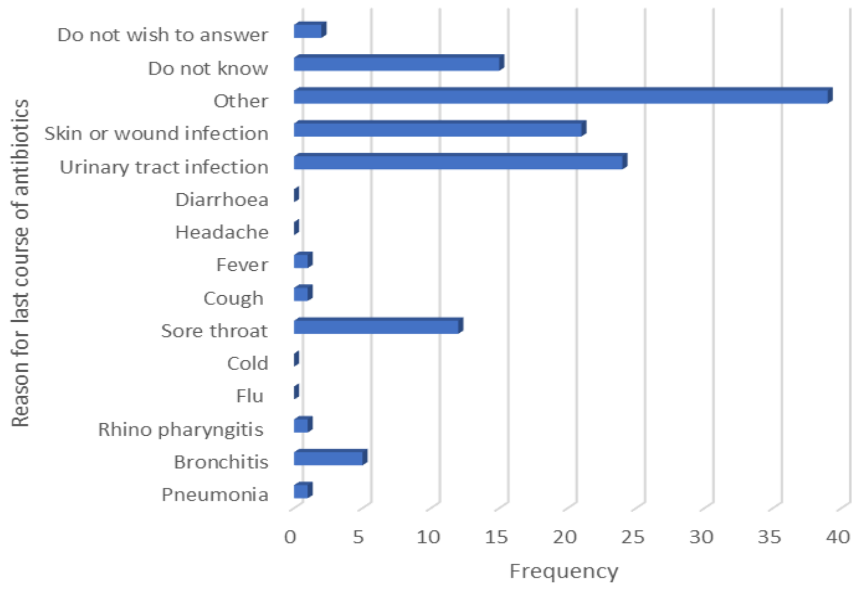
Figure 22 highlights that most of the participants had obtained their last course of antibiotics from a healthcare professional (90.8%), either from a medical prescription (n=96, 80.0%), or administered by a medical doctor (n=13, 10.8%). Only 1 participant stated that they had obtained the last course of antibiotics without a prescription and from elsewhere (0.8%), and 5 said that they did not remember how they had obtained the antibiotics (4.2%).

Open-ended questions ask participants to clarify where they had obtained the antibiotics, if they had chosen the option '*without prescription and from elsewhere*'. Only two pertinent responses were provided; one indicated that they got their last course of antibiotics via an online prescription service; Another clarified that although they would always use antibiotics as prescribed to them, they "*would always keep leftover (if any) but probably never use them…"*. This participant further explained that "*as someone who has had multiple UTIs over years and years, it can be very difficult to get antibiotics when required always. This is mainly due to due to access issues with the GP i.e., not being able to get an appointment to be seen that day or even being away from home".* The participant justified her choice of saving leftover antibiotics by saying "*I get unbearable symptoms and if I get those, I know from experience that I would need antibiotics. I also know that if I had access to a clinician, I would get antibiotics. Therefore, I always keep antibiotics just in case I am ever in this situation but would only take them if I had absolutely no choice.*" This participant reiterated that they would use the leftover antibiotics as a last resort, and that they felt reassured and "…a little safer…"

having the leftover antibiotics readily available to them. They also mentioned that they have only used leftover antibiotics once so far, and they *"…asked for advice from a medic friend when doing so…".*

Regarding how participants obtained the last course of antibiotics for their child (responses for question 25), 73.3% (n=88) stated that they obtained the last course of antibiotics from a medical prescription, 15.0% (n=18) stated that the last course of antibiotics for their child was administered by a medical practitioner, and 11 participants did not wish to answer this question (9.2%). Of the total number of participants, 2 stated that they got the last course of antibiotics without prescription, one of which was from a pharmacy (0.8%), and the other was from elsewhere (0.8%). There were no pertinent responses to the follow-up open-ended question asking participants to elaborate on where they had obtained the antibiotics for their child if they had chosen '*without prescription from elsewhere*'.

Figure 23: Frequency distribution of responses for question 26; regarding the reason for taking the antibiotics participants had last used.



Question 26, aimed to understand the reason why the participants had used their last course of antibiotics. Most respondents chose 'other' (n=39, 32.8% of cases), followed by UTIs (n=24, 20.2% of cases), and skin or wound infection (n=21, 17.6% of cases) (Figure 23). For question 27, aimed at understanding why participants had last given antibiotics to their child, most respondents chose 'other' (n=51, 42.5% of cases), followed by sore throat (n=21, 17.5% of cases), skin or wound infection (n=10, 8.3% of cases), bronchitis (n=8, 6.7% of cases), and UTI (n=8, 6.7% of cases). Similar to the results seen for question 26, none of the participants chose 'cold' or 'flu' as the reason for the last course of antibiotics given to their child.

Table 20: Frequency distribution of responses for questions 28, 29, 30, & 32; regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice.

Questions regarding parents' self-reported practices towards antibiotic prescribing & prescription advice		Frequency (Percentage)		
		Yes	No	Do not know[1]
Q 28	Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?	39 (32.5)	67 (55.8)	14 (11.70)
Q 29	Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?	24 (20.0)	76 (63.3)	20 (16.7)
Q 30	In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?	64 (53.3)	52 (43.3)	4 (3.3)
Q 32	Did the information that you received change your views on using antibiotics or giving antibiotics to your child?	35 (29.2)	76 (63.3)	9 (7.5)

[1] Including 'Do not remember' and 'Do not wish to answer'

For question 28, regarding whether participants were tested before being prescribed antibiotics, most stated that they had not been (n=67, 55.8%) and 11.70% (n=14) did not know/did not remember whether they had (see Table 20). Regarding whether their child had been tested before being given antibiotics, 63.3% said that their child had not been (n=76), and 16.7% said that they did not know or remember whether their child had (n=20).

For question 30 (*in the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?*), 53.3% (n=64) remembered getting information, whereas 43.3% (n=52) did not remember receiving any (see Table 20), which could have influenced their knowledge, understanding, attitudes, and self-reported practices on antibiotic use and antibiotic resistance. Concerning whether the information received in the last 12 months changed their views on using antibiotics or giving them to their child (question 32), most parents stated that the information had not changed their views, (n=76, 63.3%), with 29.2% stating that it had (n=35). These results show that almost a third of the participants changed their views when information was provided to them.

Chi-square tests showed no statistically significant associations in the answers provided for questions 28, 29, 30, and 32 ($p \leq 0.05$) and the following variables: age (Appendix 1, Table 51), ethnicity (Appendix 1, Table 52), place of birth (Appendix 1, Table 53), educational attainment (Appendix 1, Table 54), and deprivation (Appendix 1, Table 57).

However, based on gender, chi-square tests showed a statistically significant association between gender and the statement '*did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*' only (X^2=6.76, p=0.02), with more women than men stating that their child had not been tested before antibiotics were prescribed (Appendix 1, Table 50). However, this could be due to the sample of parents obtained for the study, i.e., more fathers than mothers.

Based on the number of children that parents had, a statistically significant association was found for the following statements: '*did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*' (X^2=14.08, p=0.02), and '*did the information that you received change your views on using antibiotics or giving antibiotics to your child?*' (X^2=19.53, p=0.001), with most parents having 2 children stating that their child was not tested before being prescribed antibiotics, and that the information they were given had not changed their views on antibiotic use.

Figure 24: Frequency distribution of responses for question 31; regarding the sources of information given to participants on the unnecessary use of antibiotics for themselves or their child.

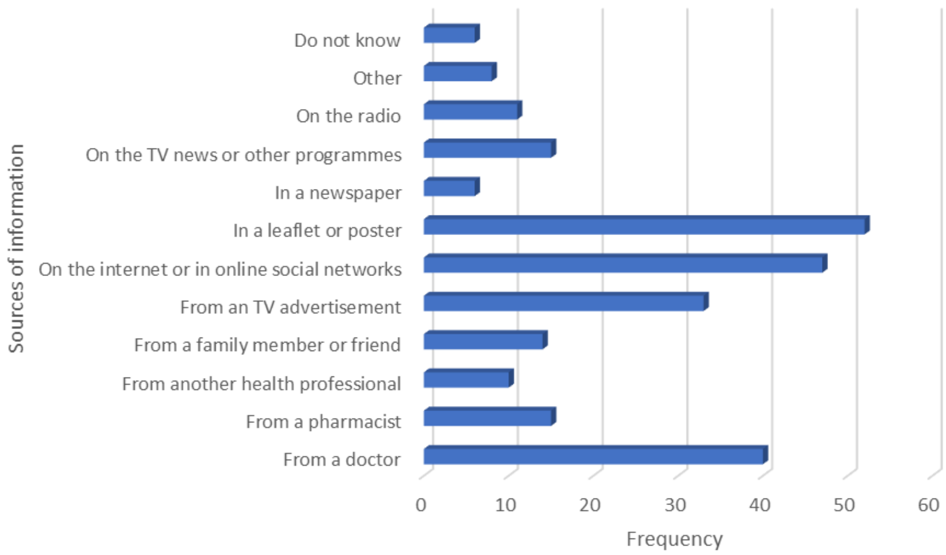
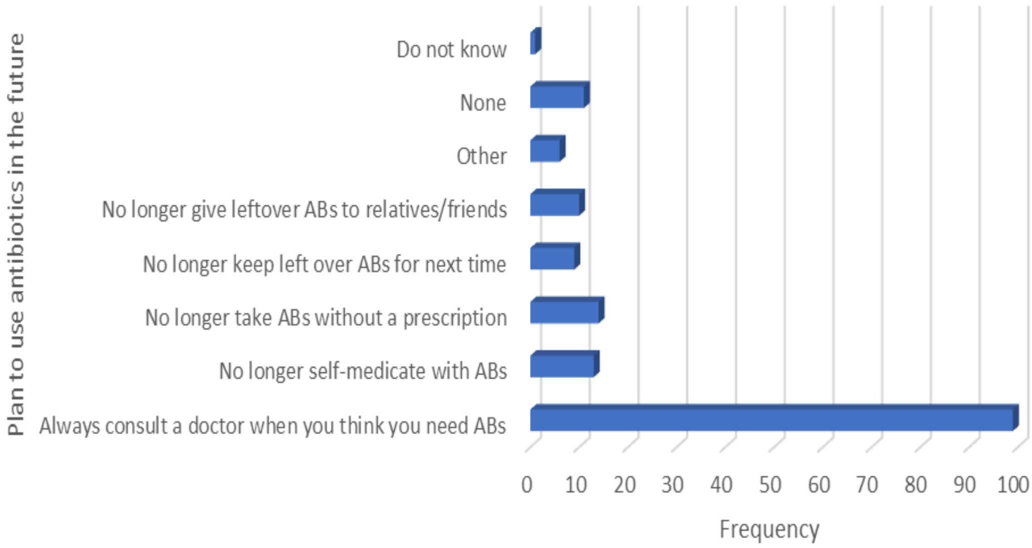


Figure 24 indicates that the source of information chosen the most by participants, was a leaflet or poster (n=52, 43.7% of cases), followed by the internet/online social networks (n=47, 39.5% of cases), from a doctor (n=40, 33.6% of cases), and from a TV advertisement (n=33, 27.7% of cases). It is important to note the perceived influence of the internet or online social networks as sources of information on the unnecessary use of antibiotics, which could be a good platform to raise awareness among parents in GM. Another noteworthy source of information chosen by the participants is '*from a family member or friend*' (n=14, 11.8% of cases), which could potentially lead to misinformation or be a route through which information on ABR and antibiotic use can spread among parents in GM.

Figure 25: Frequency distribution of responses for question 33 (*on the basis of the information you received, how do you now plan to use antibiotics?*).



For question 33 (multiple answers), most participants stated that after they had received information on the unnecessary use of antibiotics for themselves or their child, they would always consult a doctor when they felt that they needed antibiotics (n=99, 82.5% of cases) (Figure 25). Out of the total number of participants who responded to this question, 14 stated that they would not take antibiotics without a prescription from a doctor (n=14, 11.7% of cases), followed by 13 participants stating that they would no longer self-medicate with antibiotics (n=13, 10.8% of cases). On the basis of the information that the participants obtained, no longer giving leftover antibiotics to relatives or friends when they are ill, was cited by only 10 participants (7.5% of cases), and '*you will no longer keep leftover antibiotics for the next time you are ill*' was cited by 9 respondents (7.4% of the cases).

Questions 34 and 35 are reported together, as they aimed to find out self-reported practices for either themselves or their child. For question 34 participants were given a scenario "*the doctor prescribes a course of antibiotic for you. After taking 2–3 doses you start feeling better*" followed by statements about their self-reported practices. For question 35, the scenario was "*the doctor prescribes a course of antibiotic for your child. After taking 2–3 doses your child starts feeling better*", followed by statement about parents' practices, with respect to administering antibiotics for their child.

Table 21: Frequency distribution of responses for question 34 and 35; participants' self-reported practices regarding antibiotic use for themselves or their child, following a scenario where they or their child feels better after 2-3 doses of antibiotics.

Self-reported practices regarding antibiotic use for themselves, or their child		**Frequency (Percentage)**		
		Always[1]	**Sometimes**	**Never[2]**
Q34	**The doctor prescribes a course of antibiotic for you. After taking 2–3 doses you start feeling better**			
(a)	Do you stop taking further treatment?	2 (1.7)	7 (5.8)	111 (92.5)
(b)	Do you save the remaining antibiotics for the next time you get sick?	3 (2.5)	5 (4.2)	112 (93.3)
(c)	Do you discard the remaining, leftover medication?	51 (42.5)	6 (5.0)	63 (52.5)
(d)	Do you give the leftover antibiotics to your child or children if they get sick?	1 (0.8)	0	119 (99.2)
(e)	Do you complete the full course of treatment?	115 (95.8)	5 (4.2)	0
Q35	**The doctor prescribes a course of antibiotic for your child. After taking 2–3 doses your child starts feeling better**			
(a)	Do you stop giving them further treatment?	1 (0.8)	4 (3.3)	115 (95.8)
(b)	Do you save the remaining antibiotics for the next time they get sick?	2 (1.7)	2 (1.7)	116 (96.7)
(c)	Do you discard the remaining, leftover medication?	53 (44.2)	4 (3.3)	63 (52.5)
(d)	Do you give the leftover antibiotics to your other children or family members if they get sick?	2 (1.7)	2 (1.7)	116 (96.7)
(e)	Do you follow the full course of treatment for your child?	117 (97.5)	2 (1.7)	1 (0.8)

[1] Includes 'Usually'
[2] Includes 'Seldom'

Table 21 indicate that most participants' self-reported practices regarding antibiotic were responsible, with 92.5% (n=111) correctly stating they would never stop following their treatment regime if they felt better, 93.3% (n=112) would never save remaining antibiotics for the next time they were sick, and 99.2% (n=119) would never give the leftover antibiotics to their child or children if they got sick. Regarding parents' self-reported practices for their child, where their child felt better after taking 2-3 doses of antibiotics prescribed by the doctor (question 35), similar findings in answers can be observed compared to question 34. Most participants correctly stated they would not stop giving further treatment if their child felt better after 2-3 doses of antibiotics (n=115, 95.8%); they would not save the remaining antibiotics for the next time their child got sick (n=116, 96.7%); they would never give the leftover antibiotics to their other children or family members (n=116; 96.7); and they would always follow the full treatment course for their child (n=117; 97.5%). However, in both questions 34 and 35, participants stated they would always discard the remaining leftover medication in the scenario where they felt better after 2-3 doses (n=51, 42.5%) and the scenario where their child feels better after 2-3 doses (n=53, 44.2), even though in both scenarios more than 92% of the participants stated that they would always continue the treatment even if they or their child felt better after 2-3 doses. This result could be due to the ambiguity in how the questions were phrased.

Chi-square tests showed no statistically significant variations in the answers provided for questions 34 and 35 ($p \leq 0.05$) and gender (Appendix 1, Table 58), age (Appendix 1, Table 59), educational attainment (Appendix 1, Table 61), number of children (Appendix 1, Table 63), and deprivation (Appendix 1, Table 65)

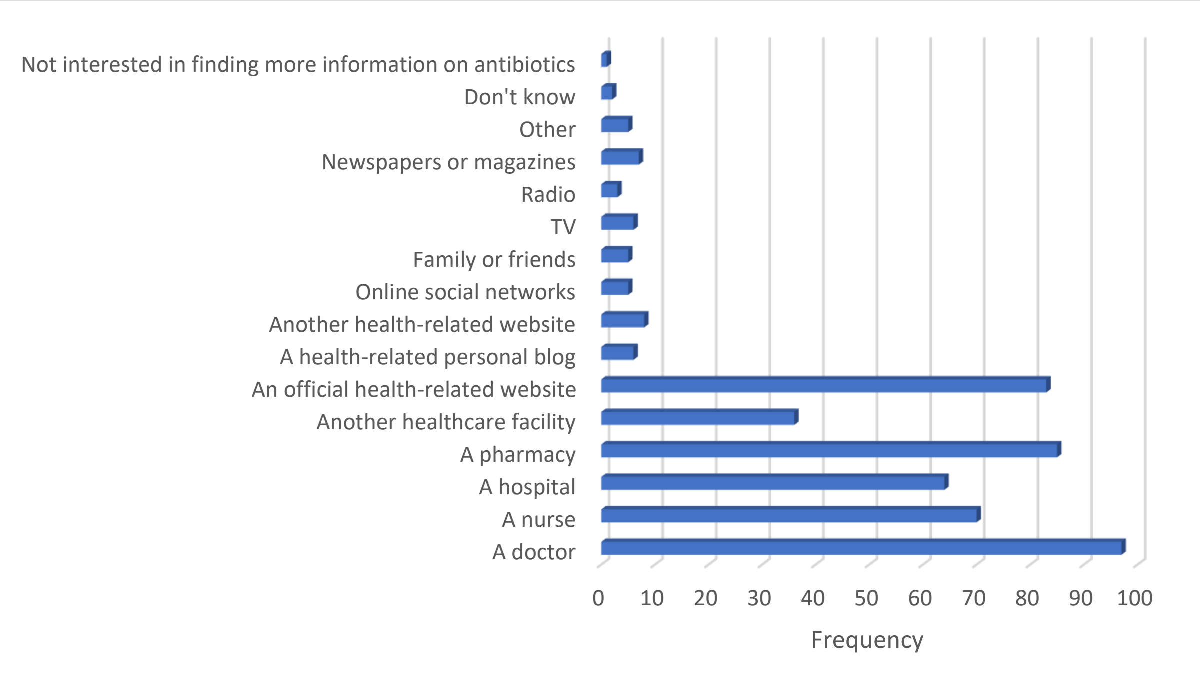
Comparisons between participant responses and ethnicity have shown statistically significant associations in several statements (Appendix 1, Table 60): *'do you stop taking the further treatment?'* (X^2=18.92, p=0.02), '*do you save the remaining antibiotics for the next time you get sick*?*'* (X^2=18.48, p=0.02), '*do you give the leftover antibiotics to your other children or family members if they get sick?*' (X^2=24.70, p=0.01), and '*do you follow the full course of treatment for your child?*' (X^2=21.39, p=0.05) (Appendix 1, Table 61). Regarding the variable 'place of birth', a significant association was also found between this variable and the statements 'd*o you stop taking the further treatment?*' (X^2=10.60, p=0.01), '*Do you stop giving them further treatment?*' (X^2=7.39, p=0.03), and '*do you give the leftover antibiotics to your other children or family members if they get sick?*' (Appendix 1, Table 61) (X^2=7.22, p=0.04). The findings from the chi-square tests show that a higher percentage of participants in who were of White ethnicity and born in the UK had better self-reported practices regarding finishing an antibiotic course, compared to those who were of other ethnicities and born outside the UK. However, these results could be due to the sample being biased towards parents of White ethnicity, who were born in the UK.

4.1.5 Topics for more information & trustworthy sources of information

The questions in the last section of the online survey pertained to the topics on ABR that the respondents would want to receive more information on (question 45), and the sources of information that they would use to get trustworthy information (question 46). Respondents were able to choose multiple answers for these questions.

Most respondents chose ‘none’ as a response (n=42, 35.6% of cases) to the question “*on which topics, if any, would you like to receive more information?*” (question 45), or chose ‘don’t want to receive more information on these issues’ (n=32, 27.1% of cases); 19 respondents (16.1% of cases) said they would like to receive more information on ABR, 18 (15.3% of cases) wanted more information on medical conditions where antibiotics are used, and 18 (15.3% of cases) wanted to know more about links between humans, animals and the environment. Only 4 respondents (3.4% of cases) wanted more information on the prescription of antibiotics, while 3 (2.5% of cases) wanted more information on antibiotic use.

Figure 26: Frequency distribution of responses for question 46 (*Which of the following sources of information would you use in order to get trustworthy information on antibiotics?*)



Regarding which sources of information respondents would use to get trustworthy information on antibiotics (question 46) (see Figure 26), most said they would get information from a doctor (n=97, 85.1% of cases), a pharmacy (n=85, 74.6% of cases), and an official health-related website (n=83, 72.8% of cases). Nurses (n=70, 61.4% of cases) were the 4th most frequent source of information chosen by the respondent, followed by a hospital (n=64, 56.1% of cases), and other healthcare facilities (n=36, 31.6% of cases). The option 'another health-related website' was chosen by 8 respondents (7.0% of cases); only 7 (6.1% of cases) chose newspapers and magazines, 6 (5.3% of cases) chose TV, 5 chose online social networks (4.4% of the cases), and 5 (4.4% of the cases) would use friends and family to be a trustworthy source of information.

4.1.5 Comparison with findings from published norms

Table 22 below shows the comparisons between the findings from the quantitative phase of this PhD study, and the studies that were used to inform the questionnaire used.

In this PhD study some parents showed a mixed understanding and attitudes regarding certain aspects of antibiotic use and individual contributions to ABR. Only 51.7% (n=62) of respondents agreed that they contribute to the development of ABR whenever they consume antibiotics (20.8% [n=25] were undecided, and 27.5% [n=33] disagreed). These results are similar to those reported in Khan et al.'s (2013) study, where similar questions were used to assess knowledge, attitude, perceptions, and practices among medical students in a Southern Indian Teaching Hospital, where 53.6% of participants agreed that they contributed to ABR when they consume antibiotics, 17.5% were undecided, and 27.8% disagreed.

In this PhD study 66.7% (n=80) of the survey respondents correctly knew that antibiotics can often cause side-effects such as diarrhoea, although 33.3% (n=40) were unaware of this. Similar results were reported in the 2018 Eurobarometer study, to evaluate the public's (n=27,474) knowledge, attitudes and behaviour, with regards to antibiotic use and AMR, which was conducted in 28 EU Member States, including the UK (EC, 2018).

According to 15% (n=19) of the survey respondents in this PhD study skipping one or two doses of antibiotics does not contribute to the development of ABR, although 56.7% (n=68) correctly understood that skipping antibiotic doses could, and 28% (n=33) were undecided.

Comparing these findings to Khan et al.'s (2013), participants in this PhD study had a better level of knowledge than the medical students in Khan et al.'s (2013) study, where only 47.4% of their participants agreed that skipping one or two doses would contribute to the development of ABR.

In this PhD study most respondents reported that they did not undergo a diagnostic test (55.8%, n=67), such as a blood test or throat swab, before being prescribed antibiotics; followed by 32.5% (n=39) who had had a diagnostic test, and 11.7% (n=14) who did not know/did not remember whether they had been tested. The Eurobarometer survey (2018) showed a similar trend, with 56% the total percentage of respondents (55% from the UK) who said that they had not been tested before starting antibiotics (56%).

Table 22: Comparison with other studies

Question	Findings from original studies	Findings from PhD study
Q1. For each of the following statements, please tell me whether you think it is true or false (a) Antibiotics kill viruses (b) Antibiotics are effective against colds (c) Unnecessary use of antibiotics makes them become ineffective (d) Taking antibiotics often has side-effects such as diarrhoea	European Commission (2018): 43% knew that antibiotics do not kill viruses 66% knew that antibiotics are ineffective against colds 85% new that unnecessary antibiotic usage makes them ineffective 68% knew that taking antibiotics often leads to side-effects	91.7% correctly knew that antibiotics did not kill viruses 99.2% correctly stated that antibiotics are not effective against colds 94.2% correctly said that the unnecessary use of antibiotics makes ineffective 66.7% knew that taking antibiotics often has side-effects such as diarrhoea
Q2. When do you think you should stop taking antibiotics once you have begun a course of treatment? (a) When you feel better (b) When you have taken all of the antibiotics as directed by your doctor (c) Other (d) Do not know	European Commission (2018). 87% disagreed that antibiotics should be stopped when they feel better 84% knew that knew that antibiotics should be taken as directed by the doctor	99.2 disagreed that antibiotics should be stopped when they feel better 99.2% knew that antibiotics should be taken as directed by the doctor
Q3. The improper use of antibiotics can lead to: (a) Ineffective treatment (b) Worsening of illness (c) Emergence of bacterial resistance (d) Additional medical cost to the patient	Khan et al. (2013): "More than 85 per cent of the respondents agreed that an indiscriminate and an injudicious use of antibiotics could lead to an ineffective treatment […] the emergence of bacterial resistance and an additional burden of medical costs to the patient." (Khan et al., 2013, Pg 1614)	97.5% agreed that the improper use of antibiotics can lead to ineffective treatment 85.8% correctly knew that improper use of antibiotics can lead to emergence of bacterial resistance 63.3% agreed that the improper use of antibiotics can lead to worsening of illness 55.8% knew that the improper use of antibiotics can lead to additional medical cost to the patient
Q4. Which statements do you agree with (a) Bacteria are germs that cause common cold and flu	Khan et al. (2013): 77.3% correctly knew that bacteria did not cause the common cold and flu	70.0% correctly know that bacteria did not cause the common cold and flu
(b) Antibiotics are effective against bacteria	André et al. (2010) 77.2% agreed that antibiotics are effective	76.7% knew that antibiotics are effective against bacteria

Question	Findings from original studies	Findings from PhD study
	against bacteria.	
(c) Antibiotics resistance can spread from animals to humans (d) Antibiotic resistance can spread from human to human	Vallin et al. (2016) "even fewer (<50%) responded correctly to questions regarding how antibiotic resistance can spread." (Vallin et al., 2016, pg 5)	27.5% knew that ABR can spread from animals to humans; 44.2% did not know this 35.0% knew that ABR can spread from human to human; 39.2 did not know this
Q5. Antibiotic resistance is an important and serious public health issue worldwide	Khan et al. (2013): 88.6% agreed	95.0% agreed that ABR is an important and serious public health issue worldwide
Q6. Antibiotic resistance is an important and serious public health issue in this country.	Khan et al. (2013): 90.7% agreed	93.3% agreed that ABR is an important and serious public health issue in this country
Q7. When I have a cold, I should take antibiotics to prevent getting a more serious illness.	Khan et al. (2013): 56% disagreed; 5.15 uncertain; 38.1% agreed	96.7% correctly disagreed; 3.3% agreed; none were undecided about this
Q8. When I get fever, antibiotics help me to get better more quickly.	Khan et al. (2013): 32% correctly disagreed; 7.21% were undecided; 60% agreed	85.5% correctly disagreed; 12.5% were undecided
Q9. Whenever I take antibiotics, I contribute to the development of antibiotic resistance.	Khan et al. (2013): 53.6% agreed; 17.5% were uncertain; 27.8% disagreed	51.7% agreed; 20.8% were undecided; 27.5% disagreed
Q10. Skipping one or two doses does not contribute to the development of antibiotic resistance.	Khan et al. (2013): 30.9% agreed; 20.6% were uncertain; 47.4% disagreed	15.0% wrongly agreed; 27.5% were undecided; 56.7% correctly disagreed
Q11. Antibiotics are safe drugs; hence they can be commonly used.	Khan et al. (2013): 15.5% agreed; 5.15% were uncertain; 78.4% disagreed	40.0% agreed; 12.5% were undecided; 47.5% correctly disagreed
Q12. If a child suffers from a cold or flu, it will be cured faster if they are given antibiotics.	Rousounidis et al. (2011) 48.4% agreed with this statement	96.7% disagreed; 1.7 were undecided; 1.7 agreed
Q13. If the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional.	Rousounidis et al. (2011)	90.8% disagreed; 5.8% were undecided; 3.3% agreed

Question	Findings from original studies	Findings from PhD study
	95.5% disagreed that they would change paediatrician if they didn't prescribe antibiotics enough	
Q14. You would re-use an antibiotic which you had used in the past if your child presents the same symptoms.	Rousounidis et al. (2011) Percentages for this question was not reported	82.5% disagreed; 8.3% were undecided; 9.2% agreed
Q16. You expect your doctor to prescribe antibiotics if your child was suffering from an Upper Respiratory Tract Infection (e.g. common cold, sinusitis, tonsillitis, or laryngitis).	Rousounidis et al. (2011) 33.5% agreed that they expect their paediatrician to prescribe an antibiotic for URTI symptoms	19.2% agreed; 12.5% were undecided; 68.3% disagreed
Q17. You would ask your doctor for antibiotic therapy if your child suffers from recurrent Upper Respiratory Tract Infections (e.g. common cold, sinusitis, tonsillitis, or laryngitis).	Rousounidis et al. (2011) 10% agreed that they would ask for antibiotics for URTI symptoms	15.0% agreed; 28.3% were undecided; 56.7 disagreed
Q18. Which of the following symptoms would make you visit a doctor for your child?	Rousounidis et al. (2011) Earache: 84 Fever 81% Sore throat: 45%	Ear pain: 77.3% Fever: 37.0% Sore throat: 28.6%
Q19. When antibiotics are prescribed for you or your child, you are given enough information regarding how to take the antibiotics, how long to take it for, and the possible side effects that could occur while taking it?	André et al. (2010) 50.7% agreed	80.0% agreed; 9.2% were undecided; 10.8% disagreed
Q22. Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?	European Commission (2018): 32% said yes; 67% said no; 1% did not know or did not wish to answer	33.3% said yes; 63.3% said no; 3.3% did not know or did not wish to answer
Q24. How did you obtain the last course of antibiotics that you used?	European Commission (2018): Healthcare professional: 93% Medical prescription: 72% Administered from a medical practitioner: 21% Without a prescription from a pharmacy: 3% Leftover from previous course: 3% Elsewhere: 1%	Medical prescription: 80.0% Administered by a medical practitioner: 10.8% Elsewhere: 0.8%

Question	Findings from original studies	Findings from PhD study
Q26. What was the reason for last taking the antibiotics that you used?	European Commission (2018): Other: 14% Bronchitis: 16% Sore throat: 14% Flu: 12% UTI: 12% Fever: 11%	Other: 32.8% UTIs: 20.2% Skin or wound infection: 17.6%
Q28. Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?	European Commission (2018): 41% said they had a test; 56% had not been tested; 1% did not know; 1% did not remember; 1% did not wish to answer	32.5% said they had a test; 55.8% did not have a test; 11.7% did not know/did not remember
Q30. In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?	European Commission (2018): 33% remembered getting information; 66% did not remember; 1% did not know	53.3% remembered getting information; 43.3 did not; 3.3% did not know/did not remember
Q31. If you have ever been given information about not taking antibiotics unnecessarily or giving your child unnecessary antibiotics, where did you get this information from?	European Commission (2018): Doctor: 41% TV news: 28% TV advertisement: 24% Newspaper: 19%	Leaflet or poster: 43.7% Internet/online social networks: 39.5% Tv advertisement: 27.7% From family member: 11.8%
Q32. Did the information that you received change your views on using antibiotics or giving antibiotics to your child?	European Commission (2018) : 29% said the information changed their views 70% said it did not change their views 1% did not know	29.2% said it changed their views; 63.3% said it did not change their views; 7.5% did not know/did not remember
Q33. On the basis of the information you received, how do you now plan to use antibiotics? You will always consult a doctor when you think you need antibiotics You will no longer self-medicate with antibiotics You will no longer take antibiotics without a prescription from a doctor	European Commission (2018): Always consult a doctor when antibiotics are needed: 65% Not take antibiotics without a prescription: 39% Would no longer self-medicate with antibiotics: 23%	Always consult a doctor when antibiotics are needed: 82.5% Not take antibiotics without a prescription: 11.7% Would no longer self-medicate with antibiotics: 10.8%

Question	Findings from original studies	Findings from PhD study
You will no longer keep left over antibiotics for next time you are ill You will give left-over antibiotics to your relatives or friends when they are ill Other None Do not know Do not wish to answer	Would no longer give leftover antibiotics to relatives: 5% Would no longer keep leftover medication for next time: 19%	Would no longer give leftover antibiotics to relatives: 7.5% Would no longer keep leftover medication for next time: 7.4%
Q34. The doctor prescribes a course of antibiotic for you. After taking 2–3 doses you start feeling better. (a) Do you stop taking the further treatment? (b) Do you save the remaining antibiotics for the next time you get sick? (c) Do you discard the remaining, leftover medication? (d) Do you give the leftover antibiotics to your child or children if they get (e) Do you complete the full course of treatment?	Khan et al. (2013): 55.6% would never stop treatment 58.8% would never save remaining antibiotics for next time 30% would discard leftover antibiotics; 32% would sometimes do this; 37% would never do this 45.4% would never give leftover antibiotics to friend 74.2% always completed the full course of treatment	92.5% would never stop treatment 93.3% would never save remaining antibiotics for next time 42.5% would discard leftover antibiotics; 5.0% would sometimes do this; 52.5% would never do this 99.2% would never give leftover antibiotics to their child 95.8% always completed the full course of treatment
Q45. On which topics, if any, would you like to receive more information? Resistance to antibiotics How to use antibiotics Medical conditions for which antibiotics are used Prescription of antibiotics Links between the health of humans, animals and the environment Other None I don't want to receive more information on these issues Don't know	European Commission (2018): Did not want to receive more information: 21% Information in ABR: 25% Medical conditions where antibiotics were used: 26% Links between humans, animals, and the environment: 24% Antibiotic prescriptions: 15% Antibiotic use: 24%	Did not want to receive more information: 27.1% Information in ABR: 16.1% Medical conditions where antibiotics were used: 15.3% Links between humans, animals, and the environment: 15.3% Antibiotic prescriptions: 3.4% Antibiotic use: 2.5%
Q46. Which of the following sources of information would you use in order to get trustworthy information on antibiotics? A doctor A nurse	European Commission (2018): Doctor: 86% Pharmacy: 42% Official health-related website: 13%	Doctor: 85.1% Pharmacy: 74.6% Official health-related website: 72.8% Nurses: 61.4% Hospital: 56.1%

Question	Findings from original studies	Findings from PhD study
A pharmacy A hospital Another health care facility Family or friends An official health-related website (e.g. a website set up by the national government/ public health body/ European Union) A health-related personal blog Another health-related website Online social networks TV Newspapers or magazines The radio Other You are not interested in finding information on antibiotics Do not know	Nurses: 14% Hospital: 21% Other healthcare facilities: 6% Newspapers and magazines: 3% TV: 4% Online social networks: 2% Friends and family: 4%	Other healthcare facilities: 31.6% Newspapers and magazines: 6.1% TV: 5.3% Online social networks:4.4% Friends and family: 4.4%

4.1.7 Summary of quantitative results

- Participants in this study showed a good level of knowledge regarding antibiotic use, where most correctly knew that antibiotics are ineffective against viruses and viral illnesses, such as colds. The vast majority of the parents also correctly knew that a course of antibiotics drugs should be taken to completion, as instructed by a healthcare professional.

- Although the majority of parents knew that the improper use of antibiotics could lead to ineffective treatment, there existed some misconceptions and misinformation regarding the other consequences that could arise due to the improper usage of antibiotics. A high percentage of parents were not aware that taking antibiotics can often have side-effects (33.3%), and that the improper use of these drugs can lead to worsening of an illness (36%).

- There exists a lack of understanding regarding how bacteria affect the body, what kind of illnesses they trigger, and how they are treated. Although the results showed that most participants knew that antibiotics were only effective against bacteria and were ineffective against colds, many wrongly believed that bacteria are germs that cause the common cold and flu (21.7%). There is also a lack of knowledge and understanding on the drivers of ABR and how ABR can spread.

- Participants showed mixed attitudes concerning their potential contribution to ABR; almost half were mistaken or unaware that they could contribute to the development of ABR whenever they consume antibiotics, and just over a third were unaware or wrong that skipping antibiotics contributes to ABR.

- More than half of the respondents would not request antibiotics from their doctor if their child had recurrent URTIs, and most parents cited seeking medical advice only if their child displayed a persisting symptom or combination of symptoms that did not subside with treatment at home (persistent fever, cough, ear discharge, vomiting, and rash). However, 15.0% agreed that they would request antibiotics and 28.3% were undecided.

- More than half of the respondents stated that they were not usually given time to inquire about the antibiotics prescribed to them, which could be an important factor influencing parents' knowledge, understanding, and self-reported practices, with regards to antibiotic use and ABR.

- While data analysis has shown that some demographic variables, such as gender, ethnicity, age, and educational attainment, are associated with parents' knowledge and attitudes towards antibiotic resistance, antibiotic use, and prescribing advice, these findings can only be considered indicative, due to the systematic bias that could have arisen due to convenience sampling. Furthermore, due to the large number of tests performed, type one errors could have occurred, and some of the significant associations made, using Chi-square tests, are likely to be significant just by chance.

- Concerning antibiotic use and antibiotic prescribing, most parents had good self-reported practices, with most stating that they obtained the last course of antibiotics (for themselves or their child) from a healthcare professional; only 0.8% reported that they obtained their last course of antibiotics from elsewhere.

- An important finding from this study was that most participants stated that neither themselves (55.8%) nor their child (63.3%) had been tested before being prescribed antibiotics.

- While slightly more than half of the parents participating in this study remembered getting information about not taking antibiotics unnecessarily in the past, most of them stated that the information had not changed their views on the unnecessary use of antibiotics.

While it is encouraging that most parents are aware of the seriousness of ABR and its consequences, and respect antibiotic prescribing advice, many parents showed a lack of understanding or awareness vis-à-vis certain aspects of ABR and antibiotic use. This could potentially translate into misinformation passed onto the next generation of antibiotic stewards, i.e., their children. Therefore, there is significant scope to improve parents' knowledge, understanding, and attitudes towards antibiotics use and ABR, as there are marked variations in the levels of knowledge and understanding displayed by the participants in this study.

4.2 Findings, Phase 2; telephone interviews

This section presents the results obtained from the telephone interviews, which aimed to explore parents' perceptions, experiences, practices, and behaviour towards ABR, antibiotic use for their child, and prescription advice.

Twelve parents were recruited for interviews, conducted between August 2020 and January 2021. Each interview lasted between 20 and 40 minutes and was transcribed verbatim by the researcher.

It is important to note that the initial plan for this phase of this study was to conduct interviews, with the 30 parents who had expressed an interest, until saturation was reached. However, out of the 30 parents who were sent invitations, only 12 took part. While similar themes were emerging after the 10th interview, it is possible that due to the lower than anticipated number of respondents, saturation did not occur. Further possible characteristics, theoretical concepts, mapping connections, and relationships could potentially have emerged if more interviews had been conducted.

Parents' demographic data for phase 2, were obtained from both the online questionnaire from phase 1 and the interview questions from phase 2, presented in Table 23 below.

Table 23: Demographic characteristics of interviewed participants

Parent ID	Gender	Age	Ethnicity	Place of birth	Education level	Number of children	Age of children
P1	Female	30-39	White	UK	Master's degree	2	Eldest - 2 years old Youngest - new-born
P2	Female	30-39	White	UK	Certificate of higher education	1	2 years old
P3	Female	40-49	White	UK	Undergraduate degree	2	Eldest - 19 years old Youngest - 3 months to 6 years old
P4	Female	30-39	White	UK	Master's degree	3	5, 6 & 7 years old
P5	Female	20-29	White	UK	Vocational qualification	2	Eldest - 4 years old Youngest – age unknown

P6	Female	30-39	White	Italy	Diploma of higher education	1	3 years old
P7	Female	30-39	White	UK	Master's degree	2	Eldest - 5 years old Youngest – age unknown
P8	Female	30-39	White	UK	Master's degree	2	Eldest - 4 years old Youngest - 2 years old
P9	Female	30-39	White	Bulgaria	Master's degree	2	Eldest - 2 years old Youngest - 10 months old
P10	Male	40-49	White	UK	Undergraduate degree	1	3 years old
P11	Female	30-39	White	USA	Master's degree	3	4, 6 & 8 years old
P12	Male	50-59	White	UK	Professional qualification	3	5, 14 & 17 years old

Most parents were female and aged between 30-39. The only 2 males who took part were aged between 40 and 59. All participants were of White ethnicity. Most parents were born in the UK, with the exception of 3; born in Bulgaria, Italy, and USA. Most had more than one child, and half were educated to postgraduate level.

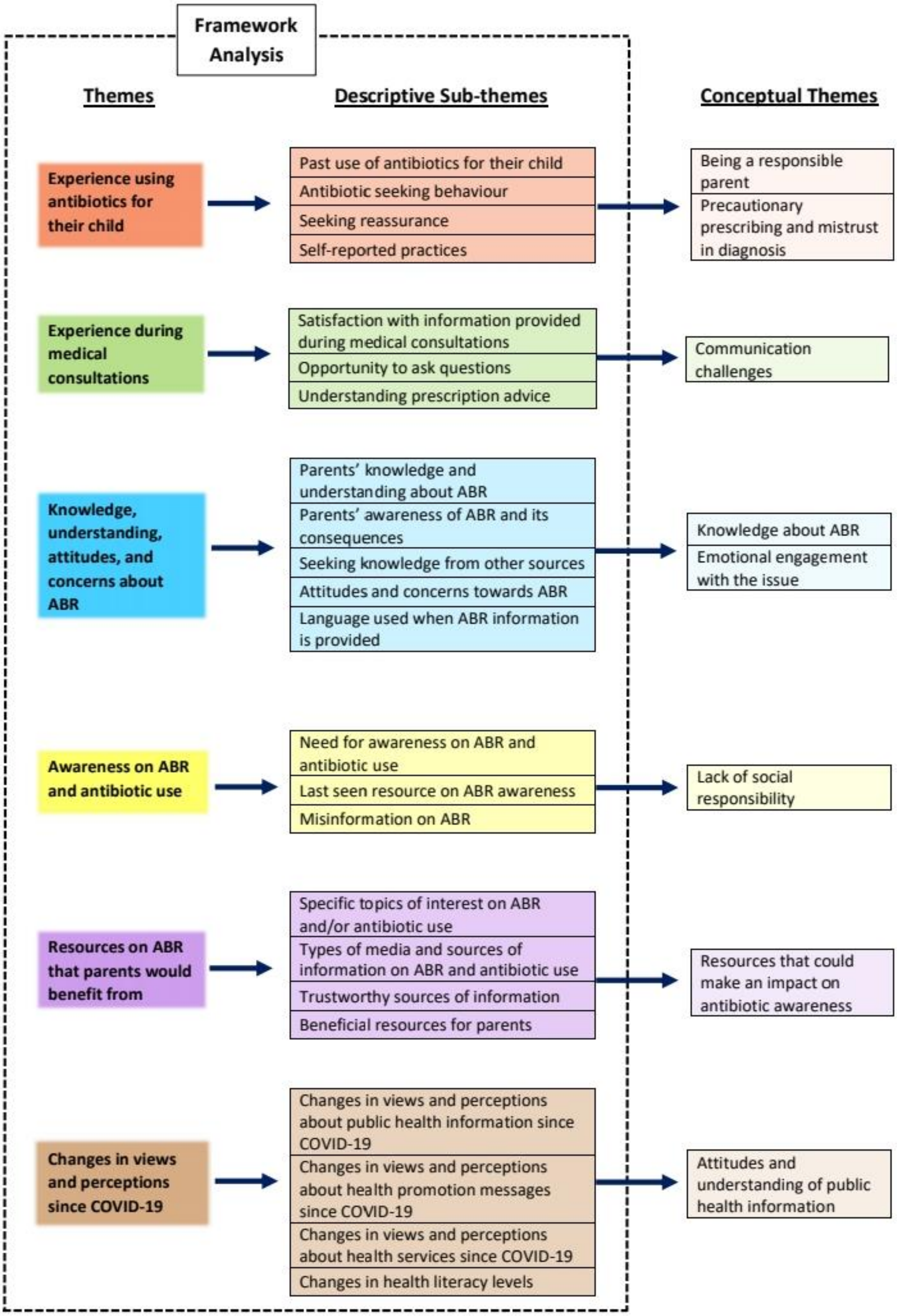
As discussed previously (see section 3.2.3.3), framework analysis was used for the systematic analysis of the interview data. Using framework analysis enabled in-depth investigation within a limited time frame, while also maintaining a clear and rigorous examination that aided the analytical processes (Smith & Firth, 2011; Gale, Heath, Cameron, Rashid & Redwood, 2013; Parkinson et al., 2016).

4.2.1 Main themes

Six main descriptive themes emerged from the data obtained from the transcripts and formed part of the framework analysis matrix (see Figure 27 below). These descriptive themes include:

- Parents' experience using antibiotics for their child/children
- Parents' experience during medical consultations
- Parents' knowledge, understanding, attitudes, and concerns about ABR for themselves and their child
- Awareness on ABR and antibiotic use
- Resources on ABR that parents would benefit from
- Changes in views and perceptions since COVID-19

Figure 27: The development of themes, sub-themes, and conceptual themes



Topics of discussion were labelled as recurrent subthemes and categorised under the corresponding main descriptive themes. This helped create the final analytical framework, which also aided in the development of eight conceptual themes. Figure 27 illustrates the descriptive themes and recurring descriptive subthemes, followed by the development of the underlying conceptual themes. Themes are interpretive propositions that emerge from the transcripts, to describe certain characteristics of the data (Gale et al., 2013), while conceptual themes help in the examination of links between themes and are drawn from the examination of various themes and subthemes that emerge across the data set during analysis (Harding et al., 2013).

The first descriptive theme of the framework analysis matrix is '**experience using antibiotics for their child/children**'. Data included recurrent descriptive subthemes around parents' past use of antibiotics for their child/children and information on particular infections that were treated, positive or negative experiences using antibiotics, and how a particular medical situation was resolved with or without antibiotics. Parents spoke about the stress and anxiety they had experienced in these situations, as well as how they felt about the diagnosis and advice given to them. Parents also spoke about situations where they would seek antibiotics for their child, including symptoms that would prompt them to consult a healthcare professional, or where they would seek reassurance rather than antibiotics for their child. The final recurrent subtheme in this category involved parents' self-reported practices when it came to antibiotic use for their child, which included compliance with antibiotic treatment regimen. Parents were also asked about their own use of and adherence to antibiotic treatment. Two conceptual themes emerged for this category of themes and subthemes, which appear to be key elements of parents' recollections regarding their experience using antibiotics for their child. These were '*being a responsible parent*' and '*precautionary prescribing and mistrust in diagnosis'*.

Theme 2 is '**experience during medical consultations'** and involved subthemes around parent's experiences during consultations with healthcare professionals. Parents offered their thoughts about how they felt communicating with doctors, whether they were satisfied with the information provided to them, whether they were given the opportunity to ask questions, and their understanding of their prescription advice. Parents also explained why some of them felt uniformed in certain cases when leaving a medical consultation, or how the amount of time available played an important part in how the consultation went. The conceptual theme of '*communication challenges*' emerged from discussions with parents who were satisfied with how the consultations went and those who were not.

The third theme is '**knowledge, understanding, attitudes, and concerns about antibiotic resistance**'. Parents explained what they knew about this public health issue and attempted to give a definition for the term 'antibiotic resistance'. Here, parents drew on their experience with this issue, recalling conversations on the topic with friends, family, or acquaintances, as well as instances where they had seen recent or past campaigns or public health messages around the subject. Parents who felt uniformed on the subject, shared examples of where they sought information on ABR from other sources or a second opinion regarding the prescription of antibiotics for their child. Discussions around parents' attitudes and concerns about ABR revolved around whether they felt it could affect themselves or their child. This led to the development of the conceptual themes '*knowledge about ABR*' and '*emotional engagement with the issue*'. Parents also shared their thoughts on the language used when information on ABR was offered to them, and discussions revolved around the technicality of language, clarity of information provided, and whether or not information on ABR was provided to them by a healthcare professional.

Theme 4, '**awareness on antibiotic resistance and antibiotic use**', involved discussions on the need for awareness about ABR and the proper usage of antibiotics. Parents shared their experiences about lack of awareness on the proper use of antibiotics and their thoughts on misinformation regarding ABR and how resistance occurs, and whether they had experienced misinformation on the subject. Drawing from past instances where they had heard misconceptions and misinformation from friends, relatives, or acquaintances, parents recalled hearing about other people misusing antibiotics. They also shared their belief that GPs could be responsible for the over-prescription of antibiotics and increased spread of ABR, due to factors such as patient pressure, lack of diagnostic tests, antibiotic prescription as a precaution, or as a short-term solution. Parents also spoke about the most recent resources they had seen on ABR. The conceptual theme of '*lack of social responsibility*' emerged from this part of the discussion.

The fifth theme is '**resources on antibiotic resistance parents would benefit from**' and encompassed parent's experience with the resources they had seen on the topic previously, whether they had benefitted from them, and what they felt was interesting/useful to them. Parents also shared their views on which topics on ABR and/or antibiotic use they felt they wanted more information on. Parents shared insights into the types of resources they would be interested in, how they should be presented, where they would like these to come from and specific features that would attract and capture their attention. They mentioned the various types of media they would be interested in seeing, and those they perceived to be less efficient, according to their lifestyles and interests. Parents were given the opportunity to discuss the sources of information they would seek and trust when it came to information on ABR, as well as those they considered untrustworthy or would be sceptical about. The conceptual theme that emerged from this category was '*resources that could make an impact on antibiotic awareness*'.

The last main descriptive theme explored in the matrix is '**changes in views and perceptions since COVID-19**' and arose from discussions with parents about their experiences with public health information, public health messages, and healthcare services during COVID-19. Parents who felt that their views and perceptions on these subjects had changed during the coronavirus pandemic shared their thoughts on why they felt this had occurred and whether this was a positive or negative change. Discussions revolved around parents' attitudes and concerns towards public health information and health promotion messages and trusting the governmental agencies and organisations in charge at the time of the pandemic. Parents also recalled their experiences with accessibility to healthcare services during this period, including how they felt when accessing these services and whether they benefitted from them at the time. Parental frustrations regarding certain aspects, such as how public information was disseminated to the public during COVID-19 and accessibility to support and healthcare services, featured very strongly in the recollections of some parents. In this category, one conceptual theme emerged, namely '*attitudes and understanding of public health information*'.

The eight conceptual themes that evolved from the development of the framework analysis matrix will henceforth be reported under the six main categories (main descriptive themes) from which they derived (see Figure 27 above).

4.2.2 Parent's experience using antibiotics for their child/children

The interviews began with each parent being asked about their past use of antibiotics for their child, symptoms that would lead them to seeking medical advice or antibiotics for the child, antibiotic-seeking behaviour, and self-reported practices regarding antibiotic use for themselves or their child. Most parents interviewed had experienced being prescribed and using antibiotics for their child(ren), with the exception of a couple of parents who, at the time that the interviews were conducted, had never needed to give antibiotics to their child.

4.2.2.1 'Being a responsible parent'

The conceptual theme of '*being a responsible parent*' was noted in all interviews, particularly in parents' recollections of situations where they would seek medical advice for their child, the types of symptoms that would lead to seeking medical advice, and their self-reported practices regarding antibiotic use for their child. All parents said that they would look for reassurance and seek medical advice for symptoms such as ear infections, eye infections with discharge, high temperatures, rash, and cough, and for *"something very persistent that [they] suspected was bacterial in nature rather than a virus…" (Parent 1; 30-39, Master's degree, 2 children)*. Medical advice was sought if their child was "*feeling off in themselves or complaining of any pain in areas that I couldn't help with…*" (*Parent 4; 30-39, Master's degree, 3 children*). Wanting a medical consult in situations where they could not help their child feel better was a sentiment reiterated by many parents:

> *"…they both had high temperatures, and it wasn't coming down with just Calpol and Ibuprofen, and I thought it must have been something more. And then obviously when we went to the doctor and they gave antibiotics, that helped and they both did get better...*" (*Parent 8; 30-39, Master's degree, 2 children*).

Treating the symptoms at home first was reiterated by many participants, who mentioned that they would *"try to ride it out…" (Parent 5; 20-29, Vocational qualification, 2 children)*, before seeking medical advice. However, there was consensus among all interviewees that rather than seeking antibiotics from their GP, they would *"just seek advice or kind of almost like confirmation that [it] is nothing…" (Parent 7; 30-39, Master's degree, 2 children)*. Some mentioned trusting the doctor's decision if antibiotics were not warranted, and others mentioned being willing to wait and see how the child's illness evolved before following doctors' suggestions to treat the illness with antibiotics:

> "*But I'll take the kid and see if the doctor thinks that antibiotics are warranted, but I leave that choice to them because I know antibiotics are over-used sometimes. So, if the doctor thinks just let it wait, I'm happy to just let it wait…*" (*Parent 11; 30-39, Master's degree, 3 children*).

Regarding how participants used antibiotics for their child and themselves, most had good self-reported practices, presenting themselves as responsible antibiotic users who followed GP instructions and guidance on antibiotics therapy, and completed the full course of treatment. However, finishing the full course of antibiotics was not a major factor that affected infection treatment for certain parents. These participants perceived antibiotics to be prescribed longer than necessary, and therefore could be taken for a shorter duration contrary to medical guidance. For example, a mother (amongst the least educated in the sample) claimed that although they would usually finish the whole course of antibiotics, they believed that skipping a few doses would not lead to any significant consequences:

> "*…it's not going to make a difference if I don't take it for a couple of days…"* (*Parent 2; 30-39, Certificate of higher education, 1 child*).

Despite their belief that skipping a couple of doses was inconsequential, this mother was aware that skipping doses for their child was not advised and could lead to negative consequences. This parent mentioned skipping antibiotic doses due to difficulties in administering the medication to their child; however, they justified this behaviour, by explaining that antibiotics were generally prescribed for longer than necessary, and therefore skipping antibiotic doses would not have consequential effects for their child. Interestingly this parent's practices administering antibiotics for their child mirrored their own self-reported practices, i.e., they believed that skipping a couple of doses for themselves would not have any consequences, therefore similar practices for their child would also be inconsequential. This participant's contradictory beliefs about the consequences of not finishing a course of antibiotics indicates cognitive dissonance, where their beliefs are not mirrored by their behaviour:

> “*I think probably administering it to my daughter would be more tricky and so I would probably be more inclined to not give her the full course, even though I know that that’s quite bad and I shouldn’t really do that. Especially sometimes they prescribe for extra days when the normal course might only be five days. They might say oh I’ll prescribe you seven days-worth there. Sometimes I think well, if we’re normally getting prescribed for five days for the same problem then surely I could just take it for five days…” (Parent 2; 30-39, Certificate of higher education, 1 child).*

Questioning antibiotic treatment for themselves was also reported by another parent who mentioned being prescribed antibiotics unnecessarily, and without appropriate diagnostic tests conducted; resulting in them stopping antibiotic treatment after only a couple of days. This participant, who was also amongst the least educated in the sample, described having flu-like symptoms that they believed did not warrant an antibiotic prescription, and therefore stopped their antibiotic treatment after feeling better after a couple of days. The lack of diagnostic tests, the flu-like symptoms, as well as feeling better after only a couple of days reinforced this mother’s views that the antibiotics were prescribed unnecessarily and therefore justified their decision to stop the antibiotics prematurely:

> *“…to be honest the last time I was prescribed antibiotics, I stopped after 2 days. I don’t think it was needed in the first place, but the GP wanted to give it to me. […] Anyway, because I was in pain, like I was having some kind of flu symptoms I would say, I agreed to take the antibiotics. But when I felt better the morning after, one or maybe 2 days after, but not more than that, I just decided that that was not the case. You know, they gave me antibiotics for 2 weeks! To recover from mastitis that I didn’t have, and not one single test was done!” (Parent 6; 30-39, Diploma of higher education, 1 child).*

Interestingly both parents who described skipping antibiotic doses had the lowest levels of education compared to the rest of the participants, which could influence their health literacy or how they understand and comply with medical advice and treatment. Parents may have contradictory views of how antibiotics should be taken, including the importance of finishing the antibiotic treatment, despite being aware that the guidance on antibiotic use insists that antibiotic courses should be completed. As seen with Parent 2, parents' self-reported practices could translate into how they administer antibiotics to their child. Practices involving antibiotic use, that may or may not comply with health guidance on antibiotic usage, could be passed on to children, who are the next generation of antibiotic stewards.

4.2.2.2 'Precautionary prescribing and mistrust in diagnosis'

More than half of the parents who recalled having used antibiotics for their child, mentioned that when they had been needed, the prescription had been effective and the child got better without needing any further medical help and/or advice. While some of these parents could not remember the reason for their child's antibiotic treatment, they did not recall any negative experiences during or after the treatment, and therefore were satisfied with their experience of administering antibiotics to their child.

> "*…he was prescribed antibiotics, it was a delightful banana flavoured I'm assuming from the smell, bright yellow that he was happy enough to take and that's kind of my experience of it really […] And I don't remember having to go back to the doctors, so whatever it was, was dealt with without any need for anything extra…*" (*Parent 7;* 30-39, Master's degree, 2 children).

Many parents who had experienced using antibiotics for their child, recalled being prescribed antibiotics as a precautionary measure, either due to an unconfirmed or unknown diagnosis that the doctor believed warranted antibiotics. Some of these parents described instances where they had not been given a satisfactory explanation for why precautionary antibiotics were needed. Doubt about the necessity for antibiotics was expressed by parents who felt that information on their child's diagnosis, was insufficient or vague. In the case of Parent 3, who was reluctant for their child to be given antibiotics, the medication had been given to the child in secondary care for a potential infection that was not confirmed; indicating that in this case the medication may have been administered to ensure that further complications were avoided:

> *"…my youngest, she was given them on day two and whether she needed them or not…and I didn't want her to be given them and she didn't need them either. Yeah, they thought there was some difficulty on day two with her after normal delivery, they*

said there may have been some infection we're going to give her antibiotics, and they gave her antibiotics…" (Parent 3; 40-49, Undergraduate degree, 2 children).

Parent 5 recalled getting precautionary antibiotic prescriptions for both her children, despite believing that only their youngest child needed them. The antibiotics had been prescribed for their oldest child "just in case" and because of an upcoming weekend. This could indicate that precautionary antibiotics may be prescribed before the weekend, due to higher levels of uncertainty that follow-up medical appointments can be obtained, or due to uncertainty about treatment accessibility during this period. In the case of Parent 5, notwithstanding an error in the medication dosage, it was clear that they trusted the healthcare professional's prescription decision and wanted to obtain the medication even though they believed the antibiotics were only needed for their youngest child.

"*…we have left before and the nurses have given us the wrong antibiotics for both of them […] they were both poorly…the littlest needed them, and they said oh the other one might do, because it's the weekend we'll give you some anyway. So, when I went in to cash in the prescription, she had given the wrong dosage for my 4-year-old, so we didn't end up using them…*" (*Parent 5; 20-29, Vocational qualification, 2 children*).

It is important to note that this parent's recollection of being prescribed precautionary antibiotics indicates good antibiotic stewardship from the pharmacist who noticed the error in the prescription. However, it also showed that the antibiotics prescribed for the four-year-old had been prescribed incorrectly and potentially unnecessarily, indicating a lack of stewardship by the prescriber.

Mistrust in diagnosis was a recurrent theme that emerged from parents' recollections of questioning the doctor's diagnosis and precautionary prescribing. Many parents refused to give their child antibiotics when they had been prescribed without any tests being done. Some parents mentioned questioning the doctor's diagnosis and decision to prescribe antibiotics, when they felt that they were not needed, and therefore refused to give their child the medication:

"…she had a lot of like bad nappy rash and there was a query about whether it was thrush or whether there was something else going on. I don't think it was any of those

things and we didn't give her the antibiotics…" (Parent 2; 30-39, Certificate of higher education, 1 child).

This parent was confident that the healthcare professional's thrush diagnosis was wrong and questioned their decision to prescribe antibiotics. Parent 2 went on to further explain that they had received confirmation from their partner and friend, who were both healthcare professionals, that the antibiotics were not warranted. The decision to prescribe antibiotics in this case was questioned by other healthcare professionals, which could enforce patients mistrust in diagnosis:

"*Well, my partner is a doctor…so I took her to the doctor's on my own but then when I got home I spoke to my partner, and he kind of said oh you know I don't really…and then a good friend of mine is a paediatrician so we kind of ran it passed her and she said I don't think it's an infection and I wouldn't bother giving them to her.*" *(Parent 2; 30-39, Certificate of higher education, 1 child).*

Questioning diagnosis and the decision to prescribe antibiotics was also observed in other parents. For example, Parent 9 explained that due to their knowledge of throat infections being usually viral in nature, they chose not to administer prescribed antibiotics for their child's infection. Like Parent 2, Parent 9 also relied on external sources (online search via Google) to confirm this belief. As no diagnostic test had been conducted prior to the GPs suggestion that the child needed antibiotics, this parent refused any antibiotic treatment. They went on to explain that they would have been more inclined to give their child the prescribed antibiotics if tests had been done to confirm that the medication was warranted, thereby justifying that they would follow medical guidance if there had been a confirmed threat to their child's health:

"*…last time when the GP said that my daughter needed antibiotics, […] he didn't even test, he looked at her throat and said oh it's a little bit red. But you know […] most of throat infections are viral they're not bacterial, all I had to do was go online and google it […] if the GP had tested, done a swab and said look there's a bacterial infection she needs antibiotics she's very small and she can get sick very quickly, I would have probably agreed to it, when there was an immediate threat to her […] I just didn't give the antibiotics...*" (Parent 9; 30-39, Master's degree, 2 children).

Almost all parents who questioned their child's diagnosis had more than 1 child, which could indicate the influence of past parental experience on how they felt about a child's infection.

A sense of mistrust was also observed among parents who recalled having negative experiences when they had been prescribed antibiotics for their child. Parent 9 explained that their reluctance, apprehension, and refusal to give their children antibiotics was due to long-lasting side-effects experienced, in the past, by one of their children. With the use of words such as "wreaked havoc", "destroyed", and "suffered", this parent's negative experience and past anguish is made evident through their compelling recollection of their child's adverse reactions to antibiotics, which influenced this parent's future behaviour in respect of administering antibiotics to their children:

> *"…my older one he was born and had to have antibiotics, and probably when he was one he had to have antibiotics for a chest infection […] since then actually, his digestion has gone completely, it has wreaked havoc on his digestion […] it basically destroyed his gut […] he suffered diarrhoea for months on end […] since then, I've done my best, and I will continue to do my best to avoid them, if possible, with my children..." (Parent 9;* 30-39, Master's degree, 2 children*).*

Stress and anxiety regarding their child's illness, diagnosis, and treatment with antibiotics also contributed to the negative experiences recalled by some parents, including Parent 5 who described feeling worried and concerned when their child had been prescribed a 6-week course of antibiotics at birth, followed by IV antibiotics 6 months later for a UTI that had not been diagnosed appropriately, even after seeking medical help on multiple occasions. This young parent recalled feeling unheard, and was not reassured by the doctor when they felt their child needed antibiotics for the UTI. She went on to explain that the delayed diagnosis had caused their ill child a lot of distress and described feeling relieved when they could voice their worries with the community nurses, who not only made the parent feel heard, but also confirmed that further medical help should be sought for the child. Despite their ordeal and feeling unheard by healthcare professionals, Parent 5 wanted to trust the doctor's advice and diagnosis:

> *"…obviously, I wasn't happy and I knew something was wrong with my child […] luckily the community nurses were still coming out so I got to express my concerns to them*

> *and then somebody actually listened to me and said yeah, I'd send her back up […] we rang the 111, and because she was screaming hysterically for an hour, they sent an ambulance […] obviously the doctor says all right no she'll be ok. You wanna take their word…you wanna take the doctor's word for it, really don't you?*" (*Parent 5; 20-29, Vocational qualification, 2 children*).

A sense of mistrust was also noted in some parents who felt that doctors overprescribed antibiotics, with one specifically mentioning that the GP would give them "*antibiotics all kinds, all the time…*" (*Parent 2; 30-39, Certificate of higher education, 1 child*), and another saying that "*some GPs are very quick to prescribe them...*" (*Parent 4; 30-39, Master's degree, 3 children*).

The belief that healthcare professionals over-prescribed antibiotics, resulted in parents questioning the need for the medication in cases where they felt it was not needed. Parents who believed that GPs overprescribed antibiotics for viral infections, and without any diagnostic tests being conducted, included including Parents 2, 4, 6 & 9. Parent 9 explained that they were often sceptical about their GPs diagnosis and decision to prescribe antibiotics, as they felt that they were too keen to prescribe the medication for viral infections. This parent expressed their intentions to insist on diagnostic tests to confirm the presence of a bacterial infection, before agreeing to an antibiotic prescription.

> "*I do feel that my GP tends to be a bit too keen on prescribing them, so I tend to be a bit sceptical […] when the first thing that the GP reaches out for is antibiotics […] from here on I would probably insist on a test to be done, so I'm sure it's a bacterial infection which requires antibiotics, rather than something viral for which our GP seems to be very excited to give antibiotics…*" (*Parent 9;* 30-39, Master's degree, 2 children).

Parent 6 claimed that they had observed an abuse in the prescription of antibiotics, and felt that doctors caused the increased usage of antibiotics, and therefore responsible for the increase in ABR. The lack of diagnostic tests was also problematic for this parent, who believed that precautionary prescribing was wrong, that antibiotics were over-prescribed in primary care, and pointed out the mixed messaging that occurred when patients are told not to overuse antibiotics, when these medications can only be obtained with a prescription from a healthcare professional.

> *"…I see an abuse again of antibiotics. Sometimes as a preventative way, just take a cycle of antibiotics in a preventative way. I think this is absolutely madness! I see antibiotics being prescribed without any tests, without any investigations […] I think is absolutely wrong […] I'm sorry but this is absolutely, 100% doctors' fault! Because we don't go to buy antibiotics at the shop [...] I remember seeing banners in the waiting room oh, don't take too many antibiotics because they won't work if you take too many… But I'm sorry, why are you telling me not to take it? Why don't you stop prescribing it* [when] *they are not needed?*" (*Parent 6; 30-39, Diploma of higher education, 1 child*).

Those parents who voiced their mistrust towards medical advice and prescriptions, were all young parents aged between 20 and 39 years, with various levels of education, and generally with more than 1 child. Mistrust was only seen in mothers and not fathers, who described trusting healthcare professionals' diagnosis and decision to prescribe antibiotics.

Mistrust in diagnosis due to the precautionary prescribing of antibiotics for themselves or their child, could stem from not being given satisfactory explanations for the prescription choice. Parents who felt unheard when it came to their child's diagnosis and their preferences for treating their child, or who had a negative experience when their child had been prescribed antibiotics in the past, seemed to have developed a sense of mistrust. This mistrust could translate into questioning their doctor's diagnosis and choice of treatment, and potential use of specific medications in the future, as seen with parent 9.

4.2.3 Experience during medical consultations

The second part of the interview involved asking the participants about their experiences during medical consultations. Parents shared their thoughts about the information given to them, whether they felt fully informed when leaving the consultation, if they their questions and queries were answered, and whether they understood their prescription advice.

4.2.3.1 'Communication challenges'

About half of the interviewees stated that they were generally happy with the information they received during medical consultations, that things were explained clearly, and that the information offered by the healthcare professional was *"enough to know how to go forward…" (P11; 30-39, Master's degree, 3 children)*. However, the conceptual theme of 'communication challenges' emerged from parents' accounts of unsatisfactory medical consultations, where they felt uniformed at the end of the consultation, felt rushed, or did not understand all the information given to them, e.g. prescription advice.

For most parents, irrespective of their demographic characteristics, time constraints were a recurrent complaint, emerging in 9 of the 12 interviews, with some parents stating that during medical consultations "*there is an element of time constraint…" (Parent 10; 40-49, Undergraduate degree, 1 child)*, and *"there's so much time pressure…" (Parent 1; 30-39, Master's degree, 2 children)*. They also mentioned that GPs were "*under time pressure…" (Parent 12; 50-59, Professional qualification, 3 children)*, and that *"their time is precious…" (Parent 10; 40-49, Undergraduate degree, 1 child)*. Most parents described feeling rushed during GP visits, with one saying that *"it feels like* [they are] *a little bit rushed sometimes…" (Parent 8; 30-39, Master's degree, 2 children)* and another stating that *"sometimes the GP will just like zip through the instructions, like for dosage really quickly…" (Parent 11; 30-39, Master's degree, 3 children)*.

When asked about whether they were given the opportunity to ask questions, many parents acknowledged that their queries were generally answered during consultations, but they did not feel as though they had an opportunity to inquire further about diagnosis and treatment:

> *"I feel the GP's rushed off their feet. They don't have time for me to ask questions…" (Parent 9;* 30-39, Master's degree, 2 children*)*,
>
> *"Not really, it's more here you go, bye…" (Parent 5; 20-29, Vocational qualification, 2 children)*.

Only a few parents claimed they were confident in their ability to obtain all the information they needed, even when it was not readily offered to them. They stated they would ask for clarifications if they were unsure about what they had been told, or would not leave a consultation until they were satisfied. Confidence in being able to get the information they needed despite various constraints, was expressed by all those who had more than one child; which could indicate that having more than one child could give some parents the confidence to seek clarifications from healthcare professionals, if needed:

> *"If they don't, I will make them…" (Parent 7;* 30-39, Master's degree, 2 children*)*,
>
> *"I would never leave if I wasn't happy with the response I got…" (Parent 8; 30-39, Master's degree, 2 children)*.

Many parents felt uninformed after their child's medical consultation, with some feeling that the information offered to them was insufficient and at times lacked clarity. These parents complained that they were not given the "full picture" *(Parent 9; 30-39, Master's degree, 2 children)*, and that diagnosis and treatment information was inadequate.

> *"It's not always the fullest information that I would like, sometimes you know it's really busy, or it feels like you're a little bit rushed […] I don't always feel the most fully informed…" (Parent 8; 30-39, Master's degree, 2 children).*

Interestingly parent 8, who felt confident in having their queries answered during consultations, also reported feeling uninformed at other times and being unsatisfied with the amount of information offered to them. Although the reason for this was not clear, it could potentially be due to the length of time available during the consultations.

However, one mother reported that they were given limited information on various occasions, asserting that this was because they were perceived by GPs as being uninterested or unable to understand this information. Although this participant mentioned that they were given minimal information as doctors think that they will not understand or are not interest in further information, factors such as time constraints and GP pressure could also contribute to insufficient information given to patients. Communication challenges could also potentially be due to healthcare professionals having preconceptions about patients' levels of understanding or interest. Parent 2, who also displayed mistrust in GPs and questioned their treatment choices, reported relying on family and friends to obtain further information after medical consultations. They also stated that they would be inclined to stop their child's antibiotic treatment due to difficulties administering the medications. These behaviours could stem from feelings of being unheard or not being given enough information during consultations:

> *"They think that I probably won't understand what they're talking about so they just tell me the bare minimum […] I've definitely had experiences of doctors who I think just presume that I wouldn't understand or that I'm not interested…" (Parent 2; 30-39, Certificate of higher education, 1 child).*

The belief that patients are not given enough information, due to GPs' perceptions about their patients, was reiterated by another participant, a social worker who works with disabled people and often accompanied them to GP consultations. This parent suggested that GPs may not fully inform these patients as they were seen as challenging, or that there were preconceptions that these patients would not be able to understand what they were told.

> *"I understand when it comes to service users, they have got lots going on, sometimes they can be challenging […] but I believe that when it comes to medication, there is no […] shortcut." (Parent 6; 30-39, Diploma of higher education, 1 child).*

It is noteworthy that some parents perceived doctors to be selective in their interactions with patients, and felt that some patients were offered more information than others, based on characteristics such as education levels. This perception could influence parents' reported mistrust of GPs. Incidentally, both of these parents had self-reported practices that did not comply with health guidance on using antibiotics, and believed that GPs overprescribed antibiotics, indicating their mistrust of GPs on a number of levels.

Parent 6, who displayed strong feelings of mistrust towards GPs also pointed out that patients were not offered enough information anymore. This could suggest that as a social worker accompanying other people to GP appointments and as a patient themself, Parent 6 may have experienced a decrease in the amount of information offered during consultations with healthcare professionals, over time. This participant implied having a lack of trust in GPs' ability to treat patients, stating that doctors were more focused on short term solutions (treating symptoms) rather than long-term ones (finding the root cause of the problem).

> *"Well, I don't think they are giving much information nowadays. It seems to me that the purpose of a doctor is just to treat the symptoms, you know to make the symptoms*

disappear. There is not much investigating, what could be the cause, or what's going on…" (Parent 6; 30-39, Diploma of higher education, 1 child).

As a result of communication challenges experienced during medical consultations, some parents mentioned having to adapt to these situations by seeking further clarification regarding diagnosis and/or prescriptions. For example, Parent 3 recalled asking probing questions about the potential side effects to look out for when they or their children start a course of antibiotics, and the outcome of the illness if the antibiotics were not taken. This parent wanted to feel more informed about their child's illness and empowered to make the right decision regarding the treatment offered to their child:

"…each time when the children have been offered them and when I have been offered them, I asked what would happen if you, if you don't take them, or if you do take them, and if they've been prescribed […] I feel like I have to get enough information to make the decision…" (Parent 3; 40-49, Undergraduate degree, 2 children).

Communication challenges were only reported by mothers, whereas for fathers they only commented on the time pressure they sometimes experienced during these consultations. The mothers who complained about a lack of clarity in the information provided to them were all aged between 30-39 years with the exception of Parent 3, and had various levels of education. Communication challenges, such as feeling unheard or uninformed, could reinforce or cause mistrust regarding diagnosis and treatments offered to themselves or their child.

External sources of information were relied upon by some parents, with one mother stating that they would often get advice from other people, while others reported using Google to find out more. This particularly applied to parents aged 30 – 39, with various levels of education, and fewer than 3 children. For example, Parent 2 recalled often seeking medical advice from other people before consulting with their GP, and therefore attended consultations with a preconceived opinion of what the diagnosis should be, which could explain why this parent often questioned GP diagnosis and treatment choice. As shown in section 4.2.2.2, this parent valued other (partner and friend) opinions more than their GP's, which influenced how they treated their child's illness. The availability of contradictory information from various sources, could lead to patient confusion, and also potentially to mistrust in the GP; i.e. believing the diagnosis and choice of treatment was wrong because other more trustworthy sources (such as a partner or a friend) provided an alternative diagnosis and treatment:

> *"I will often have already sought medical advice before I've even gone in, so I've often gone in with a preconceived notion of I think this is what it is because X person told me that's what it is. So, then I either come out thinking no I think you're wrong, or I come out thinking now I'm confused…" (Parent 2; 30-39, Certificate of higher education, 1 child).*

Using Google to search for additional information on diagnoses and treatments was mentioned by some parents. There were two reasons for searching google: to feel more informed when parents were not given sufficient information from their GP, and when parents were just interested in finding out more about their child's diagnosis or treatment:

> *"I might google what it is that they've prescribed or whatever just to kind of give myself a little bit more knowledge and information…" (Parent 8; 30-39, Master's degree, 2 children).*

> "*Unless I dig really deep and ask for all the alternatives and what are the side-effects, I still don't feel that it is enough. I go home and google, and I know that you're not supposed to, but I tend to find information online much more reliable…." (Parent 9;* 30-39, Master's degree, 2 children*).*

The need for more information about side-effects and alternatives to antibiotics was previously reported with Parent 3, and reiterated in Parent 9's justification of why they used Google to obtain more reliable information. From these recollections it can be inferred that patients do not feel properly informed about the antibiotics prescribed to their child or for themselves; a complaint echoed by many of the parents who left GP consultations feeling uninformed. Parent 9, who described refusing antibiotics on various occasions, due to their child experiencing long-lasting side effects from the medications, exhibited a lack of trust in the information offered to them by healthcare professionals, saying that information available online was much more reliable. Although both Parents 8 and 9 used online sources of information to gain more knowledge and information after medical consultations, Parent 9 mentioned being aware that using Google to obtain further evidence on medical diagnoses and treatment may be frowned upon by healthcare professionals. However, this participant trusted online sources to help them feel more informed, particularly when probing for further information from the GP was not a possibility.

There was consensus among parents that there was a lack of adequate information on ABR, and the potential consequences of inappropriately using antibiotics during consultations. They felt that GPs were more focused on diagnosis and treatment, rather than providing a more detailed explanation of why antibiotics were not needed in certain cases, and why the full course of antibiotics should be taken as advised by the GP and/or pharmacist.

> *"I don't feel that medical practitioners really emphasise the problem of antibiotic resistance. It's more…kind of more solution-based, you know. Ok you've got this diagnosis, here is the solution come back if it doesn't work, do you have any questions. Rather than I guess the context […] no-one's ever said well we're not giving you antibiotics because we're trying to reduce reliance on them or something like that…" (Parent 1; 30-39, Master's degree, 2 children).*

Like other parents who have never been given information on ABR during consultations with healthcare professionals, Parent 2 also describes never hearing about ABR in a clinical context, including when they were in hospital, being treated for sepsis:

> *"I've never heard that in a clinic, like discussed. Even when I was in hospital and I had sepsis […] nobody said anything, and obviously they sent me home with an absolute world of antibiotics after that…" (Parent 2; 30-39, Certificate of higher education, 1 child).*

Both mothers and fathers complained about a lack of information on ABR, when antibiotics had been prescribed, and there was consensus that more information on the potential side-effects of antibiotics, as well as a better explanation on why antibiotics were or were not prescribed in the context of ABR was needed.

4.2.4 Knowledge, understanding, attitudes, and concerns about ABR

The third part of the interview involved asking the participants about their knowledge and awareness of ABR. Parents were asked to explain what they understood by the term ‘antibiotic resistance’, and how much they knew about it. Parents also shared their thoughts and concerns about ABR and the potential impact it could have on themselves and their child.

4.2.4.1 ‘Knowledge about ABR’

‘Knowledge about ABR’ emerged from parents’ explanations of what they knew and understood about ABR, as well as their awareness on the issue. Overall, almost all parents showed good knowledge and understanding about ABR. Some parents stated that they did not “*really understand the intricacies of why it becomes resistant if it’s not administered properly or taken properly*” (*Parent 2; 30-39, Certificate of higher education, 1 child*) and a few struggled to clearly explain what ABR meant, despite being aware of the issue:

> “*That it’s, without knowing the ins and outs of the science, that they’re prevalence makes overall resistance lesser. The more you use them, the more resistance…yeah…less is more basically, I’m trying to explain that less is more…*” (*Parent 3; 40-49, Undergraduate degree, 2 children*).

Many parents were able to clearly articulate what they understood by the term ‘antibiotic resistance’, with some being aware about the reliance on antimicrobials, particularly antibiotics, in healthcare. Some parents had better knowledge and awareness than others, i.e. understanding the drivers accelerating the spread of ABR today (over-use of antibiotics in factory farming), and consequences of ABR during surgical interventions, such as caesareans:

> “*…so I understand antibiotic resistance happens over time anyway, but my understanding is because we’re using them so much in factory farming and we’re using them so much in healthcare […] we’re accelerating the way that the resistance comes about and creating superbugs that we aren’t able to treat anymore […] I guess that the consequences are things like normal medical interventions that are normally not much fun but we assume we will survive like hip replacements or caesareans, become a lot more risky if we can’t rely on antibiotics…*” (*Parent 1; 30-39, Master’s degree, 2 children*).

However, some participants held misunderstandings and misconceptions, e.g. parents 4 and 6 believed that ABR occurred when the body became resistant to antibiotics, when people consumed these drugs unnecessarily or too often. Parent 4 described how antibodies developed in the body, as a result of over-using antibiotics, which inhibits this medication from working effectively. This participant also believed that this process only happened with specific antibiotics:

> "*You can become resistant to an antibiotic depending on how long you take them for, if you use them regularly and your body develops an antibody to that, so it potentially doesn't work effectively as it does the first time […] It means that antibiotics don't work with you, but I think it's specific types of antibiotics not all the same ones, it depends…*" (*Parent 4; 30-39, Master's degree, 3 children*).

> "*Well, what I've heard is the body builds a resistance towards antibiotics, because if they are taken when they are not needed, they end up not working anymore when they are finally needed.*" (*Parent 6; 30-39, Diploma of higher education, 1 child*).

The misconception that the body develops a resistance to antibiotics is a common misunderstanding present among the general public, which has been reported in other studies, and will be discussed further in the discussion section (Chapter 5).

All parents were aware that ABR is a public health problem. Many, particularly those who also displayed good knowledge about what ABR was, also knew and understood the potential consequences of increasing ABR, i.e. antibiotic resistant infections and the consequences of not being able to treat these infections. Antibiotic resistant TB was an example given by some parents when discussing ABR. Parent 11 mentioned antibiotic resistant TB being a concern for many people, and a disease which is often discussed by experts in the media:

> "*I know that it exists, and it's a problem that experts are concerned about, like specifically TB is one I know, because it's such a long like programme to get through, or regimen, and antibiotic resistant TB is a thing that people are quite concerned about. Like that's one of the sort of headline diseases that is talked about.*" (*Parent 11; 30-39, Master's degree, 3 children*).

Parent 1 was pessimistic about reliance on antibiotics, particularly due to the lack of new antibiotics being developed. They were aware that antibiotic development was not a priority for the pharmaceutical industry, stating that the focus was only on the development of profitable drugs such as oncological ones.

> "*…the way things are going it's not particularly positive […] there is no investment there in the pharmaceutical sector, it's more about the oncology drugs and things like that* […] *it's not really financially attractive to find new antibiotics…*" (*Parent 1; 30-39, Master's degree, 2 children*).

Many interviewees recalled having discussions with friends, family, colleagues, and other parents about ABR. Although these people may not always fully understand the details of ABR, particularly from a microbiological point of view, people were aware that ABR was a public health issue:

> "*…it's certainly something that parents and other friends of mine, parents of young children…it's an issue which is discussed, yeah. You might not know the ins and outs of the science, but people certainly know that there is a discussion around it…"* (*Parent 3; 40-49, Undergraduate degree, 2 children*).

Regarding the language used when information on ABR was offered to them, most parents (all educated to postgraduate level) stated that it was usually clear and easy to understand. Participants described ABR information/campaigns, such as leaflets and news articles, that included advice on avoiding the unnecessary use of antibiotics, completing the full course of the medication, and taking antibiotics as advised by prescribers:

> "*I've definitely seen leaflets [...] that are clear and easy to understand saying things like don't use them if you don't need them or make sure you use the full packet and things like that. I've seen quite clear and straightforward information in the doctors [..] the basic things saying always use the packet, follow the instructions, or don't overuse them, they're quite clear I think.*" (*Parent 8; 30-39, Master's degree, 2 children*).

However, while some participants recalled seeing information on the responsible use of antibiotics at GP surgeries, most could not remember being offered ABR information in a primary care setting. For example, Parent 11 stated that their knowledge and understanding came from news articles, and questioned whether they had ever received information on ABR from a healthcare professional. This mother described the information they had seen as being understandable for a lay person, having some knowledge of biology.

> "*…I think most of my sources, like understanding of it, is* [from] *news headlines, like articles I've read […] I don't know how much of* [it] *is actually from just talking with doctors. So, I don't know…As a lay person I feel like I understand it […] well enough, remembering my high school biology classes.*" (*Parent 11; 30-39, Master's degree, 3 children*).

For those who found information on ABR difficult to understand, there was consensus that the language used was too complex, lacked clarity, and was too science-driven. For example, parent 3, a mother with an undergraduate degree, complained that the language and terminology used were not accessible to everyone, including themselves, and questioned whether their lack of comprehension of the complex language, led to their lack of ABR understanding. Indicating that this participant may believe that they may not be educated enough to understand ABR information:

> "*I don't know whether it's me and my […] perceptions, but I find it's difficult to understand and I ask again and again…*" (*Parent 3; 40-49, Undergraduate degree, 2 children*).

Often, the unclear and complex ABR information was associated with reports of a lack of understanding among participants' acquaintances:

> "*I don't think it's clear, if I talk about it to other parents, you know when I pick up the kids, generally there is a lack of understanding.*" (*Parent 12; 50-59, Professional qualification, 3 children*).

Parents who understood information on ABR found it to be "*quite compelling*" (*Parent 1; 30-39, Master's degree, 2 children*). However, although there was consensus among these participants that the language used in ABR campaigns were effective, powerful, and clear, some believed that education level was associated with better ABR understanding. These participants (for example parent 7) described themselves as having the required levels of intelligence and education to understand ABR, but felt that less educated or intelligent may display lesser understanding, and potentially be reluctant to admit, or feel judged for their lack of understanding:

> "*This is going to sound potentially big headed, but I understand it but I'm an intelligent educated woman, and I worry that perhaps some people who aren't as highly educated as I am, cause I'm educated to a postgraduate level, I worry that some people who aren't as highly educated aren't necessarily going to understand it and aren't necessarily going to say that they don't understand…*" (*Parent 7;* 30-39, Master's degree, 2 children).

> "*…it's fine for me, maybe because I am educated about it. So, I can understand what they are saying, what's the meaning of these messages. But I wonder how many friends, people around me, would understand?*" (*Parent 6; 30-39, Diploma of higher education, 1 child*).

Parent 6 also believed that being sufficiently educated was a determining factor in understanding ABR information, and questioned whether their friends and acquaintances would have their level of understanding. There was a sense of judgement among parents who believed that not being sufficiently educated resulted in a lack of understanding among others. Unlike parent 7, who was educated at a postgraduate level and believed that being highly educated improved ABR understanding, parent 6 had a lower qualification and also displayed confidence in their ability to understand ABR information, while questioning other parents' understanding.

Parent 4, a medical professional, also agreed that education level played an important role in understanding ABR, asserting that doctors would explain things in a clearer way to them, and that they would ask questions if they did not understand the information offered to them. This could indicate that education level could allow some people to be confident enough to ask for further information and clarifications when they lacked understanding, without feeling judged:

> "*I'm a medical professional so when… I think when the doctors are talking to me, they put it on my wavelength so I understand what they're talking about and if I don't, I ask questions.*" (*Parent 4; 30-39, White, Master's degree, 3 children*).

While Parents 4 (paediatric physiotherapist) and 6 (social worker) felt they had a clear understanding of ABR and the language used around it, conversely, they were also the only parents who misunderstood ABR, indicating that their confidence in their knowledge and understanding is misplaced (see section 4.2.4.1). It is also noteworthy that both parents who have mentioned being in close contact with patients due to their jobs, with one parent (Parent 6) accompanying disabled people to medical appointments, could wrongly inform patients about ABR, thereby passing on misinformation or misconceptions on ABR.

Most of the interviewees who reported finding ABR understandable were educated to a postgraduate level. Some of those participants felt that information on ABR was not accessible to everyone, particularly people who were not considered as highly educated (i.e., educated to a postgraduate level). It is interesting to note that some participants' confidence in their understanding of ABR, was misplaced as they displayed misunderstandings on ABR. These parents were confident that their level of education allowed them to have a better understanding of ABR. Those with lower educational levels were less sure of themselves, and recognised their lack of knowledge and understanding regarding ABR.

4.2.4.2 'Emotional engagement with the issue':

'Emotional engagement' was the second conceptual theme that emerged from this section. Parents were asked about their concerns regarding ABR and shared their thoughts on how it could affect themselves or their child in the future.

The gravity of the current ABR issue, was understood by most interviewees, who showed concern that it could affect themselves or their children, by no longer working in the future, resulting in the potential for life-threatening infections. For example, Parent 1 used the analogy of a child getting a cut from a rusty nail and not being able to treat the wound; implying that something as small as cut that could easily be treated today, could potentially be life-threatening in a future without effective antibiotic treatment:

"*You know your kid could fall over in the playground and cut themselves on […] a rusty nail or something and if we can't rely on antibiotics, we're kind of back to 1920s where […] you could just die from it.*" (*Parent 1; 30-39, Master's degree, 2 children*).

Concerns about the limited antibiotics available today becoming even less effective in the future, were prominent among many participants. Parents were also apprehensive about the heavy reliance on antibiotics to treat many infections, and worried about certain infections becoming even more difficult to treat and cure in the future, particularly for their children:

"…*It's certainly concerning that when we rely on them so much, if we don't have effective treatments […] it puts us at risk […] if there is a population proving that antibiotics are less effective, that then means that they could be vulnerable to infection in the future*." (*Parent 10; 40-49, Undergraduate degree, 1 child*).

Some participants were aware that ABR "*could affect anybody*" (*Parent 7;* 30-39, Master's degree, 2 children) in an indiscriminate way, and that ABR should be a concern for everyone as it could affect anyone in the world:

"*Absolutely, as it would the world yeah…and anybody in it!*" (*Parent 3; 40-49, Undergraduate degree, 2 children*).

Although most agreed that ABR was a concern, only one parent mentioned being worried about their contribution to ABR. This mother, whose child struggled with side-effects of using antibiotics in the past, was not concerned about antibiotics becoming less effective in the future, but was rather worried that giving their children antibiotics would contribute to the bacteria becoming resistant to the medication:

"*Yeah, I'm not concerned that the antibiotics they would be given would not work on them, I'm more concerned that I'm contributing longer term to bacteria becoming resistant* [to] *drugs by giving my children antibiotics…*" (*Parent 9;* 30-39, Master's degree, 2 children).

ABR was not a concern for a few participants, who considered themselves as being low-antibiotic users or claimed to never using antibiotics; therefore, they believed that ABR could not affect them or their children in the future:

> "*Personally, no. Because as I said it is something we don't take, we don't have the need. So far, so good I would say...*" (*Parent 6; 30-39, Diploma of higher education, 1 child*).

Those who were unsure about ABR being a pressing concern for their family, felt that there was the potential for it to become a future concern, particularly if antibiotics kept being overused and misused. As seen previously with parents who considered themselves to be low-antibiotic users and therefore were not concerned about antibiotic resistant infections, those who believed they were responsible antibiotic users (i.e., those who claimed to finish the full course of antibiotics and not seek/overuse antibiotics), also believed that ABR was not a pressing concern for them at the moment. However, these participants agreed that if antibiotics continued to be misused and became less effective in the treatment of certain infections, this could potentially be concerning for them:

> "*A little bit but not overly, because I know we finish the course of them […] If people keep misusing them then eventually yes…*" (*Parent 5; 20-29, Vocational qualification, 2 children*).

> "*Not really cause as I say we wouldn't be going seeking antibiotics a massive amount, […] I don't think we overuse antibiotics as a family […] If people continue to abuse them and it became a wider issue then potentially yes, but as a pressing concern now, no…*" (*Parent 8; 30-39, Master's degree, 2 children*).

Dissociation and disengagement were noted among participants who perceived themselves and their family as not being part of the ABR issue. These parents felt that ABR would only be an issue for them if *other people* misused antibiotics; implying that the responsibility for ABR lay outside of themselves and that others are responsible for ABR and the worsening of the ABR situation. Misinformation on ABR, particularly regarding the consequences of ABR for the individual and the community, could be a reason why some parents felt that ABR was other people's responsibility and why they felt detached from the issue. Similar findings were reported in other studies, where people reported not being concerned about ABR because they felt that they were responsible antibiotic users or because they considered themselves as being low users of the drug (discussed further in Chapter 5).

Parents 2, 5, and 8 believed that ABR was currently not an immediate concern for them as it had not yet become a wider public health issue, indicating that some parents may not fully understand the current scale or implications of this global public health issue. Although parent 2 mentioned being aware that ABR was a problem, it seems that because they did not know about the gravity of the situation, they did not emotionally engage with it, describing themselves as being and 'blissfully unaware' and 'ignorant' about it:

> "*I feel like it's one of those things I don't know enough about it. […] I'm aware that it's an issue but it's one of those things that […] I'm kind of blissfully unaware, ignorant to it. […] it doesn't create any kind of emotional reaction of like oh I'm a bit worried, because I just don't know anything about it […] when I think about it rationally […] I think it's probably gonna affect everybody at some point. But I just don't have any gage of how bad or how soon or […] what the implications of that would be…*" (*Parent 2; 30-39, Certificate of higher education, 1 child*).

Being uninformed about ABR enabled Parent 2 to emotionally disengage from the issue. Incidentally, this parent also displayed self-reported practices that did not comply with medical advice when it came to antibiotic use (see section 4.2.2.1), indicating that this emotional detachment potentially fostered poor antibiotic practice. This parent also mentioned questioning medical advice during GP consultations, and seeking medical advice from friends and relatives instead. This non-compliance with treatment regimen and mistrust in medical advice, could potentially be explained by this parent's lack of engagement with the issue of ABR, as opposed to other parents who have shown concern about the issue, which could possibly influence their behaviour and practices, with respect to antibiotics.

4.2.5 Awareness on ABR and antibiotic use

In the fourth part of the interview, parents were asked whether they felt there was a need for more awareness on ABR and antibiotic use. Parents also shared their experiences about misconceptions on ABR and the misuse of antibiotics.

4.2.5.1 'Lack of social responsibility'

Most parents believed that there was a definite need for more ABR awareness, believing that increased awareness on the issue was important, as it was becoming a more serious issue now, particularly in the light of the COVID-19 pandemic. For example, Parent 1 described how the scale of ABR was more understandable and relatable due to the pandemic, although it's significance, as a public health issue, was not being discussed enough:

> "*Yeah, definitely. I was reading an article about COVID deaths recently, and global COVID deaths have only just overtaken global antibiotic resistance deaths, and we're just not talking about it I don't think…*" (*Parent 1; 30-39, Master's degree, 2 children*).

Participants wanted to see better information to raise awareness on ABR, with people being given a simple and clear explanation for why certain health guidelines were in place encouraging the responsible use of antibiotics; for example, clarifications were needed about why healthcare professionals insist that the full course of antibiotics is completed. Clearer information was also needed regarding the ABR terminology, how it occurred, and how it could affect the individual, their family, and the community:

> "*…Definitely! I think especially even just on a very […] basic level of explaining to people why it's important, for example* [to] *take the full dose […] I've heard about antibiotic resistance but it's just kind of like a buzz word […] I don't know what it means in terms of for the community, for me, for my family, for the people around me…I don't know […] how that would manifest or…I don't really know what it means*" (*Parent 2; 30-39, Certificate of higher education, 1 child*).

Accessible ABR campaigns, widely distributed, were mentioned by several parents who wanted to see bolder and more sustained ABR campaigns that were "*in your face*" (*Parent 12; 50-59, Professional qualification, 3 children*). Parent 12 mentioned only occasionally seeing posters or leaflets at the pharmacist advising people that antibiotics were ineffective against viral infections, but could not recall any past campaigns on ABR:

> "*…oh absolutely! Absolutely. I mean if you said to me can you remember any campaigns… I've seen a couple of posters, a couple of leaflets from the pharmacy, there was something to do with you know…antibiotics don't cure the cold or something like that, I mean that sort of thing, but it's nothing in your face…*" (*Parent 12; 50-59, Professional qualification, 3 children*).

Parent 5, on the other hand, could recall past ABR campaigns, but mentioned that current campaigns were being overshadowed by public health information and health promotion messages, relating exclusively to COVID-19. Due to COVID-19 being the focus of health guidance issued by the government at the time of the interview, Parent 5 could not recall any recent ABR campaigns:

> "*Yeah, I think so, but I do remember there have been a few big campaigns, but I don't know if there are any recent ones, or if it's all about COVID at the minute*…" (*Parent 5; 20-29, Vocational qualification, 2 children*).

Other participants also acknowledged having seen previous campaigns regarding ABR, with one parent sharing their thoughts on how antibiotic use had changed since they were a child. This father described antibiotics as a panacea, used for any ailments, during their childhood. They acknowledged an increase in awareness over the years, stating that people have become more informed about antibiotics being only effective against bacteria. Parent 10 also specified that although there has been and still is an abuse of this medication, people are more aware and conscious of ABR now, thus showing the importance of ABR awareness:

> "*…when I think about my childhood or earlier that it seemed to be kind of a magic way just take some antibiotics for anything…and that now seems to be […] perhaps more in the public conscious or certainly in some people's conscious, that that's not necessarily a good thing, and that it has been used and is being used when not necessary…*" (*Parent 10; 40-49, Undergraduate degree, 1 child*).

There was consensus among most of the participants that there was an imperative for more awareness on responsible antibiotic use, particularly for patients who expect and request antibiotics, even for non-bacterial infections. Parent 11 compared antibiotics to candy, implying that people over-used them, and recalled acquaintances who expected antibiotics for viral infections.

> "*Probably yes! Because I think people just eat them like candy whenever they feel a bit off, and I know people who want to be prescribed antibiotics when they clearly have a virus. And that's obviously counterproductive. So yeah, I think it could do with a lot more education.*" (*Parent 11; 30-39, White, Master's degree, 3 children*).

However, Parent 4, whilst acknowledging that people consulted healthcare professionals with the hopes of obtaining antibiotics, pointed out that it was GPs overprescribed the medication, and therefore awareness on better antibiotic use include healthcare professionals as well as members of the public:

> "*Yes, I do. I think people are very quick to go to the GP to get antibiotics and some, which mine aren't, but some GPs are very quick to prescribe them*." (*Parent 4; 30-39, Master's degree, 3 children*).

The conceptual theme of 'lack of social responsibility' emerged from discussions with parents about people's attitudes towards ABR and their expectations of antibiotics. Many participants believed that people lacked social responsibility when it came to ABR, and that these people expected antibiotics too much. For example, both parents 1 and 12 believed that if people do not receive an antibiotic prescription from a consultation, they are unsatisfied with the; implying a sense of entitlement to obtain antibiotics from healthcare professionals. This expectation, or sense of entitlement may lead to GPs and nurses being pressured to prescribe antibiotics. This participant also felt that because these patients were contributing to/paying for the service (NHS), this could enhance their sense of entitlement, viewing an antibiotic prescription as value for money:

> "*I know parents who will not go away unless they get a prescription because they see that they've got to get value. There's an expectation that you come away from a doctor with a prescription, if you haven't got that…I'm paying for that service, I'm not getting any money for it […] I think there is a great deal of misunderstanding […] parents have got the assumption that they're only getting value from the NHS if they're getting a prescription…*" (*Parent 12; 50-59, Professional qualification, 3 children*).

> "*…you might feel that you are being fobbed off if you don't get antibiotics if you don't know why it's not appropriate. So […] maybe doctors and nurses get put under pressure to prescribe antibiotics…*" (Parent 1; *30-39, Master's degree, 2 children*).

People wanting a quick fix for their ailment, irrespective of whether antibiotics were actually warranted was also discussed by Parent 2, who believed that people did not consider the risks to the wider community when expecting antibiotics. Although previously mentioning being unable to understand the scale of ABR and its consequences, and feeling emotionally disengaged to the issue, this mother strongly believed that people lacked social responsibility when it came to antibiotic use and ABR. GPs being pressured to provide a quick fix with antibiotics was also mentioned by this mother, who described people as being inherently selfish. This parent believed that people were too individualistic, wanting GPs to prescribe antibiotics for any infections, including viral ones. Despite previously describing their disengagement with the issue, this parent was quite emotionally engaged with the problem of people expecting antibiotics and being oblivious to the wider consequences that overusing and misusing antibiotics could have. This could indicate again the detachment involved in believing that ABR is a problem and responsibility for others:

> "*I think part of the problem is people just think, what do you mean? Just fix it! […] People want to know what it means for them, people are selfish, me included […] people will be kind of saying well I don't care about the potential risks for the wider community, if I'm having an infection, I want some antibiotics. And I think there's a lot of pressure on GPs just to fix things? […] People don't understand, when they get told they have an infection they expect to have something to fix that, even when they are told it's a viral infection…*" (*Parent 2; 30-39, Certificate of higher education, 1 child*).

Almost half of the parents interviewed justified the need for more awareness on ABR and responsible antibiotic usage, by describing instances where they heard people, in their surroundings, misusing antibiotics or expecting an antibiotic prescription during medical consultations. Parents were quick to mention a lack of social responsibility in others, and a sense of judgement from these parents was perceived in their recollections of colleagues, parents, friends, and acquaintances expecting antibiotics for viral infections or stopping the course of antibiotics after only a couple of days.

> *"…I've heard people not taking antibiotics correctly, oh well George is taking the tablets and he got better after 2 days so* [he] *stopped taking the tablets […] I've heard quite a few parents say that as well […] and there doesn't seem to be much understanding…" (Parent 12; 50-59, Professional qualification, 3 children).*

It is quite alarming that many participants recalled knowing other parents who expected or requested antibiotics during medical consultations. However, it is also interesting to note that there was a sense of disingenuousness among many parents who described seeing a lack of social responsibility among people around them, but did not reflect on their own social responsibility when it came to antibiotic use and ABR. This was particularly observed among parents who displayed disengagement towards ABR and did not believe that the issue was a concern for them. For example, Parent 2 reiterated their belief that parents lacked social responsibility by insisting on receiving antibiotics for viral infections and even pressuring GPs to prescribe them, eventually wearing down the GP. However, this parent had previously discussed their own non-compliance with antibiotic guidance, but appeared unable to reflect on this, or their social responsibility, once again indicating that parents may see ABR as being a problem for others rather than for not themselves.

> *"…you'd be amazed at how many people I've spoken to, who have children, who have persisted going to the GP despite being told it's a viral infection and have eventually been prescribed antibiotics. That is a perfect example of a GP getting worn down despite telling them repeatedly it's not going to make a difference if you take antibiotics, it's viral, it's viral...oh just have the antibiotics, just leave me alone!" (Parent 2; 30-39, Certificate of higher education, 1 child).*

A few participants mentioned attempting to correct misconceptions and misinformation that people in their surroundings may have, with regards to antibiotic use and ABR. For example, Parent 6 recalled her experience with other parents expecting antibiotics from consultations, and always trying to explain why misusing antibiotics was dangerous. This parent was quick to judge other parents who expected antibiotics and believed it was her duty to educate the misinformed on why antibiotics were not a miracle cure for all ailments. However, this mother also had practices that did not comply with medical guidance (i.e. stopping a course of antibiotics after 2 days – see section 4.2.2.1), but see seemed unable to recognise their behaviour as irresponsible, although comfortable judging others, including GPs.

> *"I have a friend, she's always complaining because the doctor should have given her antibiotics for her son, when there is absolutely nothing wrong with her son […] People think the only way is antibiotics! […] They might be sick of listening to me! But I'm trying, every time I have a chance to do it […] I'm trying to make people aware of what antibiotics are…" (Parent 6; 30-39, Diploma of higher education, 1 child).*

This indicates behavioural inconsistencies between what Parent 6 believes and how they behave, which can also be seen in other parents. Interestingly, this parent, who claims to always seize the opportunity to raise awareness on antibiotics, displayed strong feels of mistrust towards doctors, and had certain misconceptions regarding ABR (see section 4.2.4.1). Attempting to raise awareness among those that Parent 6 considers to be unaware or uneducated, may lead to these people developing misconceptions on ABR and mistrust in GPs as well.

The conceptual theme of 'lack of social responsibility', emerged from these parents' recollections of hearing friends, colleagues, and acquaintances talk about inadequate behaviours when it came to antibiotic usage and antibiotic expectations. These parents were very vocal about the lack of social responsibility in others, and very critical of other people's antibiotic practices or behaviours. It's interesting to note that although some parents were critical of people they perceived as being irresponsible antibiotic users or lacking social responsibility, these parents have themselves displayed inadequate practices and perceptions when it came to antibiotic use (parents 2 & 6). There was also a sense of denial, and disingenuousness regarding ABR being a problem for others and not themselves, which could be why certain behavioural inconsistencies were observed among some parents.

4.2.6 Resources on ABR that parents would benefit from

Parents were asked about the specific topics they would be interested in hearing more about, and that would be useful to other parents, when it came to antibiotic use and ABR. Parents shared their thoughts on the type of media they would prefer to get information from, and spoke about sources of information that they considered trustworthy.

4.2.6.1 'Resources that could make an impact on antibiotic awareness'

In this section, the conceptual theme 'resources that could make an impact on antibiotic awareness' emerged from discussions with parents about ABR resources they would be interested in seeing. Participants believed that parents would benefit from resources that would be influential and powerful, and described campaigns that would catch their attention and highlight the importance of stopping the spread of ABR. With the use of the term "hammers home", Parent 1 implied that campaigns need to be more persistent in emphasising to parents the severity of ABR and the dire consequences, for their children, if antibiotics were no longer effective. This mother also believed people were too complacent about ABR and did not realise the consequences of not being able to rely on antibiotics. According to this participant, people needed to be educated on using antibiotics with more care:

> "*Something that really hammers home the impact that would happen to the children if we can't rely on antibiotics […] So I think something that really hammers home to parents the pretty dire consequences of what could happen to their children if we don't treat antibiotics with a bit more respect […] I don't think people realise quite how bad things could be, we're just really complacent…*" (*Parent 1; 30-39, Master's degree, 2 children*).

Complacency when it came to ABR awareness was also mentioned by other participants, who believed that there were not enough ABR campaigns. However, unlike Parent 1 who believed that there was a pressing need for stronger messaging to potentially shock complacent people on the gravity of the situation and the "dire consequences" ABR, other parents wanted more positive messaging that would encourage better usage of antibiotics. These parents also wanted to see more campaigns that would also interest their child so that the awareness, on ABR and responsible antibiotics usage, could start at a young age. Slogans using bright and cheerful messaging, that was easy to remember was suggested by Parent 12, who believed that children should also be educated on ABR:

> "*For me, a slogan campaign, something which is easy to remember […] something bright and cheerful, something which my child would pick up on to be honest […] It should be in their head, so the child is aware that they should take it as well to the end…*" (*Parent 12; 50-59, Professional qualification, 3 children*).

Convenience was an important point raised by some parents, who wanted to see short resources that would not take too much time to read. Parent 5, a busy mother, described not having enough time to read lengthy material on ABR, as being a parent was so demanding on their time; this was also noted among other parents who preferred resources that were quick to the point and convenient:

> "*…something that's quick to the point, not those with all those reading on it because it is difficult to actually sit and read anything lengthy. Especially when you've got to*

> *focus on it and the kids are fighting…*" (*Parent 5; 20-29, Vocational qualification, 2 children*).

Resources that helped parents identify when an infection warranted antibiotic treatment were identified by some parents. For example, Parent 12, a father of 3 including a disabled child needing constant care, wanted a resource that would provide guidance to parents regarding when to seek medical advice for their sick child to allow parents to identify and differentiate between symptoms caused by a viral infection that could be treated at home, and those caused by a bacterial infection, which would need medical attention. This father shared their own experience of having to take their disabled child along to every medical appointment, and therefore would prefer a resource that would help parents avoid unnecessary trips to the GP. This shows that although some parents may not want to go to the GP needlessly, they felt that a lack of adequate, informative, and accessible guidance on childhood infections, prevented parents from avoiding unnecessary visits to the GP:

> "*…it's a pain taking a child to the doctors to be honest, especially with me because I have to take my 14-year-old daughter with me every time [..] So, for me it's how to help me diagnose […] the difference between a viral infection and something which does require antibiotics so […] better guidance […]to help avoid me having to take unnecessary trips…*" (*Parent 12; 50-59, Professional qualification, 3 children*).

Resources on ABR that related to children, parenting, or that included pictures of children interested several mothers, who stated that these components in campaigns would grab their attention; particularly if these resources were on social media, such as Facebook, which was considered to be a convenient source of information for many parents.

> "*I think the things that grab my attention the most, are things that relate to children or parenting […] with pictures of children on and things like that […] something that I could see while I was scrolling on maybe Facebook or Instagram…*" (*Parent 8; 30-39, Master's degree, 2 children*).

Many parents considered social media platforms to be a good method of raising ABR awareness among parents. For example, Parent 7 explained that mothers scrolling through social media while nursing, would be see information or adverts on ABR that appeared on

Facebook or Instagram, and this would be a good way of raising awareness among new parents at the early stages of parenthood:

> "*Stuff on Facebook, especially again mums of young babies who are doing night feeds who are scrolling through Facebook, who are scrolling to try and keep awake. You're gonna see those adverts and it will get into your head at that kind of early stage…*" *(Parent 7; 30-39, Master's degree, 2 children)*.

It is interesting to note that many participants, especially mothers, mentioned being interested in seeing more ABR information and adverts on social media. These parents considered social media platforms, such as Facebook and Instagram, to be trustworthy sources of information and indicated an interest for information pertaining to children on this type of media. Only one parent mentioned social media being a source of misinformation and having "*quite a big part to play in fake news*" (*Parent 4; 30-39, Master's degree, 3 children*). As the only healthcare professional of the sample, this mother may be more aware than other participants of the prevalence and propagation of misinformation relating to public health, on social media. There are multiple studies that have found misinformation on important public health issues, such as vaccines, medication, and diseases, to be prevalent on social media; which has been recently highlighted by the COVID-19 pandemic.

There was consensus among the participants that targeting young and/or new parents would be ideal to start awareness at an early stage of family life. As new parents were considered to have heightened anxiety when their child was sick, participants believed that they be more prone to wanting and expecting antibiotics; and therefore, would benefit greatly from more awareness on antibiotics and ABR. Using health visitors to distribute resources on ABR awareness and guidance on the responsible use of antibiotics, was also suggested by many participants. As health visitors are able to approach and help new parents, this method of raising awareness was thought to be an ideal way of starting antibiotic stewardship early on in parenthood:

> "*I think a good place would be health visiting teams, as they have that input […] at the start of family life and that would be a good time…I know as a mum whenever your child is poorly you do sort of panic a little bit […] I think the go-to is always antibiotics…*" *(Parent 7; 30-39, Master's degree, 2 children)*.

Some parents, such as Parent 12, also mentioned using the "bounty pack" given to new parents, as an effective method of providing resources, on ABR and responsible antibiotic uses, that could inform these parents during the early stages of parenthood. Bounty packs are given to new parents, and provide samples of essential products that new parents may need for their baby, such as nappies, creams, and important information for new parents. Parent 12, mentioned that no information on antibiotics and ABR was provided in these bounty packs, and that this was a missed opportunity to raise awareness among parents. This father also believed that giving parents, at the start of parenthood, better guidance on when to use antibiotics would improve awareness and antibiotic stewardship:

> "…*the baby box you get […] it doesn't have any leaflets in it about when to do this, what to do etc. […] it's just again a missed opportunity by the health profession...*" (*Parent 12; 50-59, Professional qualification, 3 children*).

Schools were suggested by some parents, as an efficient way of distributing resources on ABR to parents. Comparisons were made to ongoing flu campaigns that are disseminated in schools yearly, and how campaigns on ABR could have a similar target audience and dissemination strategy. Parent 12 mentioned the abundance of information offered to parents, via schools, regarding the flu vaccine, and wanted to see a similar campaign in the same setting, to educate parents and teachers on ABR. This father also mentioned never seeing any information on antibiotics and ABR in schools, which shows that parents want to see more ABR campaigns in non-healthcare settings as well. Participants' comparisons to the flu campaign, indicate that parents would want to see an abundance of information pertaining to ABR in school settings, which could raise awareness among adults and children:

> "*I think there should be greater push for parents […] via schools. So, the campaign should go via schools […] we're very good at getting the flu vaccine over, there's lots of information, it's nice […] but there's nothing ever, I've never ever had anything in regards to that* [ABR]*…*" (*Parent 12; 50-59, Professional qualification, 3 children*).

Parent 6 also agreed that occasional ABR information distributed in schools could be helpful. This mother expressed their disapproval that only resources pertaining to flu campaigns were distributed in schools. They were adamant that the focus should not only be on flu vaccinations, and wanted to see occasional ABR campaigns in schools:

> "*Maybe something coming from the school could help you know from time to time […] ok don't think I have any meaning behind it, but they spend lots of energy when it comes to flu vaccination and it's just that! That's all! That's all!*" (Parent 6; *30-39, White, Diploma of higher education, 1 child*).

When it came to trustworthy sources information, more than half of the interviewees affirmed their trust in the NHS and PHE to provide accurate information on ABR and antibiotic use. Organisations like the WHO, were also deemed to provide trustworthy and accurate evidence on ABR. However, mistrust in the government as being a trustworthy source of information, was reported by a few parents who felt that the government lacked credibility:

> "*I'm hesitating to say the government at the moment they don't have much credibility in the public health space*…" (*Parent 1; 30-39, Master's degree, 2 children*).

Parent 6, who also had no trust in government experts, was the only participant to mention not trusting the WHO. This parent stated that they "*would put family experiences first*" (*Parent 6; 30-39, Diploma of higher education, 1 child*), as they believed that the public health information provided to the public was too politicised and not based on evidence from medical experts. It is interesting to note that this parent displayed a deep mistrust in medical experts like GPs, who they felt overprescribed antibiotics and could provide long-term solutions for illnesses; indicating inconsistencies in their beliefs.

> "*I'm sorry I don't trust government experts I think they are run by politics and not by medical expert*[s] *and […] the WHO don't have my trust. They don't have it!"* (*Parent 6; 30-39, Diploma of higher education, 1 child*).

All parents (apart from Parent 6) who had mentioned trusting family members as sources of information on ABR, explained that these family members were healthcare professionals. Although these participants mentioned family members being trustworthy sources of information, these parents also stated trusting public health bodies, and valuing the information from these sources. As it has been seen with Parent 6, valuing family experiences over medical advice issued by the government and organisations like the WHO, not only indicates mistrust in the main sources of public health information, but could also encourage the prevalence of misinformation, misconceptions on ABR, and misuse of antibiotics.

It is important to note that some parents mentioning their distrust in the government and government officials, may be due to the COVID-19 pandemic that had started before the conduction of these interviews. Frustrations due to the over-abundance of information on COVID-19, believed to be too politicised, could be one of the reasons why some parents did not trust the government to be a trustworthy source of information. This distrust was also echoed by other parents and will be described in the next sub-sections.

4.2.7 Changes in views and perceptions since COVID-19

In the last part of the interviews, parents were asked whether their views and perceptions on public health information, health promotion messages, and health services, had changed since COVID-19. This was done to better understand how people would respond to future health promotion messages and public health campaigns, particularly regarding ABR and antibiotic use. In this section one conceptual theme was developed from discussions with parents, namely 'attitudes and understanding of public health information'.

4.2.7.1 'attitudes and understanding of public health information' since COVID-19

Many parents mentioned a positive change in views and perceptions of public health information since COVID-19. For example, both parents 1 and 11 mentioned being more receptive to and aware of public health messages. Parent 11 described being more conscious about their health due to heightened public health awareness during the pandemic; and Parent 1, a mother who felt that the mortality rates of COVID-19 helped put into perspective the scale of ABR (see section 4.2.5.1), also believed that people were more aware of the consequences of not being able to treat an infection, such as COVID-19:

> "*I think we're all just terribly much more conscious of our health and like […] I think public health awareness is certainly heightened…*" (*Parent 11; 30-39, Master's degree, 3 children*).

> "*I'm more receptive to public health messages and there's a lot more awareness of what can happen…*" (*Parent 1; 30-39, Master's degree, 2 children*).

Only a few parents said there was no change in their views and perceptions since COVID-19, for example Parent 11, who still trusted UK public health institutions despite being aware of the general mistrust that the public may have of some of the public health information offered to them:

> *"No, I still like trust our public health institutions, and I trust the messaging […] It may be that other people feel less trustworthy of public health […] but I feel certainly just as trusting in our public health information as before…" (Parent 11; 30-39, Master's degree, 3 children).*

Although the increased amount of public health information, distributed to people since the start of the pandemic, has made people more aware of public health messages since COVID-19, they have also become more conscious of the politicisation of public health information. Parent 7 reported being more trustful of the public health officials and experts compared to the government, who they believed to be ignoring or downplaying certain aspects of the pandemic to suit their own political agenda. This mother, who reported having no trust in the government, believed that other people would also be less inclined to listen to advice or guidance issued by the government, due to a lack of trust in the information they are given:

> "*…I've also become quite conscious of the influence of political spin, and the government is quite happy to play down certain aspects of things that public health officials and experts have said, the government is quite happy to ignore that, when it doesn't suit them. And I don't trust this government anyway, and anything they can say about anything really. I think you run the risk of people going oh they haven't got a clue, I'm not listening…*" (Parent 7; 30-39, Master's degree, 2 children).

The constantly changing and differing politicised information provided by the government regarding COVID-19, was a recurring complaint from many participants. The dissemination of this information, provided by governmental bodies, was also perceived as unsatisfactory by these parents. For example, Parent 2 was frustrated with people not being properly informed about the situation, while Parent 8 was disappointed in how the government had provided information to the public during the pandemic, using words such as "catastrophe" and "terrible":

> "*Yes, honestly I feel like it's been a bit of a catastrophe in terms of government communication […] I feel like the way the government had gotten information across has been pretty terrible!*" (*Parent 8; 30-39, Master's degree, 2 children*).

Parent 2 (who previously displayed mistrust of GPs) also found the government to be patronising in how they informed the public. This mother believed that public were simply given instructions relating to COVID-19 measures (e.g., social distancing measure) without a satisfactory explanation, which caused some people to be mistrustful of the information provided by the government. This parent, who found public health information from the government to be patronising, also displayed mistrust in GPs who they believed did not provide enough information during consultations due to certain preconceptions about patients understanding. This could indicate a deep dissatisfaction with health information disenfranchising the public:

> "*…it's very heavily politicised, everything about it is politicised […] I do think that it's given us a lot of food for thought about how information is given out to people. I feel like my biggest frustration about the whole thing is that we're not being informed at all, people have just treated us like we're idiots, like nobody's gonna understand...*" (*Parent 2; 30-39, Certificate of higher education, 1 child*).

Losing faith in public health information, is a sentiment that was re-iterated by other parents as well, as the over-abundance of information and constantly changing evidence have led to people not following the guidance and advice issued by the government:

> "*I think a lot of people I know are not sticking to things properly because […] people have got a little bit sort of sick of the over-information and the changing information...*" (*Parent 8; 30-39, Master's degree, 2 children*).

Parent 6 believed that the government was being selective of the information given to the public, as they stated that the entire truth about COVID-19 had not been made public. This mother disapproved of the panic-inducing messaging used by the government, as well as the severe restrictions in place, which instilled fear in people. According to this participant, instead of fear-inducing public health messages, a more positive and supportive approach to health promotion should have been utilised by the government, where people were encouraged to adopt more healthy behaviours:

> "*…I don't think that we've been told the truth, entirely the truth, about it […] instead of spending 7 months putting fear into people's heads only talking about we're gonna die, […] you have to lock yourself in, don't get in contact with anybody, we would've*

> *done the opposite! How about teaching people how to get healthy? You know, in a supportive way!*" (*Parent 6; 30-39, Diploma of higher education, 1 child*).

Many parents observed that COVID-19 had overshadowed all other public health issues and had become the main topic discussed. Although prioritising public health information on COVID-19 was important during the pandemic, participants like Parent 12, were disappointed that other aspects of public health, such as encouraging healthy eating, had become less important. This father of a disabled and an autistic child, felt that there was not enough health promotion being done about mental health:

> *"I think it's all just become about COVID and I don't think there's been anything about mental health for instance […] there's no talk about healthy eating or anything like that." (Parent 12; 50-59, Professional qualification, 3 children).*

However, despite COVID-19 overshadowing other health issues during the pandemic, many parents mentioned a positive change in their behaviour, following guidance issued by governmental (NHS & PHE) and non-governmental (WHO) organisations. Parents stated being more mindful of their contribution to the spread of COVID-19, indicating an increase in social responsibility among these parents. They also reported seeking more evidence-based information to feel better informed and adopting behaviours to limit their contribution to the spread of the virus such hygiene practices (such as handwashing), while encouraging their family members to follow those behaviours as wells. Interviewees also reported inquiring more about public health information and being more discerning about information on COVID-19. According to Parent 2, being more informed about the issue has not only made them more aware of their behaviours, but has also changed some of these behaviours, such as handwashing. This parent also wanting to know more about the scientific evidence that inform public health information and health promotion information:

> "*Yes, I've definitely been more critical about it as well, you know...like asking questions about why has it done that, and how does that work […] I mean I'm acutely aware of how infrequently I used to wash my hands, in comparison to now…"* (Parent 2; *30-39, Certificate of higher education, 1 child*).

Despite the over-abundance of and constantly changing public health information and health promotion messages, the interviewees reported following health guidance and changing their behaviours i.e., washing hands more often, wearing masks, and social distancing. Many participants also reported a heightened consciousness their health and public health issues since COVID-19, as well as being more discerning of health information offered to them. The heightened level of awareness about public health information and health promotion messages appears to have made these parents more aware of the dangers of not being able to treat certain infections, such as antibiotic resistant infections which could potentially impact uptake of future interventions and campaigns on ABR.

4.2.8 Summary of findings from the telephone interviews

- All parents presented themselves as responsible parents; reporting that they chose to consult a GP only if their child had an illness that could not be treated at home, and only sought reassurance and advice for their children during medical consultations rather than antibiotics.

- While all parents presented themselves and their families as responsible antibiotic users, and most had self-reported practices that complied with health guidelines, some had self-reported practices, regarding antibiotic use, that did not comply (e.g., not finishing the full course of antibiotic treatment). Generally, these parents had lower levels of education, suggesting a relationship between education, health literacy, and compliance.

- Precautionary prescribing was reported by many parents, due to an unconfirmed or unknown diagnosis, and in the absence of diagnostic tests. Parents felt that in these cases treatment options were not sufficiently explored with them. This led to mistrust in diagnosis, and was present among many mothers, rather than fathers, who questioned their doctor's diagnosis and precautionary prescribing.

- Almost all mothers who questioned GPs' diagnoses had more than 1 child. Some of these parents recalled refusing precautionary antibiotics, particularly when diagnostic test had not been conducted or when parents felt that their child did not need the prescription. This intimates that potentially parents with more than one child felt more competent to question a GP's diagnosis and refuse antibiotics for their child, perhaps due to their previous experience with children's illnesses.

- Mistrust in GPs was reported to be determined by a number of factors:
  - precautionary prescribing,
  - lack of diagnostic tests,
  - feeling unheard about child's illness, diagnosis, and treatment
  - lack of a clear explanation from the GP, regarding diagnosis and treatment choice,
  - advice and suggestions from external sources,
  - previous negative experience with giving their child antibiotics,
  - previous stress and anxiety relating to child's illness, diagnosis, and treatment,
  - preconception that participants' GP over-prescribed antibiotics.

- Many parents experienced communication challenges during medical consultations. This was attributed to time pressure experienced during these consultations; which was reported in almost all interviews. Consequently, parents reported feeling unheard or uninformed at the end of consultations.

- Information given to participants during medical consultations, was reported to often lack clarity and be insufficient. There was consensus that information on ABR, the potential consequences of misusing antibiotics, or the possible side-effects of antibiotics, was generally never offered in primary care. As a result of feeling uninformed, some parents stated that they resorted to external sources of information (Google, friends, and family). Those who reported experiencing communication challenges during consultations, also displayed mistrust in GP diagnosis and prescribing.

- Almost all parents showed a good knowledge and understanding about ABR, and many were able to clearly articulate what ABR is. Misunderstandings were present among some parents, particularly regarding how ABR occurred, and the consequences of inappropriate antibiotic use and ABR.

- Educated parents felt the language used about ABR used was easy to understand. Most of these parents were confident that that their higher education resulted in better ABR understanding; although this confidence was misplaced for some. Those with lower education were less sure of themselves, and recognised their lack of knowledge and understanding of ABR.

- Parents showed concern that ABR could affect themselves or their child(ren) in the future, particularly given the heavy reliance on antibiotics to treat many infections. However, ABR was not a concern for those who had never used antibiotics for their child or considered themselves as being low antibiotics users. These parents displayed a detachment to the issue, indicating a belief that they were not a part of the ABR problem, although others were. Emotional disengagement was noted among those that did not know the scope of the issue and felt uniformed about ABR and its consequences.

- Participants reported a lack of social responsibility in other parents who misused antibiotics, expected or requested antibiotics during medical consultations, and those who were misinformed about the responsible use of antibiotics. Behavioural inconsistencies were observed among those who described a lack of social responsibility in others, but did not reflect on the own social responsibility and non-compliance. This was particularly seen among those who presented themselves as being responsible antibiotic users and were not emotionally engaged with the issue, and those who had misplaced confidence in their understanding of ABR.

- Regarding resources that parents would benefit from and that could make an impact on ABR awareness, parents wanted a convenient and attention-grabbing resource, that provided better guidance on antibiotic use for young parents and new parents. Parents suggested using health visitors, schools, and social media to disseminate awareness campaigns on ABR.

- When it came to trustworthy sources of information on ABR, parents mentioned they would trust the NHS, PHE, and WHO. However, many parents did not perceive the government to be a trustworthy source of information.

- Many parents reported positive behaviour changes (e.g., handwashing) and a heightened level of awareness about their health and public health issues since the pandemic. Although many described losing faith and trust in the government and complained about the over-abundance of public health information during the pandemic, they also described being more receptive to and aware of public health messages. These parents were more mindful of their contribution to the spread of infection, indicating an increase in social responsibility among these parents.

4.3 Findings, Phase 3; online creative workshops

This section presents the findings from the online creative workshops, undertaken to inform recommendations for the design and development of a future intervention/tool, aimed at improving knowledge, understanding, and attitudes with regards to antibiotic use and ABR.

Online creative workshops were conducted to enable collaborative discussions to develop creative ideas and new solutions for a health promotion intervention, and to explore what parents wanted to see in an intervention that would affect them as stakeholders. Data collection for this phase of the study was conducted between November 2021 and May 2022.

Despite multiple attempts at recruitment (see section 3.2.3.1) only eight parents agreed take part, with 4 parents ending up participating in 3 separate workshops (because of last minute cancellations due to unforeseen circumstances). See table 24 below.

Table 24: Characteristics of parents participating in the online workshops (OW)

OW (n=4)	Gender (participant ID)	Age	Ethnicity	Place of birth	Number of children	Participation in other phases
OW 1 (n=1)	Female (P1)	30-39	White	Italy	1	Phases 1 & 2
OW 2 (n=1)	Male (P2)	50-59	White	UK	3	Phase 1 & 2
OW 3 (n=2)	Female (P3)	30-39	White	UK	1	Phase 1 & 2
	Female (P4)	20-29	Black	Nigeria	1	Phases 1

Each workshop lasted between 1 and 1.5 hours. Most participants were mothers, aged between 20-39, with only 1 father (aged between 50-59). All parents had taken part in at least one phase of the study; most were of White ethnicity, with 1 being of Black ethnicity, and half were born in the UK, the others being born in Italy and Nigeria respectively.

As discussed previously (section 3.2.3.3), a pragmatic approach to data analysis was used. Each workshop was transcribed by the researcher to encourage familiarisation with the data. Main themes from the transcriptions were identified and workshop a mind-map was generated where parents' ideas and suggestions collated. Three individual mind-maps were generated which were combined to form a summary one (Figure 28 below).

4.3.1 Main themes from the online creative workshop:

Three main descriptive themes emerged from the workshops, relating to key areas participants saw as important, namely:

- Target audience and inclusivity
- Dissemination strategies
- Content

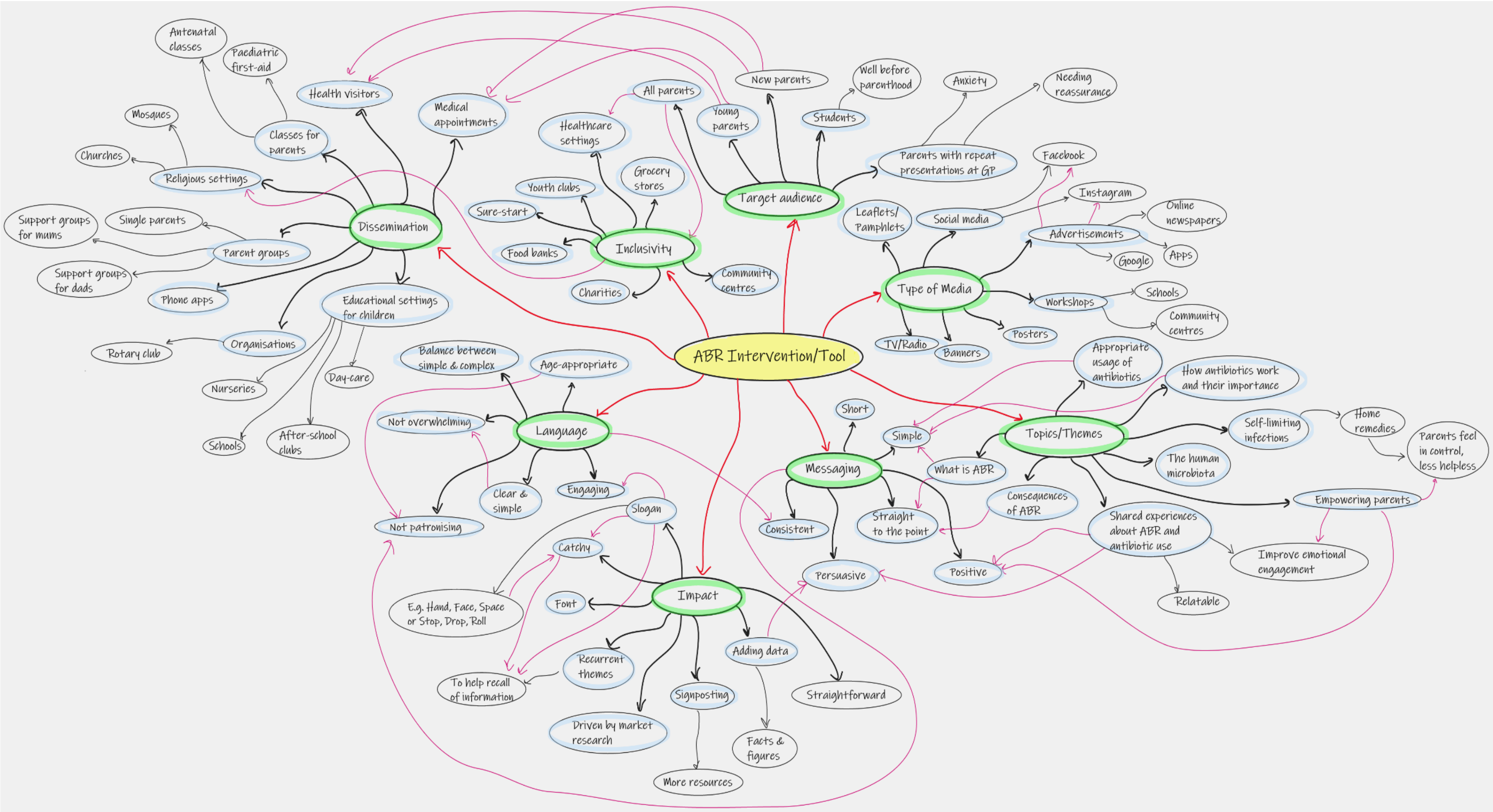
The first main descriptive theme that emerged related to the '**target audience and inclusivity**'. Participants described the characteristics of parents who they felt would benefit from the intervention, and how targeting these particular groups could eventually help improve awareness on responsible antibiotic usage and ABR, among parents in GM. They also discussed the complexity of the language used in the intervention, that is whether it should make use of lay and simple terms, to make it more accessible to the target audience. There was also a discussion around inclusivity, particularly regarding ways to help intervention uptake in all areas of GM, including deprived areas.

The main descriptive theme, '**types of media and dissemination**' emerged from discussions around the type of intervention that could interest parents, and capture their attention. Participants discussed their previous experience with the various media used in health promotion, together with their likes and dislikes. This theme emerged from participants discussing features that could catch parents' attention and trigger their interest to learn more about ABR and antibiotic use via the intervention, such as the type of font they would like, the inclusion of data and facts, and the use of pictures. Participants also discussed how the intervention should be disseminated to ensure that it was seen and used by the targeted audience. Participants shared their experiences and views regarding dissemination strategies that they have found effective, and that could be helpful for this intervention.

'**Content**' was the last main descriptive that emerged from the online workshop. Parents discussed which topics they felt needed to be included in the intervention, which they believed could be beneficial to the target audience. Parents in the online workshops also went on to debate the type of messaging that would be more effective to improve awareness and educate people using the intervention.

These main themes are shown in the mind map below (Figure 28), which illustrates the flow of ideas and suggestions that were captured during the online workshops. Main themes included more detailed subthemes, which included suggestions and ideas provided by the parents.

Figure 28: Mind-map illustrating the main themes, ideas, and suggestions from parents



4.3.2 Target audience and inclusivity

All parents agreed that a novel intervention was needed to improve ABR awareness. However, discussions focused on accountability for ABR, i.e., whether it rested with parents or medics (particularly as they are the only ones who can prescribe). Most parents were defensive about an intervention that only focused on parents, questioning whether the focus would be better on the prescribers.

> "*But why parents are misusing? I mean antibiotics are prescribed. You don't just buy antibiotics from the shop like you get paracetamol…*" (OW1, P1).

Participants in 2 workshops believed that patients blindly followed their GP's advice, without questioning whether an antibiotic prescription is warranted in certain cases. Doctors' social power, authority in society, and their unquestionable influence on people's beliefs and behaviours were discussed, particularly with regards to antibiotics. These parents described doctors as being authority figures in society, whose treatment decisions are never questioned; contributing to patients being too compliant when GPs decide to prescribe antibiotics, even when not warranted. The term "blindly follow", often used in negative contexts, indicates that some parents question medical expertise, while also judging patients who follow any medical advice without any critical reflection:

> "*…it's all fine telling parents to not misuse antibiotics, but they're being told by a doctor to take antibiotics, to give their child antibiotics, and we do as a society tend to blindly follow doctors without much question. If a doctor […] not even your own doctor, just someone who says they're a doctor has told you to do something, we tend to do it*…" (OW3, P3).

Parents also questioned streamlining the intervention to a specific group (e.g., parents of children aged between 3 months and 6), given that the issue also affected other age groups. For example, this mother believed both new and more experienced parents needed know more about ABR and responsible antibiotic usage; and believed that certain habits and behaviours, that may not follow health guidelines, may be difficult to change irrespective of whether some people were more experienced parents than others:

> "*…if you just became a parent or you've been a parent for 10 years or 15 years, certain habits are really hard to break. This information should just reach everybody, I think…*" (OW1, P1).

There was consensus among parents that if a specific population of parents were to be the target for the intervention, new parents, specifically young parents would be the best ones to focus on. Participants believed that reinforcing responsible behaviours, with regards to antibiotic use, at the start of parenthood would be an efficient way of ensuring responsible antibiotic use and awareness among parents in the long run. Participant P3 pointed out that parents with young children would probably consult healthcare professionals, repeatedly over a short period of time, due to their anxiety when their child is poorly. This parent mentioned that repeat presentations to the GP could result in the GP perceiving this as pressure for antibiotics; which could eventually lead to the unnecessary prescribing of this drug. Getting an antibiotic prescription, after consulting a GP multiple times for a sick child, gives parents back some control in a situation where they feel helpless. Therefore, this parental group could potentially benefit from the intervention:

> "[GPs] *get a lot of parents come to them who are really anxious about their child and they might have been to see them three or four times about the same problem and they […] eventually kind of get worn down and they're just like, ok have some antibiotics […] parents need to feel like they've got something to do so that they don't feel helpless…*" (OW3, P3).

Although most parents questioned the tendency "*to blindly follow doctors without much question*" (OW3, P3), all parents acknowledged the effect of parental pressure, particularly pressure from parents with young children, on whether antibiotics were prescribed or not during a medical consultation. Therefore, there was consensus among workshop participants that new parents and parents with young children would benefit from an intervention to raise awareness on ABR; so that this could empower them to discuss treatment options with their GPs, or be more aware of when antibiotics are needed.

While discussing the target audience for the intervention, participants also discussed ways to encourage inclusivity when the intervention will be conducted. Many mentioned making use of community-settings to encourage all parents to be involved in the intervention, such as

Sure Start centres, children centres, leisure centres, nurseries, day-care, baby groups etc. Mothers drew from their experiences when they started parenthood, and shared what they found useful at the time. For example, participant P4 explained that there are various pre-natal and post-natal sessions that take place in children centres, that they had found useful; therefore, children centres would be an ideal place to distribute resources on ABR and antibiotic use (e.g., leaflets and pamphlets) to new mothers:

> "*I think the children centres are one place […] I found it really useful while I was pregnant […] they would have different sessions for parents […] that are currently pregnant and then they have sessions for parents […] when […] they have their children […] So, I'm sure […] if there was going to be, say, pamphlets or some leaflets, that's one place that a lot of moms, new moms are going to. And you know, they just find time…*" (OW3, P4).

Participant P1, a social worker, questioned whether conventional resources to raise awareness, such as leaflets, would be an inclusive way of educating parents. They pointed out that literacy levels may vary among parents, particularly in deprived areas; therefore, low literacy levels may affect the uptake of an intervention using resources such as leaflets, particularly in areas with high levels of deprivation. This is an important point given the literacy levels and the multicultural nature of GM. This mother suggested the use of multiple media to ensure inclusivity of the intervention, such as reading material that can be distributed to the public, as well as encouraging GPs and health visitors to spread awareness on ABR, as this would ensure that all parents, including those with low literacy levels, would be exposed to the intervention.

> "*Well, if you do a campaign with leaflet and banners that that could reach everybody… If everybody can read. Well, I hope everybody in 2021 is able to read. But there might be some cases where in very deprived areas, that there might be some issues related to reading as well […] I think no matter the area you live in, you are reachable […] through a leaflet, a banner, a health visitor coming home, or going to your GP. Messages can still pass.*" (OW1, P1).

While discussing using nurseries, day-care, and baby groups to expose parents with young children to resources on ABR, participants debated how inclusive these settings would be, particularly in more deprived areas, as many of these services can be costly may not be accessible to all parents. Therefore, participants suggested using mandatory health appointments, such as antenatal appointments, vaccination appointments for babies, and health visitor drop-ins, that could be opportune moments to educate parents, about ABR and antibiotic use. As these appointments are attended by all parents, irrespective of demographic characteristics, this would encourage inclusivity. Participant P4 used the term "common ground" to describe settings that were visited by all parents, at some point during parenthood, such as GP surgeries and hospitals; as well as consultations with healthcare professionals such as midwives and health visitors, who are able to reach parents in both deprived and less deprived areas:

> "E*very woman would attend an antenatal appointment, up until the time that she would have a baby and then crossover to the community midwives […] as well when they go into hospital […] to have these appointments or when they go to the GP […] so these are […] places that are common ground for everyone…*" (OW3, P4).

Religious settings, such as churches and mosques, were also mentioned by most participants, as being a good way of making sure that health promotion messages on ABR and antibiotic use reached everyone. Participant P4, a mother who described themselves as being a frequent churchgoer, described parents in religious settings as being bound together by social, cultural, and religious ties. Due to being a close-knit community, these parents were influential on each other's beliefs and behaviours:

> "*…I feel like if there is anywhere to target specific populations, it would be religious settings. […] And because […] some of them are such a close knitted group, once one person says something, they're like, oh if you're doing it yeah […] I'll just go along with that […] so religious settings, churches, mosques are places where you can really target some ads…*" (OW3, P4).

The use of social media (e.g. Instagram, Facebook, Google ads) to spread information on ABR, was also considered to be a good way to promote inclusivity, particularly with the use of targeted advertisements online. Participant P2, a father who works from home, stated that targeted advertisement would allow ABR information to be far-reaching; allowing various groups of parents to be exposed to the intervention:

"*...things like reinforcing on Instagram, Facebook, Google ads...*" (OW2, P2).

When it came to the intervention language needed, participants mentioned the need for a clear and simple language to enable the intervention to be inclusive and accessible to all parents. Some participants felt that the concept of ABR was difficult to understand, due to the language used in ABR health promotion material being too complex or medically-driven. Participant P2 equated ABR medical jargon to 'gobbledygook' for some people, stating that this would discourage engagement with the intervention. Parent P3 felt that due to the complexity of the language used, they struggled to understand how ABR occurred and how it could affect people; therefore, more clarity was needed in ABR information offered to the public:

"*It's medically-driven and that's not appropriate... I mean, if you have a load of gobbledygook, then you can kind of lose interest.*" (OW2, P2).

"*I think it's really difficult to understand the concept. [...] I wouldn't really be able to explain it or what it is or why it happens...*" (OW3, P3).

4.3.3 Dissemination strategies

Discussions around the type of media that would interest parents when it came to ABR awareness interventions, brought forward a range of suggestions on the most effective methods of conveying health promotion messages to the public, such as through the TV, radio, posters (in the GP surgery), and radio. There was consensus among parents, that broadcasting health promotion messages would have a more widespread reach. Participant P1 believed that information on ABR should be broadcast daily on the TV and radio, as it was an important public health issue:

"*I believe it should be on TV you know, every single day [...] I think the radio could reach lots of people, and television as well! [...] I know probably 99% of the people out there watch television on a daily basis so. This kind of information should just be there!*" (OW1, P1).

Interestingly, most participants wanted to receive more information on ABR and antibiotic use from their children's schools, asserting that this would be an effective way of getting their attention on the matter. Almost all participants mentioned prioritising information that directly related to their children, particularly if this information was sent to parents from schools. Based on their own experience as parents, participants believed that getting schools involved in raising awareness on ABR, would not only stress the importance of the issue among parents, but it would also encourage parents to engage more emotionally with this issue:

> "*To be honest, if my child was to bring a pamphlet from school […] everything she brings from school, always, always gets my attention […] So, I feel like, if there is a way to get the schools involved...*" (OW3, P4).

Participant P1 mentioned workshops where parents could congregate, and be informed about responsible antibiotic usage and ABR. This mother gave the example of classes and groups on breastfeeding being supportive for breastfeeding mothers, and how a similar support could be offered to parents, through workshops. Having workshops for mothers, where they are given the opportunity to discuss with experts, could help educate and inform parents on certain infectious illnesses, antibiotics and ABR:

> "*Workshop I think is amazing […] So maybe the idea to attend a place weekly, you know, kids can play and moms can talk. And maybe a GP could be there and share some important information. You know there are classes, groups for breastfeeding, support for breastfeeding mothers, there could be support for mothers that don't know much about children's illnesses...*" (OW1, P1).

Regarding the format used in the intervention, there was consensus that the intervention had to attract people's attention and be straightforward. Creating a slogan that would stick in people's minds and would be used consistently was recommended. Their suggestions were for the slogan to be short and catchy, drawing on examples of previous health promotion campaigns/interventions that have used these types of slogans to share important information, for example the "hand, face, space" slogan that was used during the COVID-19 pandemic. Using a slogan that promoted the responsible use of antibiotics with clear, simple, and consistent messaging, would allow all members of the public to engage with the intervention, irrespective of their educational background:

> *"…*[it] *has to be catchy, something […] which sticks in your head. Hand-face-space, things like that. Very simple, clear messaging would be relatable to all kinds of groups*

of people, not just people that are from a scientific background, even people that have no clue what you know, bacteria is they would see that and understand straight away that they shouldn't, you know, misuse antibiotics." (OW3, P4).

Participants also wanted to see facts and figures included in potential reading resources used in the intervention. According to these parents, the use of facts and figures would convey the gravity of ABR and the over-use of antibiotics, as well as put things into context; for example, rates of COVID-19 deaths compared to deaths from ABR, highlighted previously in the telephone interviews (section 4.2.5.1). Some other examples provided by workshop participants included the rates of unnecessary antibiotics used in the UK, examples of childhood infections that do not need antibiotics, and the number of cases of antibiotic resistant infections found in children:

> "*So, it needs to start off with […] don't use antibiotics, 90% of them are not needed or whatever the statistics are. Or […] did you know that in the majority cases you don't need antibiotics? It has to be very simple…*" (OW2, P2).

Along with information that included facts and figures, the use of signposting in the intervention was suggested by some participants who felt that it was important to direct parents to trustworthy sources of information if the parent needed or wanted further information on ABR or antibiotic use. According to these participants, this would be a useful addition to the intervention, as it would allow parents to feel more in control of the information they are given and more empowered during their child's recovery. It would also encourage parents to learn more about ABR and antibiotic use, on their own terms:

> "*It's about the parents feeling like* [they are] *doing something […] I want to believe in constructive signposting parents on […] places to go to or links to read or you know other resources that would be useful to them. […] If you are interested in knowing more about this XYZ then you can click on this or […] you can get this leaflet from your […] GP practice…*" (OW4, P4).

Participants shared their previous experience with health promotion messages/campaigns, and how this could be applied to an intervention on ABR. All parents wanted to see more campaigns on the topic and compared the potential dissemination strategy to the way COVID-19 health promotion information was shared with the public during the pandemic. Participant

P2, mentioned that information on COVID-19 was everywhere during the pandemic, and people were being repetitively reminded about germs, practicing safe behaviours (e.g., hand-washing), and being mindful of the consequences of not following health guidance. This parent believed that the constant exposure of important information during the pandemic was useful, and should be applied to ABR awareness as well, i.e., persistent public health information and health promotion messages relating to ABR and antibiotic use should be everywhere:

> "*There was a lot of stuff when COVID came out, about germs and […] why we need to be really careful about things. And I think that was done in a really good way […] I mean, it was everywhere*" (OW3, P3).

Participant P1 compared the COVID-19 health promotion information and messages to propaganda, stating that COVID-19 information was disseminated everywhere and in various ways. Although the term 'propaganda' has negative connotations, this participant suggested that other public health issues, such as ABR, should also benefit from the approach. Public health information during the pandemic was considered by many people, including the parents who participated in this study, to be heavily politicised. This could explain why this mother used the term propaganda to describe the dissemination of public health information. However, it is important to note that this parent had previously displayed strong feelings of distrust against the government (see section 4.2.7), which could also explain their comparison of public health information and health promotion messages to propaganda:

> "*They should do a proper propaganda you know, as they did with all the COVID stuff, the COVID vaccine. Oh my God everywhere you turn, you find messages in shops, on the road while you* [are] *driving, on your social media, on your TV, on the radio, on a paper, everywhere, at the bus stop, everywhere there's a message related to the COVID vaccine. So, what about everything else? There's so much that needs attention next to COVID, there's still so much. Antibiotics is one of these.*" (OW1, P1).

Many participants suggested making use of health care settings, such as pharmacies and GP surgeries to disseminate the intervention, as these would be the first contact with a prescriber and a supplier of antibiotics. Pharmacists, considered as the suppliers of this medication, were deemed to be in the best position to offer information on ABR to parents collecting antibiotic prescriptions. Parents trusted pharmacists to give them the necessary information regarding the antibiotics prescribed to them, and felt that pharmacists were not given enough opportunity to improve antibiotic stewardship among patients, particularly parents:

> "*You know chemists, pharmacists who are very well trained. We don't make use of those and we need to make more use of those, I think…*" (OW2, P2).

> "*Most likely the pharmacy […] That's where I would go in to pick up my antibiotic prescription if I've got one. So that's one place.*" (OW3, P4).

4.3.4 Content

When it came to the topics and information that should be included in the intervention, all participants wanted to see more information on what antibiotics are, how they should be used, and the importance of finishing the full course of antibiotics. For example, Participant P4 recommended a clearer explanation of why medical guidance insists that a course of antibiotics should be taken to completion. They felt that providing a clear and simple explanation for parents would not only make consultations and prescribing easier, but it would also allow parents to understand the potential consequences for their child if this guidance is not followed:

> "*I think it's very important for not just health professionals or doctors prescribing the medication... If there is information out there to remind parents that it's very important that you're completing the dose because the next time your child has this same infection, it might take a bit longer...*" (OW3, P4).

Providing parents with a simplified and accessible version of how antibiotics work, with regards to the microbiota and ABR, could also improve parents' behaviours as antibiotic users. Participant P3 believed that parents are often relieved to obtain antibiotics from their doctor if their child was poorly, as this meant that their child's recovery could finally begin and parents' worries and anxiety would finally decrease. How antibiotics worked and the potential consequences of taking this medication, were not primary concerns for parents with a sick child, who first and foremost want their child to recover a soon as possible. Therefore, educating parents about what antibiotics are, how they work to treat an infection, and the effect this medication may have on the body, could potentially discourage antibiotic expectation among parent, and also encourage a more judicious use of antibiotics:

> "*I think part of the problem is that […] you don't really think about why they're giving you antibiotics […] like you've gone to the doctor, your child's got an ear infection, they've given you some medicine. Good! Thankfully! […] Like great, […] there's a light at the end of the tunnel! Like, we'll give them the medicine, they're gonna be better, this is gonna be all over in a few days. You don't really think about what that medicine's for or what it's doing to their body, how it's working with the body. […] Maybe something like that, that would be accessible for everyone…*" (OW3, P3).

Participants wanted to see an intervention that explained to parents the potential consequences of misusing antibiotics, particularly with regards to how ABR could affect individuals including their children. According to these participants people are not aware of the gravity of ABR and the potential consequences for individuals and society. Participant P1 believed that parents are unaware of the long-term consequences of using antibiotics for childhood infections, and did not take this public health issue seriously. This mother believed that adding data on ABR infection rates and how ABR affects people, could stress the severity of the situation and result in better antibiotic stewardship among parents:

> "*I don't think they see how serious this thing is! Would it be possible to bring some data in, what ABR is causing out there? How people […] are affected by this? […] But they need to take these things seriously. It's not a joke! The way they behave in terms of you know the way they give these antibiotics can really, really affect the health of their children once they grow up…*" (OW1, P1).

Although there was consensus among the workshop participants that improved awareness on ABR and its consequences would be an important outcome for the intervention, the most important topic all participants wanted to see in the intervention was ways of supporting parents when their child was unwell. This included ways of better understanding the symptoms that their child presented with, how to alleviate these symptoms at home, and when to seek medical help. Participant P3 wanted the intervention to provide constructive advice and guidance on ways that parents can deal with and overcome a child's illness; for example, alternative remedies parents may try at home when antibiotics are not needed.

Parents wanted more helpful guidance rather than simply being told that their child had a viral infection and did not need antibiotics, so that they could feel supported during and after their child's illness:

> "*I know that sometimes they say like oh cold and flu is a virus, so you don't need antibiotics, but what can you do? That's the point. People don't wanna hear what you can't do, people wanna hear what you can do. […] It's like what can I do for my child in that situation? People just want to do something…*" (OW3, P3).

Empowering parents to make the right choices when their child is sick, particularly regarding how they could help the child at home before seeking medical advice, was something that participants felt very strongly about and wanted to see in the intervention. Participants believed that if parents felt reassured about their child's ailment and felt empowered and in control when it came to alleviating their child's suffering, parents would be less inclined to request antibiotics or pressuring GPs into prescribing antibiotics with repeat presentations for medical consultations:

> "*…I think it's it needs to be something that parents feel like they have some control over, like parents would just say, well, I don't control whether I get antibiotics or not […] it's more about feeling more confident with managing your child's day-to-day ailments without feeling like you have to push*." (OW3, P3).

There was consensus among all participants that simply being told that their child had a viral infection that will get resolved with time and patience, was frustrating and demoralising. Being given minimal information, rather than constructive advice on how to help a child's recovery, increased parental anxiety. For example, Participant P3 described feeling frustrated when GPs do not offer further guidance on their child's infection. This mother described strong feeling of helplessness, and feeling let down by their doctor in this situation; which could explain why some parents (including Participant P3) expressed dissatisfaction with their experiences during medical consultations, and voiced mistrust towards GPs (see section 4.2.2.2). This mother also explained that they would pressure for antibiotics, if they were exasperated at the lack of support from their GP as they wanted to feel like they were doing something tangible to ease their child's suffering and discomfort. The lack of empowerment that some parents may feel with a sick child could strongly influence the outcome of medical consultations with GPs, with regards to antibiotic prescribing:

> "*Sometimes the problem is that they do literally just say it's a viral infection it will sort itself out, and you come away thinking […] I still feel helpless, and actually I feel worse now because I don't feel like I can get the help from the doctors […] But if they were to say it's a viral infection, have you tried these things that are not to do with antibiotics […] feeling like you can do something about your child's pain or discomfort is really important […] if I was gonna get like really exasperated, that is where I would start pushing for antibiotics…*" (OW3, P3).

Almost all parents agreed that the intervention needed positive messaging, as they believed that using negative messaging would scare parents or would make parents uninterested in the health promotion message that the intervention would be trying to convey. Participants felt very strongly that the use of messaging that would insinuate that they were putting their child in danger by using antibiotics inappropriately, would be unhelpful and could have a negative effect on how parents engage with health promotion on ABR. Participants also believed that parents are already constantly worried about their child's health and not being a good enough parent, and adding to that fear with negative messaging about ABR and antibiotic use, would only make them unapproachable with the intervention. Using positive messaging that did not lay blame on parents, would allow better engagement with the intervention:

> "*I think it has to be positive. I think we've got to change people's attitude and your heart and mind never work on a negative view. If I see a negative statement that yeah, I've been a bad parent, the first thing I'm gonna do is turn the thing off* [because] *I don't want to be told that. […] Like you can't go through life sort of saying you're a bad parent if you give your child or children antibiotics because most parents would just get turned off…*" (OW2, P2).

Although most parents mentioned not wanting negative messaging to scare parents into changing their behaviour and attitude regarding ABR and antibiotic use, the use of facts and figures previously mentioned (section 4.3.3) to convey the gravity of the ABR situations, could be considered as negative messaging. This indicates that some participants may have contradictory views on what may be considered negative messaging, as wanting positive messaging conflicts with wanting the gravity of the ABR situation to be emphasised as well. However, participant P1 (social worker) pointed out that negative messaging could in fact stress the seriousness of ABR to parents, thereby reducing complacency regarding this public health issue:

> "*I don't want to say we need to scare them, but when […] people are afraid of something, they* [are] *more focused. They pay more attention…*" (OW1, P1).

Some participants mentioned not appreciating that some past campaigns were patronising, or had patronising messaging; particularly if the messaging contradicted what they had experienced in the past with their GP. There was mixed messaging when it came to ABR health promotion, where certain campaigns mention not using antibiotics unnecessarily while GPs were believed to be prescribing antibiotics unnecessarily (mentioned previously, by P1, P3, and P4, in section 4.3.2). Parents mentioned accountability when it comes to antibiotic prescribing; particularly with regards to how public health campaigns, on ABR and the responsible use of antibiotics, do not reflect the shared responsibility of patients and prescribers in this issue. Many believed prescribers had to be held accountable for over-using antibiotics, rather than patients/parents, as prescribers were the ones to decide whether antibiotics were warranted or not. They also felt that the campaigns encouraged patients to follow the advice offered by healthcare professionals, but also simultaneously admonished patients for prescribers' decisions to prescribe antibiotics. Therefore, most participants did not appreciate how previous ABR campaigns, advocating for more responsible usage of antibiotics, have projected responsibility for the over-use and misuse of antibiotics on patients rather than prescribers:

> "*I don't like it to be honest, because they list a few things that you should not use antibiotics for and then they went on to say […] take your pharmacist advice, take your doctor's advice. But what if my doctor is giving me antibiotics to use?*" (OW3, P4).

Interestingly some participants mentioned wanting to hear from other parents, believing that hearing about other parents' experiences with ABR and antibiotic use would be relatable and could improve parents' emotional engagement towards the issues. Participant P1, mentioned that the intervention should include people sharing their experiences with ABR and antibiotics, as was done with people sharing their experiences with COVID-19 during the pandemic. This was reiterated by other participants who also mentioned valuing other parents' views and opinions on the matter, as they felt this would be more relevant to them as parents, particularly when it came to children's illnesses and treatments. As P3 mentioned below, some parents appreciated other parents' experiences, suggestions, and opinions more than medical advice, as they felt reassured when speaking to other parents going through a similar ordeal thing as them. This reassurance was not always offered to parents during medical consultations; therefore, it was valued when obtained from other parents:

> "*I'm thinking if people will share their experience. I mean look at […] those people that went online and shared their experience about Covid. People were really paying attention to that, they felt it could happen to me…*" (OW1, P1).

> "*I think it's not uncommon that parents probably […] give a lot more weight to what another parent says, even over what a medical professional might say […] having somebody else who knows what you're going through or you feel like you can relate to […] I think is […] really helpful …*" (OW3, P3).

4.3.5 Summary of findings from the online creative workshops

- Participants wanted doctors to be held accountable for overprescribing antibiotics and were defensive about an intervention that focused solely on improving antibiotic usage among parents. However, there was consensus that parental pressure could influence healthcare professionals' choice to prescribe antibiotics.

- New parents were considered to be the best group to target for the intervention, to encourage antibiotic stewardship at the beginning of parenthood.

- To ensure inclusivity, participants suggested distributing ABR resources in community and religious settings, during mandatory health appointments at hospitals (antenatal appointments) and via health visitors. To guarantee accessibility to everyone (particularly those with low literacy levels), the language used would have to be simple, clear, and engaging.

- Regarding dissemination of the intervention, schools were suggested to increase parental emotional engagement with the issue, while stressing the importance of antibiotic stewardship. Workshops were also suggested as being a way of building a community for parents, to support each other and get occasional expert advice on ABR. Pharmacies and GP surgeries were settings suggested, as these would be the first point of contact with a prescriber and a supplier of antibiotics.

- In terms of content, participants wanted the interventions to have a simple and consistent message, to encourage engagement and behaviour change. Although, there were conflicting views regarding what was considered as negative messaging, there was consensus that the intervention should have positive messaging. Participants disliked past campaigns that had patronising or mixed messaging, particularly if the message contradicted what they had experienced in the past with their GP.

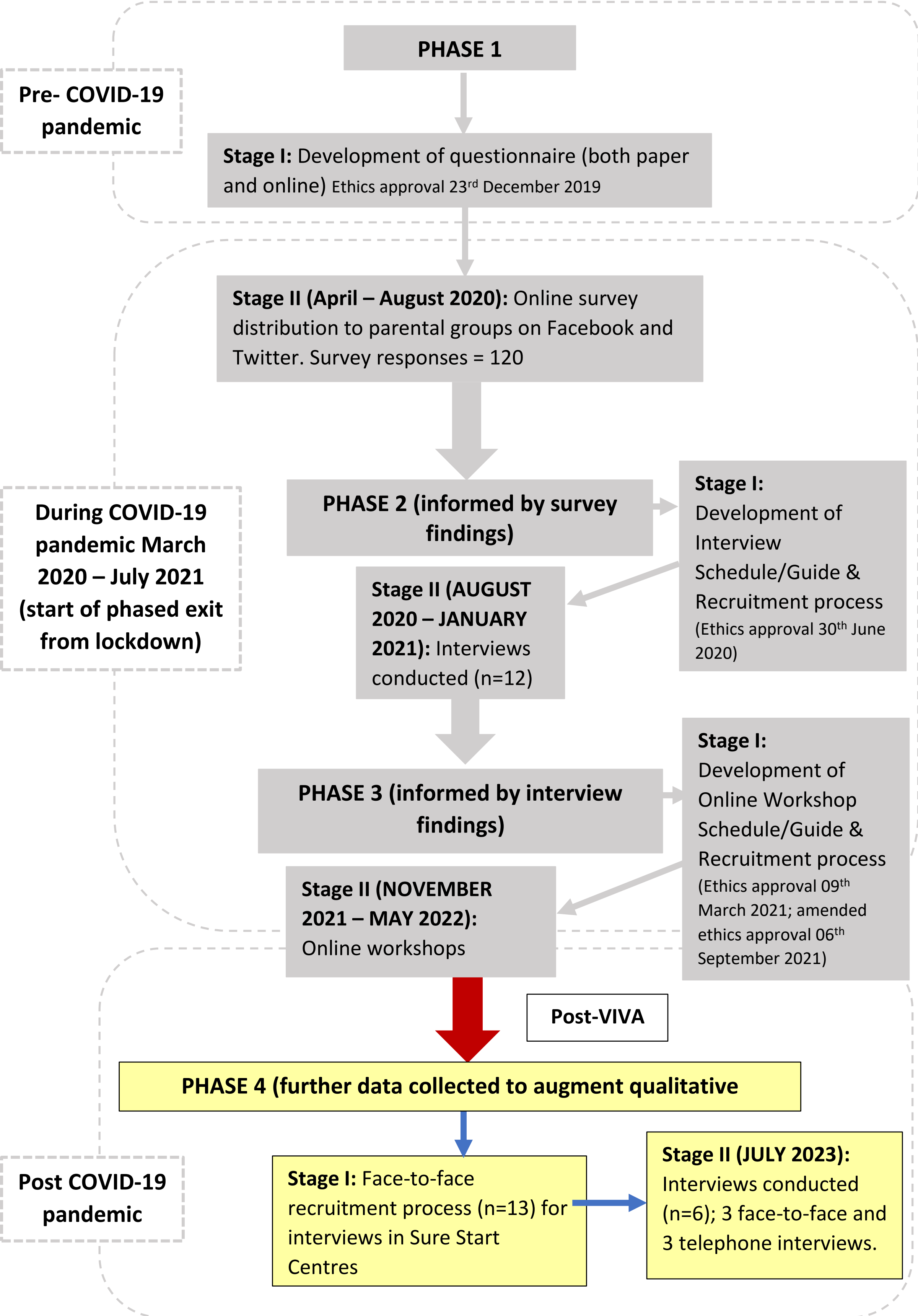
- There was consensus that supporting and empowering parents, should be one of the main priorities of the intervention. The intervention should empower parents to make the right choices when their child is sick, particularly regarding how they could help the child at home, before seeking medical advice. This would not only improve the outcome of medical consultations, but would also improve antibiotic stewardship.

- Participants valued other parents' experiences with dealing with a sick child, or using antibiotics, and that including other parents' experiences with ABR and antibiotic use, in the intervention, would make the issue more relatable and improve parents' emotional engagement towards ABR.

4.4 Findings, Phase 4; Sure Start Centre interviews

This section presents the results obtained from the interviews with parents recruited from Sure Start Centres in Manchester. These interviews aimed to explore parents' perceptions, experiences, practices, and behaviour towards ABR, antibiotic use for their child, and prescription advice. This phase of the study was conducted post-pandemic, to provide a better understanding of a deprived sample (see Figure 29 below).

Figure 29: Research timeline and flowchart for Phase 4



Of all the parents approached and spoken to for the study (n=21), 13 showed an interest in taking part, and six participated in the interviews conducted between June and July 2023. Although initially interested in participating, 7 parents (5 mothers and 2 fathers) subsequently de-selected themselves from the recruitment process once they had been given the participant information sheet and consent form. Reported reasons for the de-selection were: no longer interested (n=3), did not fully understand the participant information sheet (n=1), did not want to sign the consent form (n=1), and did not want to be audio-recorded (n=2).

Interviews lasted between 20 and 40 minutes and were transcribed verbatim by the researcher. Parents' demographic data is presented in Table 25 below.

Table 25: Demographic characteristics of interviewed participants

Parent ID**	Gender	Age	Ethnicity	Place of birth	Education level	Work	Number of Children	Age of children	Deprivation decile*
P13 (T)	Female	33	White	Lithuania	High School	Stay-at-home-mum	2	Eldest – 8 years old Youngest – 6 months old	1st
P14 (T)	Female	33	Asian	Hong Kong, China	Undergraduate degree	Stay-at-home-mum	1	1.5 years old	1st
P15 (F2F)	Female	35	Asian	India	Undergraduate degree	Retail worker	1	3 years old	1st
P16 (F2F)	Female	31	Arab	Saudi Arabia	Undergraduate degree	Stay-at-home-mum	1	1.5 years old	1st
P17 (T)	Female	22	British Asian	UK	High School	Stay-at-home-mum	1	2 years old	1st
P18 (F2F)	Female	31	African	Nigeria	Master's degree	Healthcare assistant	1	7 months old	1st

*Indices of Deprivation 2019 for Lower-layer Super Output Areas (LSOAs) assigned to a decile ranking from 1 (most deprived 10%) to 10 (least deprived 10%) (MCC, 2019)

**Including whether the interviews were conducting via telephone (T) or face-to-face (f2f)

Although all parents were recruited in person, the interviews were conducted either face-to-face (n=3) or via telephone (n=3). All parents were female and aged between 20-39 years old, of mixed ethnicities. Almost all participants were born outside the UK, and most had only one child. Educational levels varied between parents, with the majority being educated to undergraduate level, followed by those having high school diplomas, and one educated to postgraduate level. All the participants were recruited from deprived areas in Manchester, specifically Gorton and Ardwick, which are ranked in the 1st decile (most deprived 10%), using the Indices of Deprivation for Lower-layer Super Output Areas in England (Department for Levelling Up, Housing and Communities, 2023). It is important to note that despite being recruited in deprived areas, these parents were not typical of a deprived population, i.e., most of them were educated at a university level.

As discussed previously (see section 3.2.2.3), framework analysis was used for the systematic analysis of the interview data. This type of analysis enabled a clear and rigorous investigation within a limited time frame (Smith & Firth, 2011; Gale, Heath, Cameron, Rashid & Redwood, 2013; Parkinson et al., 2016).

4.4.1 Main themes

Six main descriptive themes emerged from the data and formed part of the framework analysis matrix (see Table 26 below). These descriptive themes were similar to those obtained with the first set of transcribed interviews (see Figure 27 in section 4.2), and include:

- Parents' experience using antibiotics for their child/children
- Parents' experience during medical consultations
- Parents' knowledge, understanding, attitudes, and concerns about ABR for themselves and their child
- Awareness of ABR and antibiotic use
- Resources on ABR that parents would benefit from
- Changes in views and perceptions since COVID-19

Table 26: The development of themes, subthemes, and conceptual themes

Main themes	Descriptive sub-themes	Conceptual themes
Experience using antibiotics for their child	Past use of antibiotics for their child	Being a responsible parent
	Self-reported practices	
	Antibiotic seeking behaviour	Trusting diagnosis and subsequent decision to prescribe antibiotics
	Seeking reassurance	
Experience during medical consultations	Satisfaction with information provided during medical consultation	Communication challenges
	Opportunity to ask questions	
	Understanding prescription advice	

Knowledge, understanding, attitudes, and concerns about ABR	Parents' knowledge and understanding about ABR	Lack of knowledge of ABR
	Parents' awareness of ABR and its consequences	
	Seeking knowledge from other sources	
	Attitudes and concerns towards ABR	
	Language used when ABR information is provided	
Awareness on ABR and antibiotic use	Need for awareness on ABR and antibiotic use	Language barrier
	Last seen resource on ABR awareness	
	Misinformation on ABR	
Resources on ABR that parents would benefit from	Specific topics of interest on ABR and/or antibiotic use	Disinterest in ABR information and awareness
	Types of media and sources of information on ABR and antibiotic use	
	Trustworthy sources of information	
	Beneficial resources for parents	
Changes in views and perceptions since COVID-19	Changes in views and perceptions about public health information since COVID-19	Attitudes and understanding of public health information
	Changes in views and perceptions about health promotion messages since COVID-19	
	Changes in views and perceptions about health services since COVID-19	Frustration with healthcare strikes

The first theme of the framework analysis matrix is '**experience using antibiotics for their child/children**'. Data included recurrent descriptive subthemes about parents' past use of antibiotics for their child/children, specifics of the infections that were treated with antibiotics, and their positive or negative experiences of using antibiotics. Parents also discussed the symptoms that would prompt them to consult a healthcare professional for medical advice. The final recurrent subtheme involved parents' self-reported antibiotic practices for themselves and their child. Two conceptual themes emerged from this category of themes and subthemes, these were '*being a responsible parent*', and '*trusting diagnosis and subsequent decision to prescribe antibiotics'*.

Theme 2 is '**experience during medical consultations'** and comprised of subthemes about parent's experiences during consultations with healthcare professionals. Parents discussed their experiences communicating with healthcare professionals in a GP setting, levels of satisfaction with the information provided to them during consultations, whether they were given the opportunity to ask questions, and their understanding of their prescription advice. Parents also shared the challenges they encountered during medical consultations, particularly '*communication challenges*', which was a conceptual theme that emerged from these discussions.

The third theme in the matrix is '**knowledge, understanding, attitudes, and concerns about antibiotic resistance**'. Parents were asked what they knew about ABR, and those who had heard about it attempted to give a definition for the term 'antibiotic resistance', as well as discuss ABR consequences. Discussions around parents' attitudes and concerns about ABR focused on whether they felt it could affect themselves or their child. This led to the development of the conceptual theme '*lack of knowledge about ABR*'. Parents also discussed whether information on ABR was provided to them by a healthcare professional.

Theme 4, '**awareness of antibiotic resistance and antibiotic use**', involved discussions about whether there was a need for more awareness on ABR and the proper usage of antibiotics. Parents mostly discussed their thoughts on the lack of awareness of the proper use of antibiotics and their thoughts on misinformation regarding ABR and how resistance occurs. Most parents discussed how a language barrier would negatively impact awareness of correct antibiotic usage and ABR, how it could inhibit the parents' understanding of basic information on antibiotics, and how this barrier must be addressed first before raising awareness on ABR. A few parents mentioned the need for translators to be present during medical consultations, or having healthcare professionals learn the various languages spoken by the ethnic minority patients. The conceptual theme of '*language barrier*' emerged from this part of the discussion.

The fifth theme explored in the matrix is '**resources on antibiotic resistance parents would benefit from**' and comprised of parents sharing their views on which topics on ABR and/or antibiotic use they felt they wanted more information on. Parents shared insights into the types of resources they would be interested in and where they would like these to come from.

They also mentioned the various types of media they would be interested in seeing, and those they perceived to be less efficient, according to their lifestyles and interests. The conceptual theme that emerged from this category was '*disinterest in ABR information and awareness*'.

The last main theme is '**changes in views and perceptions since COVID-19**' and emerged from discussions with parents regarding their thoughts on public health information, public health messages, and experience with healthcare services since COVID-19. Discussions also revolved around parents' attitudes and concerns towards public health information and health promotion messages, and whether they had lost trust in governmental agencies and organisations in charge since COVID-19. Parents recalled their experiences with accessibility to healthcare services in the aftermath of the pandemic. In this category, two conceptual themes emerged, namely '*attitudes and understanding of public health information*' and *'frustration with healthcare strikes'*.

Findings from the eight conceptual themes that evolved from the development of the framework analysis matrix are reported below, under the six main themes from which they derived (see Table 26).

4.4.2 Experience using antibiotics for their child/children

Parents were asked about their children's past use of antibiotics, as well as symptoms that would lead them to seeking medical advice or antibiotics for their child. They were also asked about antibiotic-seeking behaviour, and how they used antibiotics for themselves and/or their child. Although most mothers had been prescribed antibiotics and had uses them for their child(ren), a couple reported never needing to administer them at the time that the interviews were conducted.

4.4.2.1 'Being a responsible parent'

The conceptual theme of '*being a responsible parent*' emerged from all interviews, especially during discussions with mothers regarding situations where they would seek medical advice for their child, and the types of symptoms that would lead them to do so. This theme also emerged from participants talking about their self-reported practices regarding antibiotic use for themselves or their child. All mothers mentioned seeking a medical consultation for symptoms such as persistent respiratory issues, difficulty breathing, persistent coughing, as well as pain in ears or throat.

> "*…she's breathing like heavy breath, or when she's coughing and can't cough properly, or she's having pain in her ears or in her throat…*" (P13; 33yrs; White; Lithuanian; high school diploma; stay-at-home mum; 2 children).

All mothers with a child younger than 2 discussed being worried about persistent fevers, which they felt would warrant seeking medical attention. Participant 14 mentioned that a fever was the most important symptom that would require medical attention, while for other symptoms, such as a runny nose, they would just wait for the symptom to disappear on its own:

> "*Like fever and when she got high temperature, and then like…yeah these will be more important. Because when she sometimes got runny nose, we just keep an eye on her for a few days and then if it gets better, we won't go to the doctor.*" (P14; 33yrs; Asian; Chinese; undergraduate degree; stay-at-home mum; 1 child).

There was fear about the dangers and consequences of persistent fever on a child's neurological and auditory development, particularly when they were new-borns or very young. Participant 16 feared this would cause long-term sequelae, and as a result, they would seek medical attention for a fever straight away:

> "*…in the first months, it's so dangerous if the temperature does not become lower. Because it affect for the mentality, affect for the ear…and I study that before, that's why I'm worried and I take care immediately…*" (P16; 31yrs; Arab; Saudi Arabian; Undergraduate degree; stay-at-home mum; 1 child).

Mothers (for example P17 and P15) with children older than 2 sought medical attention when their child's behaviour was different from usual, for example if they were not eating, drinking, or urinating normally:

> "*It's when he's not within himself, if he's not eating or drinking, that's when I know he's bad.*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

> "*If the child is not eating, that will be one. And secondly if he's not urinating properly, not drinking water. And if he is not the normal behaviour as he would be, and a high temperature.*" (P15; 35yrs; Asian; Indian; Undergraduate degree; retail worker; 1 child).

Regarding self-reported practices when using antibiotics for themselves or their child, half of the mothers (P13, P14, P15) self-reported practices that complied with prescription guidance on antibiotic therapy. They presented themselves as responsible parents, stating that they followed their GP's advice and instructions and completed the full course of antibiotics when prescribed:

> "*I'm taking how it's written in the prescription, like two three times in the day or two times in a day, depends how they are writing. I'm following instructions... […] like they're saying I need to use for five days, I'm using for five days, if they're saying only to use for four days, I'm using for four days.*" (P13; 33yrs; White; Lithuanian; high school diploma; stay-at-home mum; 2 children).

However, parents P16, P17, and P18 (who was educated to postgraduate level) all described not finishing the full course of antibiotics prescribed to them. Their reasons were different, with one mother being worried about the potential side effects of the medication for their child, and two feeling that the medication was prescribed for longer than necessary:

> "*I just give her 2 or 3 days, that's enough for me. […] I'm worried about this medicine, it helps ok...but I'm not sure if there will be other side effects.*" (P16; 31yrs; Arab; Saudi Arabian; Undergraduate degree; stay-at-home mum; 1 child).

> "*The duration could be for seven days and then you stop after that […] or as soon as you get well. […] That's my discretion, but they tell you to take it for a longer number of days.*" (P18; 31yrs; African; Nigerian; master's degree; healthcare assistant; 1 child).

Participant P17, who was particularly vocal about not wanting to take any medication and did not take the antibiotics prescribed to them, perceived that antibiotics should only be administered to their child until they felt better, and that using them for longer was pointless to their recovery. They explained that they did not take any medication and therefore also believed that their son did not need antibiotics when they were prescribed. They questioned themselves as to why they sought medical attention when their child is poorly, as they usually got better, by the time they are prescribed antibiotics. This could imply that the mother sought a prescription as a precaution.

> "*Personally, when I get prescribed [antibiotics] I do not take them. Like, I don't take no medication […] when he starts getting better there's no point of having it, and by day three my son's alright. Like my son doesn't need the medication. Sometimes I don't even know why I go doctor's because by the time I get the medication, he's all healed.*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

It is important to note that this parent expressed strong feelings against the use of medication, stating multiple times that they did not trust it. This distrust extended to medication prescribed for their child, which could explain why they did not administer the full course of antibiotics to their son:

> "*I don't trust medication, I really don't. Even for my son I don't trust it. I actually do not trust no medication!*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

When asked what they would do with the unused antibiotics, there were different views, with one parent (P16) discussing the potential of re-using the leftover medication at another time, while another (P17) threw it away, as she believed it could not be used after a week. P16, from Saudi Arabia stated that they would keep the leftovers away from the light, based on advice offered to them from an acquaintance. It is interesting that while neither of these mothers followed medical guidance regarding administering the drugs, P16 seemed happy to take advice from friends and acquaintances, while P17 appeared to be happy following guidance on how long antibiotics could be kept for:

> "*I'm actually following the date for this medicine, when it's finished I will throw it. […] And I hear about…someone told me don't keep it under the light, I'm not sure about it, but always I put it in the…not in the light room.*" (P16; 31yrs; Arab; Saudi Arabian; Undergraduate degree; stay-at-home mum; 1 child).

"*It just gets disposed. You're not allowed to use antibiotic after a week.*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

Looking at demographic factors that could have influenced the mothers who did not finish an antibiotic course, all three mothers had various levels of education, had children younger than 3 years old, and were of different ethnicities. Two were from countries (Saudi Arabia and Nigeria) where people's practice with antibiotics may not comply with UK antibiotic guidance, which could explain their antibiotic practices.

4.4.2.2 'Trusting diagnosis and subsequent decision to prescribe antibiotics'

Most parents who had administered antibiotics to their child in the past, did not recall any negative experiences during or after the treatment, and therefore were satisfied with how it had gone. For example, P15 administered antibiotics to their child for a week for a throat infection, which they found effective for their child's recovery:

"*Yes I have done, […] when he had a throat infection, it was for a period of a week but it was quite effective and then I literally stopped it after that.*" (P15; 35yrs; Asian; Indian; Undergraduate degree; retail worker; 1 child).

Many mothers reported trusting their doctor (more than family or acquaintances) and being satisfied with their child's diagnosis and treatment (e.g., P13), as they felt their doctor had enough experience examining and treating children, was more knowledgeable about infections, and therefore a trustworthy source of information on antibiotics:

"*Of course, I trust medical professionals because they know better about them [antibiotics]. I am not trusting about family or some other people who is telling, because they can't tell proper about them [antibiotics], how doctors can tell you. Because they [doctors] are all the time giving to children, working with them, and they know better than us.*" (P13; 33yrs; White; Lithuanian; high school diploma; stay-at-home mum; 2 children).

For mothers who trusted their doctors, e.g., P15, they would be their primary point of contact when guidance or antibiotic treatment was required, implying that an established doctor-patient relationship encouraged trust:

> “*I would trust the doctor I would say because the doctor […] has done more research on it and he would be my frequent person that I would be meeting most of the time, so I could have more faith in the doctor, thinking that he would give me the right information that I already require.*” (P15; 35yrs; Asian; Indian; Undergraduate degree; retail worker; 1 child).

Only one mother recalled having a negative experience when their child had been misdiagnosed with a non-existent chest infection and prescribed the wrong antibiotics. P17 was vocal about their frustration with healthcare professionals, particularly as the antibiotics were prescribed without the doctor actually examining their child. This mother sought a second opinion from a secondary care doctor, implying that more trust may be given to doctors during face-to-face compared to telephone consultations:

> “*The GP actually diagnosed him saying there was a chest infection when it was actually related to his stomach. […] The same day I took myself to the hospital with my son to find out that he had two infections in his stomach. […] …it’s just that receptionists think that they’re doctors. […] And the doctors believe what the nurses are saying and prescribe medication like without even seeing the child…*” (P17; 22-year-old; High school diploma; British; 1 child).

Other mothers also questioned GP prescribing decisions, either due to the belief that doctors overprescribed antibiotics (e.g., P14), or the perception that healthcare professionals were inattentive towards parents. This led to some parents to question their GP’s diagnosis, as well as feeling uninformed during medical consultations, e.g., P16 who felt more informed after getting a second opinion from other doctors:

> “*I don’t know if it is a difference of culture because when we are in Hong Kong we’re not very happy to use the antibiotics* […] *here in the UK the doctor will always prescribe the antibiotics […] so we just think it’s very simple and very easy to give the antibiotics.*” (P14; 33yrs; Asian; Chinese; undergraduate degree; stay-at-home mum; 1 child).

> “*Sometimes I don’t just take it from just one side. I search the doctor here and I search a doctor in my country. I mean I search for many doctors to see if all of them say the*

same things." (P16; 31yrs; Arab; Saudi Arabian; Undergraduate degree; stay-at-home mum; 1 child).

There were no demographic similarities between the mothers who expressed degrees of mistrust in their doctor, or questioned their diagnosis and decision to prescribe antibiotics, other than having a child that was older than 1 year old and being stay-at-home-mums. All these mothers were aged between 20 and 35 years old, had one child, were of different ethnicities, and from the same level of deprivation.

4.4.3 Experience during medical consultations

The second part of the interview involved questioning participants about their experiences during medical consultations, where parents shared their thoughts about the information offered to them by their GP, whether they felt fully informed at the end of a GP consultation, if they had the opportunity to ask questions, and whether they understood their prescription advice.

4.4.3.1 'Communication challenges'

Although some parents were generally happy with the information provided to them during medical consultations, communication challenges were noted in most parents' recollections of unsatisfactory medical consultations. These parents discussed feeling rushed, dismissed, or uninformed by the end of the consultation.

The main reasons for most parents dissatisfaction with medical consultations were time constraints and feeling rushed, irrespective of demographic characteristics. Although parents understood the reasons for time constraints during medical consultations, i.e. due to the volume of patients (e.g., P16), they still felt rushed and uninformed at times, which they felt needed improvement. Some parents expressed their dissatisfaction with the information offered by some doctors (P16 & P17), as they often lacked clarity regarding diagnosis and prognosis of their child's illness. This added to parents feeling uninformed and dismissed without much reassurance from their GP after medical consultations. Many also felt that healthcare professionals could improve patients' experience during consultations, by being more attentive to their needs and worries:

"*Some of them [doctors] is like not give you enough information if you ask is it my child will be ok, they say we don't know… sometimes there is a small details you know, you need to know it. They didn't give it to me. […] I understand that sometimes there is many patients wait a long time.*" (P16; 31yrs; Arab; Saudi Arabian; Undergraduate degree; stay-at-home mum; 1 child).

"*I feel rushed […] And they [their GP] won't tell me what's going on, and […] I'm telling them this is happening that's happening, but they don't take into consideration what I'm saying because they've done that tiny bit of checkup, they'll be like, oh he's alright, he's fine!*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

Feeling uninformed, dismissed, or dissatisfied with the general information provided to them during medical consultations, did not help alleviate parental worries, which could explain why further information on diagnosis and treatment from other sources was sometimes sought.

Irrespective of demographic characteristics, more than half of the parents looked for further information online after a medical consultation, regardless of whether they trusted their GP to provide accurate and trustworthy information (e.g., P13 & P15) or questioned the information provided to them by their GP (e.g., P16 & P17). This was particularly noted among those who mentioned not fully understanding the information provided by the GP regarding diagnosis and the antibiotics prescribed to them or their child. Parents also resorted to online information to confirm their child's symptoms and to search for recommended treatment for their child's ailment. This online information was perceived as validation of the diagnosis and treatment information provided by their GP, which helped alleviate parental worries regarding their child's treatment and prognosis:

"*Actually, you know when doctors are giving information to me and […] I'm not understanding, and I don't know which one is antibiotics, I am going to Google about this antibiotics...*" (P13; 33yrs; White; Lithuanian; high school diploma; stay-at-home mum; 2 children)

"*…we would go online and check what are the symptoms and what are the remedies. And you know they may repeat what the doctor says and what is online, so most of the time it has been that and it has calmed us down and he has responded as well.*" (P15; 35yrs; Asian; Indian; Undergraduate degree; retail worker; 1 child).

Although uninformed mothers sought further information online to better understand their child's diagnosis and treatment, or to confirm the information provided by the GP, which alleviated their worries, it is important to note that having no other alternative but to seek further information online, could further deepen the mistrust in GP diagnosis and treatment options. This may also expose parents, who are already in a worried state of mind, to misinformation regarding their child's illness, as seen with P16 who stopped antibiotic therapy after a couple of doses and saved antibiotics based on information obtained from non-medical sources.

4.4.4 Knowledge, understanding, attitudes, and concerns about ABR

The third part of the interview involved asking parents about their knowledge and awareness on ABR. Parents were asked to explain what they understood by the term 'antibiotic resistance' and encouraged to share their thoughts and concerns about ABR, particularly regarding its potential consequences.

4.4.4.1 'Lack of knowledge on ABR'

Overall, parents' knowledge on ABR was lacking. Only parent (P14) satisfactorily articulated how ABR occurred and was concerned that it could affect themselves or their child in the future. They described parents in Hong Kong as being very aware of ABR and its consequences, and subsequently careful when using antibiotics, with some even refusing antibiotics prescribed by the doctors, which could indicate a high level of social responsibility and ABR awareness among parents in Hong Kong, including P14:

> "*When we use antibiotics for many times, even though we use it properly, but after many times and then the antibiotics will not work […] when we live in Hong Kong, so many people or parents know this will happen. So […] we are careful when we use antibiotics, or sometimes we refuse to use antibiotics from the doctor.*" (P14; 33yrs; Asian; Chinese; undergraduate degree; stay-at-home mum; 1 child).

Most parents, irrespective of levels of education, age, and employment status, had never heard of ABR or were confused about how it occurred, believing it resulted when the body got used to antibiotics, or reacted negatively to certain dosages of antibiotics (e.g., P18):

> "When you're reacting to whatever dosage of antibiotics you are using…if you're reacting in the wrong way." (P18; 31yrs; African; Nigerian; master's degree; healthcare assistant; 1 child).

There was a certain amount of misunderstanding regarding whether ABR involved viruses or bacteria, even though some parents understood that ABR involved the microbiota or aspects of the microbiota (e.g., P16), which could indicate that the term antibiotic resistance may be too complex, or could simply be lost in translation for those who are not fluent in English. This could also imply that the scientific language/medical jargon used when ABR is discussed, particularly regarding the challenging concepts linked to ABR, could be a barrier to fully understanding how ABR occurred and what the medical consequences could be:

> "*Is it virus? […] Bacteria to attack the body? I think like I know there is bacteria in my body. But sometimes it becomes out of my body and attacked me and the bacteria inside me like try to protect me.*" (P16; 31yrs; Arab; Saudi Arabian; Undergraduate degree; stay-at-home mum; 1 child).

Mothers who lacked ABR knowledge, reported not being worried about it, or its consequences. Even though an explanation was offered to those who were confused or simply unaware of ABR, many could not relate to the issue, nor understand it could affect them in the future. This finding was irrespective of the education level, employment, age etc. of the respondents; thereby reinforcing the need for more ABR awareness with simpler and more relatable information, to encourage parents to engage more public health information and health promotion messages relating to it.

Other than P14, who had mentioned that ABR was a concern for parents in Hong Kong, only P17 stated that ABR could affect anybody in the future. However, considering that this mother was misinformed about ABR and its origins, and was vocal about their mistrust in medications, this response may have resulted from their misguided belief that antibiotics are dangerous medications that have been made to kill people and would eventually kill those who used them. There was also a strong perception from P17 that healthcare professionals were untruthful about the dangers of antibiotics, and that their use prevented the immune system from fighting off infections. They implied that using antibiotics made people too reliant on these medications for recovery from infections; thus, reiterating misconceptions about ABR and how they worked, and reinforcing the need for more and better awareness on ABR and antibiotics.

> "*It's going to affect everyone one day. […] antibiotics are made to kill people, like antibiotics slowly kill the body […] like all the drugs that we take, all the drugs as in pills, what's it called medication like antibiotics, they slowly kill you […] and the doctors will say that is safe for your body, it's safe for your body… but we're not dumb, we're not born in a dumb world! We know what medications do to you! […] Antibiotics taken over the years, you're destroying your whole system. You're destroying your immune system! Where your white blood cells ain't gonna be wanting to fight back f*****g diseases and that!*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

4.4.5 Awareness on ABR and antibiotic use

In the fourth part of the interview, parents were asked whether there was a need for more awareness on ABR and antibiotic use, and what they felt needed improving.

4.4.5.1 'Language barrier'

Many participants, especially those who acknowledged their lack of knowledge on the issue, agreed that there was a need for more awareness on ABR, particularly regarding responsible antibiotic use. However, almost all mothers pointed out that the language used when discussing antibiotics was "difficult" (P16; Undergraduate degree; Saudi Arabian; 1 child; Stay-at-home mum) to understand. Some expressed the need for more accessible information and awareness on ABR and antibiotics, as generally it was too scientific regarding microbiological concepts:

> "*You have to make it as a knowledge for all of the people. […] I think the main point is it should be easy for parents to know… […] easy to understand. You can use simple words so you can deliver the message, the whole concept. […] Yeah, maybe they are using the professional words, professional phrases.*" (P14; 33yrs; Asian; Chinese; undergraduate degree; stay-at-home mum; 1 child).

Some felt that the language barrier that inhibits many parents from understanding and engaging with information on ABR, should be addressed first and foremost, particularly for those without a good grasp of the English language (e.g., P13 & P17). They expressed the need for these patients, to be offered a simpler explanation without the use of medical jargon or overly complicated words, so that they were not disadvantaged when using health services. Emphasis was made on the need for a translator (where relevant) to be present during medical consultations to ensure satisfactory communication between doctor and patient (e.g., P13). Parents felt that healthcare professionals needed to be more considerate of those with communication challenges. For example, P17 suggested that doctors should learn the languages used by their patients, such as Bengali, Urdu, and Jamaican patois, to facilitate better doctor/patient interaction.

> "*…if some people are not understanding they should be better explaining for these people, like if they cannot speak in English properly and they can't understand […] I give you an example, yesterday in the play room [there] was one woman and she was not speaking English and she was not understanding everything. If she went to doctor, I'm thinking then they should be translating in their language when they're explaining…*" (P13; 33yrs; White; Lithuanian; high school diploma; stay-at-home mum; 2 children).

> "*Yeah, I feel like there are people who are you know, illiterate or like having that language barrier […] for example, like my mother, she's got a language barrier […] they [doctors] expect you to understand it [medical prescription] […] Like you're not even explaining it right! Explain it right first […] Learn some Bengali, learn some Pakistani, learn f*****g Jamaican patois, learn African languages, learn all of that.*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum).

All of the mothers who mentioned language barriers during consultations were stay-at-home mums, from the same deprivation levels, of different ethnicities and levels of education, and from various countries, including the UK.

4.4.6 Resources on ABR that parents would benefit from

Parents were asked about the specific topics that they wanted to hear more about and that would be useful to other parents like themselves. They shared their thoughts on whether they were interested in further information, and the type of media they felt they would engage with more.

4.4.6.1 'Disinterest in ABR information and awareness'

There were mixed views among parents when it came to specific topics on ABR and antibiotic use that they wanted to know more about. Only half of the mothers felt there was a need for more information and awareness on antibiotics and ABR, particularly if the latter was going to become a more serious problem in the future (e.g., P18). As some of these parents had not heard of ABR or were not fully aware of the issue, they believed that it was very likely that other parents were also unaware of ABR and its consequences, thereby emphasising the need for more awareness (e.g., P15):

> "*Yeah, if it's going to be a problem, I think there should be more awareness.*" (P18; 31yrs; African; Nigerian; master's degree; healthcare assistant; 1 child

> "*Yes I think, because if I am not aware of it, then there are people who are also not aware of it…*" (P15; 35yrs; Asian; Indian; Undergraduate degree; retail worker; 1 child).

All parents who agreed on the need for more awareness on ABR and antibiotic use were educated at university level, either at undergraduate (e.g., P14 & P15) or postgraduate level (e.g., P18). All mothers who showed a disinterest in the topic, or did not feel that there was a need for more awareness were stay-at-home mothers, mostly educated to high-school level, were aged between 20 and 35, with children aged between 6 months and 2 years, and from different countries (Lithuania, Saudi Arabia, and the UK). The difference between views, according to level of education, could indicate an inability/unwillingness to engage with the topic for those of lower education levels, except if they needed to use them, for example, P13:

> "*When I need to use then yes, if I'm not using and I don't need, then I'm not going to find out about antibiotics anything, like not looking around, like not reading anything. When I need then I'm reading and checking out.*" (P13; 33yrs; White; Lithuanian; high school diploma; stay-at-home mum; 2 children).

It would appear that mistrust in healthcare professionals and misconceptions on antibiotics, could translate into disinterest and disengagement with ABR awareness, as seen with P17, who was defensive about their choice of not wanting to use antibiotics for them or their child. It is noteworthy that P17 was the parent who had reported being prescribed the wrong antibiotics for their child in the past and having to go to hospital for a new prescription (section

4.3.2.2). This could indicate cognitive dissonance about the dangers and benefits of antibiotics, i.e., being vocal that antibiotics were used to control and slowly kill people (section 4.3.4.1), whilst also seeking a different antibiotic prescription when they felt their child had been misdiagnosed:

> "*I don't really think about antibiotics like that way* [needing more awareness] *anyway. So, I wouldn't really like get myself involved anyway. Like it is what it is, like at the end of the day it's my choice. Like, no one can force me unless my child's in danger. No one can force me to […] because it's my child. I know my child the best!*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

Interestingly, some of the mothers showing disinterest in ABR and ABR awareness were also those who questioned their GPs' diagnosis, for example P16 who had previously mentioned seeking a second opinion when getting information form their doctor; and P17 whose mistrust in doctors was evident in their recollections of past GP consultations. Both mothers also had self-reported practices that did not comply with antibiotic guidance, and also misunderstood how ABR worked. Although their disinterest in awareness and information on antibiotics and ABR could be reflected in their misconceptions on ABR and the how they used antibiotics, it is important to note that P16 did mention seeking further information from various sources including other doctors (from the UK and Saudi Arabia). This could reiterate that some parents would engage with information and awareness on ABR and antibiotic use only when this issue directly affected them, for example if their child had been currently using antibiotics. This was also noted with participant 13 who mentioned being interested in information on antibiotics only when they or their child were using antibiotics. Therefore, making information relatable to parents is an important aspect that needs to be considered when improving awareness on ABR and the responsible use of antibiotics.

4.4.7 Changes in views and perceptions since COVID-19

In the last part of the interviews, parents discussed whether their views and perceptions on public health information, health promotion messages, and health services, had changed since COVID-19.

4.4.7.1 Attitudes and understanding of public health information since COVID-19

There were mixed opinions among parents regarding whether their views of public health information and health promotion had changed since COVID-19. Although a couple of mothers mentioned still trusting public health information, most complained that it lacked accuracy at times, indicating a lack of trust in information disseminated. This material was often thought as being overwhelming, and inaccessible to all, with parents asserting that it should be more interesting and relatable (e.g., P15).

> "*There's too much information and it's tiring as well, like I don't know how to relate to it but I feel they have to be more concerned about the public which is more important than anything else and the right information has to be put out….*" (P15; 35yrs; Asian; Indian; Undergraduate degree; retail worker; 1 child).

Some parents did not trust the accuracy of the information provided by the government and/or public health agencies (for example P18), asserting that it was manipulated to a certain extent to fit a specific agenda. For example, the governmental push for COVID-19 vaccines was questioned by P17, who believed that the government and world health advisors were hypocritical in promoting products they were not using themselves:

> "*…I feel the information is not as accurate as it ought to be. So, I feel they've [the government] been doctoring most of the information out there…*" (P18; 31yrs; African; Nigerian; master's degree; healthcare assistant; 1 child).

> "*I don't even trust them! […] Half the time they're not even using it, the people, the government and the world health advisors, the stuff that they're providing for us people, they're not even using it! […] the thing is people ain't stupid…*" (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child)

There was consensus among parents, irrespective of demographic factors, that access to healthcare services had worsened since the pandemic and that accessibility to doctors should be improved. Parents specifically complained about the difficulties in getting GP appointments (e.g., P18) and the challenges when seeking medical attention in A&E (e.g., P13):

"…if need to go hospital nothing changed, its long time to wait, like 3-4 hours sometimes 5 hours." (P13; 33yrs; White; Lithuanian; high school diploma; stay-at-home mum; 2 children).

"First even getting an appointment is hard […] I just think it could be improved generally. […] Listen to patients more. It shouldn't be this difficult to see the GP! I think they should make these things much more easier, much more accessible, and then learn to listen to people more…" (P18; 31yrs; African; Nigerian; master's degree; healthcare assistant; 1 child).

There was consensus that GP accessibility needed to be greatly improved, and a sense of disbelief among parents at how difficult it was to get GP appointments (e.g., P18) or how long it took to get medical attention in A&E (e.g., P13) post-pandemic. Most participants expressed an urgent need for the UK healthcare system to be improved, particularly with regards to doctor-patient communication, as they felt that doctors needed to be more attentive to their patients' needs.

4.4.7.2 Frustration with healthcare strikes

A couple of parents discussed their frustrations regarding the post-pandemic strikes, particularly those involving healthcare professionals. They argued that healthcare professionals should be more considerate of the impact this has on patients. They found it difficult to relate to healthcare professionals who complained about the strain on the NHS, particularly as these parents felt the strikes were adding to the strain (e.g., P15). There was a perception that saving lives was more important than striking for better working conditions and/or pay (e.g., P15 & P17). Although both parents believed that healthcare workers should prioritise the health wellbeing of their patients first, they expressed different reasons for being frustrated about the strikes; P15 worried about who they could turn to for a medical emergency, believing that there was a need for a backup workforce to ensure that patients still received care. P17 on the hand was frustrated that healthcare providers were demanding a pay rise, despite not doing their job satisfactorily enough to require higher wages:

"…I mean I know they must be concerned about the pay rise or whatever they may be their concerns […] it's very difficult, where should I run if I have an emergency, who can I trust? I'm already in a panic situation and on the contrary you're all saying you're on

strike or something will happen to the system. There has to be a backup, you know what I mean. It's very important because it is a life you have to save which is more important that everything else." (P15; 35yrs; Asian; Indian; Undergraduate degree; retail worker; 1 child).

*"…they're crying out here, saying that we don't get enough money and s**t Like that! […] You might be getting s****y wages, but you're still getting wages. […] they wanna complain about they're not getting paid more, do your job first and then complain!"* (P17; 22yrs; British Asian; British; High school diploma; stay-at-home mum; 1 child).

Other than being Asian, both having only 1 child, and having the oldest children in the sample (3 years old and 2 years old), the mothers who expressed frustration about the strikes had different demographic characteristics, i.e., they both had different levels of education (1 educated to a high school level and the other educated to a university level), were of different ages, employment status, and place of birth (one being British and the other being Indian).

4.4.8 Summary of findings from the Sure Start Centre interviews

- All mothers presented themselves as responsible parents; seeking a GP consultation only if their child had an illness that could not be treated at home, and only wanting reassurance and advice for their children during medical consultations rather than antibiotics.

- While all mothers presented themselves and their families as responsible antibiotic users, half had self-reported practices that did not comply with medical advice (e.g., not finishing the full course of antibiotic treatment). These mothers had various levels of education, of different ethnicities, and from different countries.

- Many trusted their doctor and were satisfied with diagnosis and decision to prescribe antibiotics. However, mothers who did question GP prescribing decisions and displayed degrees of mistrust in their doctor, either believed that doctors overprescribed antibiotics, or that healthcare providers were inattentive towards parents and did not provide enough information and reassurance regarding their child's diagnosis and treatment.

- Many mothers experienced communication challenges during medical consultations and complained about time constraints during consultations. Consequently, they reported feeling uninformed or dismissed when leaving consultations.

- Information given to participants during medical consultations, often lacked clarity and was insufficient. As a result, more than half of the mothers resorted to seeking information online, which served as validation of the information given to them during their consultation.

- Almost all parents lacked knowledge and understanding about ABR, having either never heard of ABR, or being confused and misinformed about how antibiotics worked and how ABR occurred. This could potentially indicate that language used when antibiotics are discussed may be too scientific and complex, and that awareness and information on ABR and antibiotics may not be accessible to all; all parents complained about the complex language used (including the only UK-born participant in this sample).

- Mothers who lacked ABR knowledge, also lacked engagement with the ABR issue, reporting not being concerned or aware of its consequences.

- Language barriers during GP consultations was reported by many mothers who expressed the need for more accessible information on ABR and antibiotics, with clearer language being used. Some mothers discussed the need for a translator for satisfactory communication with healthcare providers.

- A disinterest in ABR awareness was observed in half of the mothers, who did not feel that there was a need for more and better ABR information. These mothers were mostly educated to high-school level, were stay at home mothers, and were from various countries. Most of these mothers also displayed degrees of mistrust in their GPs.

- Many mothers complained of a lack of accuracy in public health information and displayed mistrust in how the information was disseminated, indicating degrees of mistrust in the government and public health agencies.

- There was consensus that access to healthcare services had worsened since the pandemic, particularly regarding getting GP appointments and the waiting times in A&E. All expressed the need for better accessibility to healthcare services.

- Some mothers expressed frustrations about the post-pandemic strikes having occurred in the health sector, believing that the strikes would add further to the strain on the NHS, and that patients would be at a disadvantage if they continued.

The table below (Table 27) compares the main findings from analysis of phases 2 and 4 (qualitative interviews).

Table 27: Comparative analysis of phases 2 and 4

Phase 2 findings (during pandemic) n=12	Phase 4 findings (post pandemic) n=6
• Most were of White ethnicity • Included 2 fathers • Most were UK-born (n=10) • Most were highly educated (university level)	• Mothers were of various ethnicities • No fathers participated • Most were non-UK born (n=5); only 1 UK-born mother • Most were highly educated (university level)
• All parents presented themselves as responsible parents • They chose to consult a GP only if their child had an illness that could not be treated at home • Only sought reassurance and advice for their children during medical consultations rather than antibiotics	• All mothers presented themselves as responsible parents • Wanted a GP consultation only if their child had an illness that could not be treated at home • Only sought reassurance and advice for their children during medical consultations rather than antibiotics.
• All parents presented themselves and their families as responsible antibiotic users; most had self-reported practices that complied with health guidelines, • Some had self-reported practices, regarding antibiotic use, that did not comply (e.g., not finishing the full course of antibiotic treatment). • Generally, parents who had self-reported practices that did not comply to guidance had lower levels of education, suggesting a relationship between education, health literacy, and compliance.	• All mothers presented themselves and their families as responsible antibiotic users • Half had self-reported practices that did not comply with medical advice (e.g., not finishing the full course of antibiotic treatment). • These mothers had various levels of education, of different ethnicities, and from different countries
• Precautionary prescribing was reported by many parents, due to an unconfirmed or unknown diagnosis, and in the absence of diagnostic tests. • Parents felt that in these cases treatment options were not sufficiently explored with them. • This led to mistrust in diagnosis, and was present among many mothers, rather than fathers, who questioned their doctor's diagnosis and precautionary prescribing, and showed mistrust towards healthcare providers • Many mothers questioned and complained about GPs overprescribing	• Precautionary prescribing was not reported or questioned by mothers, nor did they report about a lack of diagnostic testing. • Mothers felt that treatment options were not sufficiently explored with them. • Most mothers did not express mistrust in diagnosis or in their doctors. They trusted their doctor's experience with diagnosis and treatment. • Only a few mothers questioned the overprescribing of antibiotics
• Almost all mothers who questioned GPs' diagnoses had more than 1 child.	• This was not observed in mothers in Phase 4 • None of the mothers refused antibiotics for their child

• Some of these parents recalled refusing precautionary antibiotics, particularly when diagnostic test had not been conducted or when parents felt that their child did not need the prescription. • This intimates that potentially parents with more than one child felt more competent to question a GP's diagnosis and refuse antibiotics for their child, perhaps due to their previous experience with children's illnesses.	
Mistrust in GPs was reported to be determined by a number of factors: • precautionary prescribing, • lack of diagnostic tests, • feeling unheard about child's illness, diagnosis, and treatment • lack of a clear explanation from the GP, regarding diagnosis and treatment choice, • advice and suggestions from external sources, • previous negative experience with giving their child antibiotics, • previous stress and anxiety relating to child's illness, diagnosis, and treatment, • preconception that participants' GP over-prescribed antibiotics.	• Many trusted their doctor and were satisfied with diagnosis and decision to prescribe antibiotics. • Mothers who did question GP prescribing decisions and displayed degrees of mistrust in their doctor, either believed that doctors overprescribed antibiotics, or that healthcare providers were inattentive towards parents and did not provide enough information and reassurance regarding their child's diagnosis and treatment.
• Almost all parents experienced communication challenges during medical consultations. • This was attributed to time pressure experienced during these consultations (reported in almost all interviews). • Consequently, parents reported feeling unheard or uninformed at the end of consultations.	• All mothers experienced communication challenges during medical consultations • This was attributed to time constraints during consultations, but also attributed to healthcare providers not providing enough reassurance. • Consequently, they reported feeling uninformed or dismissed when leaving consultations.
• Information given to participants during medical consultations, was reported to often lack clarity and be insufficient. • There was consensus that information on ABR, the potential consequences of misusing antibiotics, or the possible side-effects of antibiotics, was generally never offered in primary care. • As a result of feeling uninformed, some parents reported resorting to external sources of information (Google, friends, and family).	• Information given to participants during medical consultations, often lacked clarity and was insufficient. • As a result, more than half of the mothers resorted to seeking information online, which served as validation of the information given to them during their consultation.

• Those who reported experiencing communication challenges during consultations, also displayed mistrust in GP diagnosis and prescribing.	
• Almost all parents showed a good knowledge and understanding about ABR. • Many were able to clearly articulate what ABR is. • Misunderstandings were present among some parents, particularly regarding how ABR occurred, and the consequences of inappropriate antibiotic use and ABR • Some found that the language used with ABR was too complex at times	• Almost all parents lacked knowledge and understanding about ABR, having never heard of ABR. • Most were confused and misinformed about how antibiotics worked and how ABR occurred. • This could potentially indicate that language used when antibiotics are discussed may be too scientific and complex, and that awareness and information on ABR and antibiotics may not be accessible to all.
• Educated parents felt the language used about ABR used was easy to understand. • Most of these parents were confident that that their higher education resulted in better ABR understanding, although this confidence was misplaced for some. • Those with lower education were less sure of themselves, and recognised their lack of knowledge and understanding of ABR.	• This was not observed with mothers in Phase 4, as most were educated at university level and had not heard of ABR. • Confidence in their understanding of information on antibiotic use was not observed in these mothers, as all mothers felt that not enough information was given to them and resorted to other sources for further information and reassurance. • All mothers recognised their lack of knowledge and understanding of ABR, and most of these mothers had university degrees.
• Parents showed concern that ABR could affect themselves or their child(ren) in the future, particularly given the heavy reliance on antibiotics to treat many infections. • However, ABR was not a concern for those who had never used antibiotics for their child or considered themselves as being low antibiotics users. • These parents displayed a detachment to the issue, indicating a belief that they were not a part of the ABR problem, although others were. Emotional disengagement was noted among those that did not know the scope of the issue and felt uniformed about ABR and its consequences.	• Only one mother was concerned about ABR as a public health issue (i.e., the only parent who had knowledge about ABR). • Mothers who lacked ABR knowledge, also lacked engagement with the ABR issue, reporting not being concerned or aware of its consequences.
• Parents reported a lack of social responsibility in other parents who misused antibiotics, expected or requested antibiotics during medical consultations, and those who were misinformed about the responsible use of antibiotics.	• None of the mothers reported a lack of social responsibility in other parents for their use of antibiotics. • A disinterest in ABR awareness was observed in half of the mothers, who did not feel that there was a need for more and better ABR information.

• Behavioural inconsistencies were observed among those who described a lack of social responsibility in others but did not reflect on the own social responsibility and non-compliance. • This was particularly seen among those who presented themselves as being responsible antibiotic users and were not emotionally engaged with the issue, and those who had misplaced confidence in their understanding of ABR.	• These mothers were mostly educated to high-school level, were stay at home mothers, and were from various countries. • Most of these mothers also displayed degrees of mistrust in their GPs.
• Regarding resources that parents would benefit from and that could make an impact on ABR awareness, parents wanted a convenient and attention-grabbing resource, that provided better guidance on antibiotic use for young parents and new parents. • Parents suggested using health visitors, schools, and social media to disseminate awareness campaigns on ABR.	• Although some mothers mentioned a need for ABR awareness as they had never heard of it, all mothers wanted better information on antibiotic use and managing infections from their GP.
• When it came to trustworthy sources of information on ABR, parents mentioned they would trust the NHS, PHE, and WHO. • However, many parents did not perceive the government to be a trustworthy source of information	• Many mothers complained of a lack of accuracy in public health information and displayed mistrust in how the information was disseminated, indicating degrees of mistrust in the government and public health agencies.
• Many parents reported positive behaviour changes (e.g., handwashing) and a heightened level of awareness about their health and public health issues since the pandemic. • Although many described losing faith and trust in the government and complained about the over-abundance of public health information during the pandemic, they also described being more receptive to and aware of public health messages. • These parents were more mindful of their contribution to the spread of infection, indicating an increase in social responsibility among these parents.	• This was not reported among mother in this phase. • Mothers only complained about the over-abundance of information they considered inaccurate
• Language barriers were not reported among parents in this phase	• Language barriers during GP consultations was reported by many mothers who expressed the need for more accessible information on ABR and antibiotics, with clearer language being used. Some mothers

	discussed the need for a translator for satisfactory communication with healthcare providers.
• None of the parents complained about access to healthcare services	• There was consensus that access to healthcare services had worsened since the pandemic, particularly regarding getting GP appointments and the waiting times in A&E. All expressed the need for better accessibility to healthcare services.
• None of the parents complained about industrial action, nor the strain on the NHS • None worried about not being able to access healthcare services	• Some mothers expressed frustrations about the post-pandemic strikes having occurred in the health sector, believing that the strikes would add further to the strain on the NHS, and that patients would be at a disadvantage if they continued

Chapter 5: Discussion

This chapter provides a summary of the aim and objectives of the thesis, the main findings from the 4 phases of this study critically discussed with the current literature, and the contributions to knowledge. The strengths and limitation of this study will also be provided, along with recommendations for future research.

5.1 Summary of the aims and objectives of the thesis

This PhD study aimed to obtain an in-depth understanding of the current knowledge, attitudes, and practices of parents living in GM, regarding antibiotic use, prescription advice, and antibiotic resistance, based on a mixed methods explanatory study. This 4-phased mixed-methods study used an explanatory approach to fulfil all the objectives of the study.

The objective of the first phase of the study was to investigate parents' knowledge, understanding and attitudes towards antibiotic use, antibiotic prescription advice and antibiotic resistance, in GM. As discussed in the COVID-19 statement and methodology (Chapter 3) the original plan for this phase of the study was to carry out both paper (in locations of different deprivation levels across the region) and online surveys, however due to government restrictions during the pandemic, an online survey was the only possible way to collect this data. The cross-sectional survey was completed by 120 respondents. Most parents who responded were female (n=114), aged between 20 and 39 years old, of White Ethnicity, born in the UK, and having tertiary education qualifications. Most parents were from Stockport, an area of GM that has better health outcomes, and lower levels of socioeconomic disadvantage, compared to most of the other boroughs in GM (GMCA, 2023) (see Appendix 2, Table 2). Stockport also has better literacy levels than other boroughs in GM with 37.6% of the population in Stockport having a university degree (GMCA, 2023). This shows a skewed representation of the population in GM, which affects how the findings of this study can be interpreted.

Findings from phase 1 were then used to inform the second phase of the study; namely, to explore the findings from phase 1 in more depth, to include the factors that influence parents' perceptions, experiences, and practices, in the context of their young child being prescribed antibiotics. Telephone interviews were conducted with 12 parents (during the pandemic), who discussed themes such as their past experiences of using antibiotics for their child, experiences during medical consultations, and attitudes and concerns about ABR. Questions were developed to gain more insight into the questionnaire findings, whereas others were included to generate data about perceptions, attitudes and expectations, regarding ABR and antibiotics use. Discussions with these parents also involved exploring their awareness of ABR and antibiotic use, resources needed for ABR awareness, and changes in their views and perceptions since COVID-19. Most parents in this phase were mothers, aged between 30-39 years (n=10), born in the UK (n=9), and who had more than one child (n=9). All participants were of White ethnicity. Only 2 fathers took part in the interviews and were aged between 40 and 59 years. Half of the sample were educated to postgraduate level.

Once the data from the second phase was analysed, findings from the first two study phases were used to inform the third phase, which aimed to provide recommendations for future research on interventions to improve antibiotic awareness among parents. This phase involved 3 online creative workshops and used a participatory approach to encourage the participation of parents in the process. It explored what parents wanted to see in future interventions aimed at improving parents' ABR awareness and antibiotic stewardship. The online workshops involved 3 mothers and 1 father. All parents had previously taken part in the other phases of the study. Most were of White ethnicity (n=3).

As samples obtained from phases 2 and 3 consisted predominantly of White mothers with high levels of education, phase 4 was added to collect further data to include the perceptions, experiences, and practices of more socio-culturally diverse parents recruited from a deprived area in GM, regarding antibiotic use for their child. This phase was conducted post-pandemic, and parents were recruited from Sure Start Centres in Manchester. These parents either participated in face-to-face interviews or telephone interviews based on parents' preference.

While the sample (n=6) obtained for phase 4 of this study were all mothers, participants were more ethnically diverse than those who participated in phase 2 (all were of White ethnicity). These mothers were mostly born outside of the UK and were aged between 22 and 35 years old (only one participant was born in the UK in this phase). Despite living in a deprived area participants from phase 4 were also mostly educated to a university level (3 had an undergraduate degree, and 1 had a master's degree), most were stay-at-home mums (n=4), and most had only 1 child (n=5). Similarly, participants in phase 2 (n=12) were mostly aged between 30-39 years old and born in the UK (n=9). They were also mostly educated to a university level (n=8), with 2 participants having an undergraduate and 6 having a master's degree. Compared to the participants in phase 4, most of the participants in phase 2 had more than 1 child (n=9), who were almost all older than 1 year old.

Despite having 4 phases of recruitment, participants in this study were predominantly mothers. However, the findings will be discussed in terms of parents rather than mothers to avoid negating the valuable opinions provided by the fathers (n=6 in phase 1, n=2 in phase 2, and n=1 in phase 3). Mothers, as an individual category of the participant sample, will be discussed wherever relevant.

This study was conducted in GM, a culturally and socio-economically diverse area in the NW. GM is the second most populous urban area in England (ONS, 2024). GM has similar socio-demographic characteristics to other large conurbations in the UK, such as Birmingham and Liverpool; for example, ethnicity make-up, unemployment rates, education levels and self-reported health status (see Appendix 3).

5.2 Parents' knowledge, understanding, and attitudes towards antibiotics use, antibiotic prescription advice, and ABR in GM (Objective 1):

A generally good level of knowledge and understanding regarding antibiotic use and ABR was observed among participants from both the online surveys and the phase 2 interviews. For example, most survey respondents (phase 1) and interviewees correctly knew that antibiotics are ineffective against viruses, and should be taken to completion, as instructed by a healthcare professional. As previously mentioned, a highly educated sample of parents were involved in this study, which could explain why most of them generally displayed good knowledge and understanding. Evidence suggests that there is a strong link between education level and good knowledge and understanding of ABR and antibiotics (Anderson, 2018; Salm et al., 2018; McNulty et al., 2019; Bianco et al., 2020; McNulty et al., 2019; Mallah et al., 2021). McNulty et al. (2019) found that educational qualifications were strongly positively associated with antibiotic knowledge, in their cross-sectional study (n=2283, including 777 parents of children <5 years old). This has also been corroborated in other studies (Salm et al., 2018; Hemsen et al., 2020; Harani et al., 2021; Mostafa et al., 2021; Muflih et al., 2021; Guo et al., 2022), such as Muflih et al.'s (2021) cross-sectional study (n=194) where high levels of education and health literacy were found to be substantially ($p<0.05$) associated with greater knowledge and awareness of ABR and a better understanding of antibiotics (OR=1.37, $p=0.017$).

Notwithstanding this, a lack of knowledge and understanding was observed, in all phases, regarding the potential side-effects of antibiotics, the consequences of using antibiotics improperly, how ABR occurs, and its consequences. In this PhD study, 66.7% of the survey respondents correctly knew that antibiotics can often cause side-effects such as diarrhoea; similar findings were reported in the 2018 Eurobarometer study, where 68% correctly knew of antibiotic side-effects (EC, 2018) (see Table 22). Although most of the phase 1 participants correctly knew that improper antibiotic use could lead to ineffective treatment (97.5%), many (36.7%) were unaware that the improper use of these drugs can lead to worsening of an illness. The Eurobarometer survey reported a slightly lower percentage (85%) of respondents correctly knowing that the improper use of antibiotics can lead to ineffective treatment (EC, 2018); with those more likely to know about the effect of misusing antibiotics being people having high socioeconomic status (SES) (EC, 2018).

It is important to ascertain whether antibiotics are being prescribed for unwarranted (i.e., for viral infections or self-limiting infections) reasons, as it has been reported in other studies (Pouwels et al., 2018; Akhtar et al., 2021; NHSBSA, 2021). Most phase 1 participants reported being prescribed antibiotics for infections such as UTIs (n=24, 20.2% of cases) and skin or wound infection (n=21, 17.6% of cases), followed by 'other' reasons (n=39, 32.8% of cases), infections that do not usually warrant antibiotics. As previously mentioned, antibiotics have been found to be over-prescribed for URTIs and other self-limiting infections, particularly for young children (Pouwels et al., 2018; Smieszek et al., 2018; NHSBSA, 2021); although whether they were being prescribed unnecessarily cannot be ascertained definitively from the phase 1 findings from this study. Previous research has indicated that GPs prescribe antibiotics for these self-limiting infections, due to factors such as a diagnostic uncertainty, to prevent further complications, or due to parental or time pressure (Horwood et al., 2016; Fletcher-Lartey et al., 2016; Biezen et al., 2019; Rose et al., 2021). According to the Eurobarometer survey (2018) the illnesses Europeans are most likely to cite as reasons for last taking antibiotics are bronchitis (16%), flu (12%), sore throat (14%), UTIs (12%), and fever (EC, 2018).

In this study, the top reason why participants had last given antibiotics to their child was ‘other’ (n=51, 42.5% of cases); followed by sore throat (n=21, 17.5% of cases), skin or wound infection (n=10, 8.3% of cases), bronchitis (n=8, 6.7% of cases), and UTI (n=8, 6.7% of cases). The Eurobarometer survey results differed greatly from the results obtained in this PhD study, where encouragingly none of the participants chose ‘cold’ or ‘flu’ as the reason for the last course of antibiotics they had consumed, and only one cited taking the last course of antibiotics for a fever (0.8%).

Regarding individual contribution to antibiotics, only 51.7% phase 1 participants agreed that they contribute to the development of ABR whenever they consume antibiotics, which was similar to the ones reported in Khan et al.’s (2013) study (53.6% of participants agreed that they contributed to ABR when they consume antibiotics). In McNulty et al.’s (2022) study (n=2022) in England, it was also found that although the general public knew that the misuse of antibiotics could contribute to ABR, there were misconceptions regarding how ABR occurs or that their consumption of antibiotics can influence its spread. Although all parents from phase 2 were aware of ABR and that antibiotic use was directly linked to it, some misunderstood how ABR occurred; with some parents (all with low education levels) believing that it occurred when the body became resistant to antibiotics. Similar findings were reported in a multi-country European qualitative study (Brookes-Howell et al., 2012), which found that people often attribute ABR to the human body becoming resistant or immune to antibiotics with increasing exposure to the drug. While this study was conducted in 2012, other more recent studies have also shown that this misconception still persists among the public (WHO, 2015; Bakhit, et al., 2019; Van Hecke et al., 2020; Shahpawee et al.,2020). However, almost all parents from phase 4 displayed a lack of knowledge regarding ABR, and some confusion regarding what antibiotics were used for. These mothers were all recruited from areas of high deprivation in GM, were mostly from ethnic minorities, and almost none of them had heard of ABR. The Eurobarometer surveys (EC, 2018; EC, 2022) report that respondents who were more likely to know about the side-effects and consequences of misusing antibiotics were people of high socioeconomic status (SES), a measure based on an individual’s income, education, and occupation (Pampel et al., 2010; Brogan, 2017). White participants, those with high SES, and higher levels of education, were also reported to have significantly more understanding about ABR and antibiotics, than the other participants (those with lower education levels and those from ethnic minorities) in McNulty et al.'s (2019) study. Although SES does not directly impact health, health literacy is a major factor that links SES to health (Stormacq et al., 2019).

Findings from this PhD study provide a mixed picture regarding the relationship between knowledge and education, as participants who were highly educated displayed varying levels of knowledge and understanding. One of the factors that could have influenced this finding is SES, which is an important determinant of health literacy, whereby low SES is persistently associated with suboptimal use of healthcare services, behaviours detrimental to health, and non-adherence to medication regimens (Pampel et al., 2010; Jansen et al., 2018). However, due to the size and homogeneity of participants in this PhD study, it was difficult to ascertain how participants' SES and other demographic variables (e.g., gender and ethnicity) may have influenced their knowledge and understanding of ABR and antibiotic use. Another factor could be participants' country of origin. Most phase 2 parents were UK-born, and therefore may have been exposed to more health promotion information and messaging on ABR and antibiotic stewardship compared to phase 4 parents who were mostly recent immigrants/migrants to the UK (from Nigeria, Hong-Kong, Poland, India, and Saudi Arabia). Similar findings were reported in a study investigating ABR and antibiotic understanding in diverse ethnic communities in Australia, where some participants who had lived in Australia for 3 to 10 years had not heard of ABR or antibiotic resistant infections (Whittaker et al., 2019). Whittaker et al. (2019) suggests that language barriers, as well as a lack of literacy, could affect how information and health promotion material on ABR and antibiotics are understood. However, parents who were non-UK born in phases 2 (from Italy and Bulgaria) and 3 (from Nigeria and Italy) had all heard and knew about ABR, with most displaying good knowledge on the subject, which could suggest that country of birth, rather than education per se was associated with ABR knowledge.

Findings from phases 1, 2, and 4 confirmed that some participants misunderstand how bacteria affect the body and the types of illnesses that can be cured with antibiotics. Among participants who had not heard of ABR in phase 4, there was also confusion about the infections caused by bacteria and which specific types could be treated with antibiotics. This could be due to factors such as cultural diversity and language barriers, as previous studies have shown that cultural diversity may influence knowledge and understanding of antibiotic use (Touboul-Lundren et al., 2015; Whittaker et al., 2019; Charani et al., 2021; Papamidou et al., 2022). For example, Lescure et al.'s (2022) qualitative study reported that immigrant patients were more likely to expect antibiotics than non-immigrants due to differing antibiotic prescribing culture in various countries. Furthermore, due to the language barriers that may be present, GPs in Lescure et al.'s (2022) study experienced greater diagnostic uncertainty and struggled to convey medical information to patients, such as explanations of when antibiotics were not necessary. Antibiotic Research UK (ARUK) suggests that as approximately 8% of the UK population do not speak English as their first language, and that the average reading age of adults in the UK is estimated between 9 and 11 years, the use of medical jargon should be reduced considerably to improve public understanding of antibiotics and ABR (Staples, 2020; ARUK, 2021). Data from the 2021 Census shows an increasingly diverse population in GM, which can also be seen in other indicators such as cultural identity and main language spoken by the residents, and is likely to continue over time (GMCA, 2023). In 2021, 3.1% of the GM population (89,331 people) were from Pakistan, 1.1% (31,030 people) were from India, and 1.0% (29,859 people) were from Poland (GMCA, 2023). The GMCA 2021 census briefing report suggests that at least 91 different languages are spoken as a main language in GM, with Urdu being the main language spoken by 45,249 residents, followed by Polish (24,869 residents) and Arabic (19,323) (GMC, 2023). This implies that uptake of public health information and health promotion messages, as well as accessibility to services such as GP consultations, may be inhibited for much of GM's population due to cultural differences, such as language barriers. Thomson & Chandler (2021) suggest that language barriers could hinder community engagement interventions on ABR, indicating a need for more culturally appropriate interventions to improve antibiotic awareness and stewardship. These demographic changes highlight the requirement for public services, including healthcare, to provide for a diverse range of ethnic groups (NIHR, 2022).

It is important to consider that terms used when discussing antibiotics and ABR may be too complex or abstract for a lay person. Although language barriers could be a reason phase 4 parents displayed confusion regarding what antibiotics are used for, those in phase 2 also had misconceptions and misunderstandings about how ABR occurred. While evaluating the knowledge and awareness of the general public about ABR, in both affluent and deprived areas of London, Mason et al. (2018) did not find that language influenced knowledge on antibiotics use in deprived areas. Although Mason et al.'s (2018) study did not provide much information about how deprived and affluent areas were selected, other than using 2015 IMD scores, they did find, that more respondents in affluent areas were exposed to antibiotic awareness campaigns compared to those in deprived areas. Furthermore, differing ABR terminology, wording, and verbalisation may lead to misunderstandings regarding how ABR occurs and spreads, which has been found to be counterproductive in improving knowledge and awareness on the issue (Lum et al., 2017; Mendelson et al., 2017). The use of clearer and unambiguous language could improve people's understanding and engagement with ABR (Lum et al., 2017; Mendelson et al., 2017). Scientific terminology regarding ABR may have disciplinary, geographic, and societal variations that influence understanding and interpretations (Medelson et al., 2017). Therefore, more research is needed to optimise ABR lexicon and reach consensus on the appropriate terminology to use, such as the use of 'antibiotic resistant infections' or 'antibiotic resistant bacteria' instead of simply using 'antibiotic resistance' (Lum et al., 2017; Mendelson et al., 2017).

While parents in this PhD study displayed misunderstandings and a lack of knowledge and awareness of ABR, they had been recruited from various areas in GM (including deprived parts of Manchester). Given the recruitment methodology used in this PhD study and the parent sample obtained, it is difficult to infer whether deprivation is associated with knowledge and understanding. Nevertheless, what can be inferred is that parents in Phase 4 who are non-UK born appeared to have poorer knowledge and awareness of ABR and antibiotic use, compared to those born in the UK, as even though there was some degree of misunderstanding among parents in phase 2 (almost all UK-born), all were aware of ABR and how it is linked to antibiotic use. However, it is of concern that misunderstandings regarding ABR and antibiotics are still present today. These misunderstanding are even present among highly educated individuals, indicating that better, more varied, and more accessible methods of communicating information on antibiotics and how ABR occurs, are needed to prevent further misinformation on ABR, and potentially contribute to better antibiotic stewardship (Salm et al., 2018; McNulty et al., 2019; Bianco et al., 2020; Anderson et al., 2020; Sobeck et al., 2021; Hawkins et al., 2022).

Parents asserted that ABR information included language that was too medically driven, too complicated, and lacked clarity, which resulted in misinformation and misconceptions on the

ABR. The need for clear and simple language was mentioned by most parents, in phase 2, 3 and 4. Those concerned about the complexity of the language used in phases 2 and 3, had lower levels of education compared to the other parents, displayed less confidence in their knowledge, and recognised their lack of understanding of ABR. All parents in phase 4 complained about the complexity of the language use with information on antibiotics; however, they all had various educational attainment, with most being educated to a university level. Parents who found the language used easy to understand, were all educated to postgraduate level. Most of them confidently associated their high education levels to their ability to comprehend information on ABR and questioned whether less educated people would have a good understanding of it. This confidence was misplaced in some of these participants, who displayed misconceptions regarding ABR and/or antibiotic use, despite being adamant that they clearly understood ABR information. This can be explained by the Dunning-Kruger Effect (DKE), a cognitive bias which posits that people tend to grossly overestimate their social and intellectual abilities (Kruger & Dunning, 2000; Coutinho et al., 2021). The DKE lends a scientific explanation to the proverb “a little learning/knowledge is a dangerous thing” (Cherry, 2022), suggesting that low-ability people’s misguided and incomplete knowledge result in mistakes, and an inability to recognise their lack in knowledge or skill (Ehrlinger et al., 2008; Coutinho et al., 2021). This has been found to result from difficulties with metacognition, i.e., the ability to objectively reflect on one’s behaviour, abilities, and limitations outside of oneself (Cherry, 2022); which can affect people’s beliefs, decision-making processes, behaviours, and desire to self-improve (Ehrlinger et al., 2008; Coutinho et al., 2021). The findings in this study show an over-confidence in ABR knowledge and understanding among parents who held misconceptions on ABR; therefore, illustrating the DKE.

Attitudes towards ABR as a public health problem varied among parents in this PhD study. Although parents in phase 3 felt that ABR was not a priority for parents of young children, and those in phase 4 were not aware of ABR and therefore struggled to comprehend how it would affect them, it is encouraging that the majority of participants in phases 1 and 2 were aware that ABR is an important and serious global public health issue. However, as found in this study, not all parents understand the scale of the ABR problem and the implications for individuals and the community. Similar findings were reported in a qualitative study conducted in Oxfordshire, where parents understood that ABR was a national problem but were divided about its wider impact, particularly how it could affect the community (Van Hecke et al., 2020). There is a critical need to highlight the interdependence of individual action, with regards to the misuse of antibiotics, and societal consequences of ABR (Lum et al., 2017; Cars et al., 2021). For people to better understand the gravity of the issue and engage better with antibiotic stewardship, awareness campaigns should focus on the impact of ABR at both individual and community level (Lum et al., 2017; DoHSC, 2019b; Mitchell et al., 2022). Although the macro concepts of ABR (e.g., global number of deaths) are important to understand, the lack of personal relevance prevents public engagement with this issue (Wellcome Trust, 2015; DoHSC, 2019b; Mitchell et al., 2022). Therefore, shifting the focus to concepts that could make this issue more relevant and less abstract for the public (e.g., how ABR can affect routine surgical procedures or how irresponsible antibiotic use can cause dysbiosis) could increase ABR awareness and engagement (Wellcome Trust, 2015; Lum et al., 2017; DoHSC, 2019b; Mitchell et al., 2022). It has been asserted that changing the narrative around ABR and stressing the immediacy of this public health problem, could enable a strong social movement, and political commitment to the issue (Wellcome Trust, 2015; DoHSC, 2019b; Cars et al., 2021; Mitchell et al., 2022). This is of critical importance now, as the COVID-19 pandemic has highlighted how quickly health gains can be lost, and the serious need for better preparedness (Balasegaram, 2021; Car et al., 2021). ABR can be considered a silent pandemic, and lessons learnt from COVID-19, especially regarding collaboration at the medical, scientific, social, and political levels, is of utmost importance to tackle this public health issue (DoHSC, 2019b; Balasegaram, 2021; Car et al., 2021; Waterer et al., 2021).

Findings from this PhD study indicate that knowledge, understanding, and attitudes on antibiotic use and ABR was good among participants, providing evidence on what ABR knowledge could potentially look like among a highly educated population in GM, which is a novel finding. However, these findings have also shown that having high levels of education does not automatically imply high levels of health literacy with regards to ABR and antibiotic usage.

As mentioned previously (see Chapter 1; Chapter 2, section 2.9) deprivation is measured in different ways in the literature (using IMD or other area level deprivation scores). For example, in some UK studies looking at deprivation in relation to ABR knowledge and understanding, area-based deprivation measures such as IMD, are usually used to determine SES (Mason et al., 2018; Adekambi et al., 2020; Shebehe et al., 2021; Tyrell et al., 2022). Although this method can provide an understanding of the level of deprivation of an area, it does not adequately measure individual deprivation, i.e., whether an individual is experiencing poverty; as within any area there will be people who are deprived and those who are not (MoHCLG, 2015; Clelland & Hill, 2019). McCartney et al. (2023) suggests that using area-based deprivation measures to identify income- and employment-deprived individuals is limited in sensitivity and specificity, hence interventions and place-based policies introduced to reduce inequalities are unlikely to be effective. Therefore, previous studies looking at ABR and antibiotic use among the public could have potentially engaged with people who lived in deprived areas, who were atypical of a deprived population.

As found in this PhD study, a sample recruited from a deprived area (phase 4) does not necessarily fit the criteria expected from a deprived population (i.e., having low education levels). Whilst those in phase 4 were from deprived areas, they would not be considered socio-economically deprived per se, due to their high levels of education. This study aimed to recruit parents from various areas in GM, that reflected the diversity of the GM population of the area; however, despite repeated recruitment sampling rounds the sample obtained were mostly highly educated parents, who appeared to be sufficiently confident in their health literacy skills to participate in a study on ABR, as they were confident to engage with the participant information sheet and consent form. Many parents who were approached for recruitment in the deprived areas of Manchester (phase 4), were unwilling to take part, potentially for a range of reasons, including disinterest in the topic or language barriers. However, what is notable was that originally 13 participants agreed to take part in the phase 4 interviews, but subsequently deselected themselves after being given the participant information sheet and consent form. For example, Pakistani mothers deselected themselves from the study when they were informed that the interviews would be audio-recorded and/or when they were asked to sign a consent form. The reasons for this are unknown, however, it seemed that only parents in deprived areas who had an interest in the topic, who were confident in their ability to converse in English, and were also able to understand complex topics such as antibiotics, infections, and ABR, participated in the interviews conducted in phase 4. This leads one to question what is actually known of ‘deprived populations’ when it comes to a complex topic such as ABR, and whether findings from previous studies evaluating knowledge and understanding of ABR and antibiotic use, based on deprivation levels (see section 2.9, Table 8) truly recruited 'deprived populations', or whether, as is the case with this study, they recruited educated participants from deprived areas. For example, Mason et al. (2018) described poorer knowledge and understanding among participants in less affluent area in London compared to those in affluent areas; these areas were determined by IMD scores. In Adekambi et al.'s (2021) study looking at antibiotic prescribing by SES, it was reported that deprived populations (determined by WIMD quintile) received more antibiotics than less deprived populations. Tyrell et al. (2022) also used WIMD to locate schools where their intervention could be used to raise awareness of AMR deprived students. In Shebehe et al.'s (2021) study knowledge about infections and antibiotic use was measured in relation to deprivation, and the Northern Ireland Multiple Deprivation Measure was used to determine whether participants were deprived or not. This PhD study has highlighted that previous ABR studies on the knowledge and understanding of deprived populations need to be treated with caution.

5.3 Factors that influence parents' perceptions, experiences, and practices, in the context of their young child being prescribed antibiotics (Objective 2).

Self-reported practices were generally good (i.e., complied to medical guidance) among parents in this study, who presented themselves and their families as responsible antibiotic users. However, not all parents' practices complied with medical guidance (see Chapter 2, section 2.5.1.2, Table 6), such as stopping antibiotic therapy after a couple of doses, which was observed in parents in phases 1, 2, and 4. According to 15% of the survey respondents in phase 1 skipping one or two doses of antibiotics did not contribute to the development of ABR, and 28% were undecided about this. Comparing these findings to Khan et al.'s (2013) study, participants in this study had a better level of knowledge than the medical students in Khan et al.'s (2013) study, where only 47.4% of their participants knew that skipping one or two doses would contribute to the development of ABR (see Chapter 4). It is interesting to note that although phase 1 participants displayed mixed understanding regarding their potential contribution to ABR, the attitudes displayed are better in some areas compared to those of Khan et al.'s (2013) medical students regarding antibiotic use and resistance. Medical students are assumed to have prior medical knowledge and experience regarding the appropriate use of antibiotics, and therefore would have been expected to have better attitudes regarding the proper use of antibiotics, compared to the participants in this PhD study, who were members of the general public. However, it could be argued that attitudes towards ABR and appropriate usage of antibiotics could vary greatly between participants in a developed country or high-income setting, and those in a developing country or low-income setting, where antibiotics are more readily prescribed to patients (Machowska & Lundborg, 2018).

Stopping antibiotic therapy after a few doses was also observed among mothers in phases 2 and 4. Generally, phase 2 mothers who showed incompliance, and had lower levels of education compared to the other parents in the same phase, which could indicate a relationship between education, health literacy, and compliance. As previously established in the literature (section 2.4.4), low health literacy is associated with poor knowledge and understanding of health problems, as well as poor adherence to treatment regimen (van der Heide, 2013; PHE, 2015b; Jansen et al., 2018). A contradictory finding in this study was that mothers in phase 4 who had similar poor practices were all mostly educated to university level (at non-UK universities), which is contradictory to evidence that high education levels equate to good antibiotic stewardship behaviours (Salm et al., 2018; McNulty et al., 2019; Antwi et al., 2020; Bianco et al., 2020; Charani et al., 2021). Therefore, the determinants of incompliance in this study were found to be multifaceted. It could be argued that gender, may play a role in how antibiotics are used, as fathers (albeit a small number) in phase 2 all displayed better self-reported practices than mothers. However, Pham-Duc et al.'s (2021) scoping review found that females tended to have better knowledge and awareness of antibiotics and ABR than men, were more likely to seek medical advice and hence receive more information on antibiotics, and also had better antibiotic practices. Torres et al.'s. (2019) systematic review found that women were more likely to self-medicate with antibiotics than men. Nevertheless, inferences on how gender may influence self-reported antibiotic practices are not possible in this PhD study, due to the sample being biased towards women (n=114).

Reasons for stopping antibiotic treatment for themselves and/or their child, after 2 or 3 doses, included feeling better after a couple of days on the antibiotic treatment, belief that the antibiotic was wrongly prescribed, belief that taking the full course would damage the microbiota, belief that completing the therapy was not necessary (mostly due to the lack of diagnostic test), and difficulty administering the drugs to their child. These could intimate that a lack of understanding on how to use antibiotics responsibly, how antibiotics work, and the individual's contribution to ABR, could potentially translate into incompliant antibiotic practices. West et al. (2019) found a significant association between knowledge of ABR and adherence to antibiotic treatment ($X^2 = 14.138$, $p = < 0.0005$), and Lee et al. (2023) found that adherence was associated with education ($p< 0.01$) and knowledge levels ($p < 0.05$). Anderson et al. (2020) looking at incompliant attitudes towards antibiotic prescription completion in the UK, reported that respondents who had good knowledge of antibiotics and their uses, as well as the consequences of misusing these drugs, were less likely to report incompliant attitudes. However, they also reported that respondents who knew that antibiotics caused side-effects were more likely to report incompliant attitudes (Anderson et al., 2020). In this PhD study all parents were defensive about their practice, indicating awareness among them that these practices did not comply with guidance; some justified this by saying that it was their prerogative as a parent to decide how and when to use antibiotics for their child. This indicates that there is room to improve antibiotic stewardship behaviours among parents, as such practices will not only drive ABR but are also detrimental to the antibiotic users, particularly in children, where exposure to antibiotics cause disruptions to the microbiota, which could lead to adverse health outcomes in the short and long term (as discussed in Chapter 1 and Chapter 2, section 2.3.1). Van Hecke et al (2019) conducted a cohort study with children aged (1 to 5 years) (n= 114 329) and found that children who had taken two or more antibiotic courses for RTIs had a 30% increased risk of not responding to future antibiotic therapy, compared to children who had not taken any antibiotics. As even moderately low antibiotic usage in children has health implications and as children are prone to having multiple infections per year due to their environment (nursery, day-care, school etc.), it is critical to reinforce the concept of responsible antibiotic use among parents (Price et al., 2018; van Hecke et al., 2019). Parents decide when, how, and for how long to administer antibiotics to their child, making them an important link in the chain that is antibiotic stewardship (McNulty et al., 2001; McNulty et al., 2007; Price et al., 2018; Alejandro e al., 2023; Calvo-Villamañán et al., 2023).

Precautionary antibiotic prescribing was not well received by most mothers in phase 2. For some of them this was a justification for stopping antibiotic therapy after only a few courses.

Antibiotics are usually prescribed by clinicians for a fixed duration (e.g., 7, 10, 14 days) for common community-acquired bacterial infections. However, there is debate about the duration that antibiotics should be taken for, with some experts arguing that a fixed duration, without accounting for the patient's clinical response to the treatment, may not actually be beneficial to the patient (Langford et al., 2017; Llewelyn et al., 2017). Emerging evidence suggests that shorter courses of antibiotics may be more effective than longer ones for some community-acquired infections, and that it could also reduce risks of getting an antibiotic resistant infection (Langford et al., 2017; Llewelyn et al., 2017; WHO, 2020b; Lee, Centor et al., 2021; Palin et al., 2021). Furthermore proponents of shorter antibiotic therapy argue that encouraging patients to complete a full course of antibiotics to minimise ABR, may be counterproductive to antibiotic stewardship, and is not supported by enough evidence (Langford et al., 2017; Llewelyn et al., 2017). Therefore, some experts believe that this narrative is outdated and should be changed, to encourage patients to stop treatment when they feel better, as was the case with the parents in this study, and to consider a more patient-centred decision-making process (Langford et al., 2017; Llewelyn et al., 2017). In a population-based cohort study, conducted in the UK, Palin et al. (2021) found that shorter antibiotic courses were as effective as longer courses for respiratory tract infections. They also found that patients who were prescribed antibiotics for 7 or 14 days, had a greater risk of developing infection-related complications compared to those who were prescribed antibiotics for only 5 days (Palin et al., 2021). Pouwels et al.'s (2019) cross-sectional study (UK) found that a substantial portion of antibiotics prescribed, for the most common infections treated in primary care, were prescribed for longer than guideline recommendations. This study highlighted the need to reduce antibiotic prescribing, through better adherence to recommended guidelines on antibiotic therapy duration (NICE, 2019; Pouwels et al., 2019; Lee, Centor et al., 2021; Yahav et al., 2022). Such controversies in prescribing guidance, particularly when experts advocate for patients to stop antibiotics when they feel better, could be counterproductive when encouraging responsible antibiotic practices among the public. Mixed messaging regarding certain antibiotic practices could also encourage incompliant behaviours among parents, which could be mirrored in how they administer antibiotics to their child (For example: Phase 2, Parent 9; Phase 4, Parent 16) (see section 4.2). It could also lead to mistrust in antibiotic prescribers (discussed further in section 5.3).

None of the parents in the qualitative phases of this PhD study reported expecting antibiotics from the GP or any prescriber. However, in the findings from phase 1, 15% (n=18) stated they would ask for antibiotics from their doctor if their child had recurrent URTIs, 28.3% (n=34) were unsure if they would request antibiotics and 56.7%, (n=68) reported that they would not request antibiotics. There were no statistically significant variations between survey respondents' demographic characteristics and requesting antibiotics for recurrent URTIs. Most survey respondents cited seeking medical advice only if their child displayed a persistent symptom or combination of symptoms that did not subside with treatment at home (persistent fever, cough, ear discharge, vomiting, and rash). None of the interviewed parents reported requesting antibiotics. These findings contradict those reported in other UK studies, where parental expectation for antibiotics was reported (Rooshenas et al., 2014; Bosley et al., 2018; O'Doherty et al., 2019; Borek et al., 2020; Bosley et al., 2021). For example, Bosley et al.'s (2022) study, reported that mothers would request or pressure GPs for antibiotics; and expressed feelings of anxiety when antibiotics were not readily prescribed for their child, as they believed this could lead to complications. All interviewees in this PhD study reported seeking medical advice for persistent symptoms that did not get better with home-remedies and were adamant that they would never expect or request antibiotics. This could potentially be attributed to the high levels of education of participants in this study. While there is an association between antibiotic prescribing and clinicians' perceptions of parental expectations for antibiotics (Cabral et al., 2015; Cabral et al., 2016; Horwood et al., 2016; Bisgaard et al., 2021; Saliba-Gustafsson et al., 2021; Rose et al., 2021), many studies have shown that parents seek medical reassurance and advice rather than antibiotic prescriptions (Biezen et al., 2019; Cabral et al., 2019; Bosley et al., 2021), which is similar to the findings from this study. This need for reassurance regarding their child's illness was more pronounced among the participants in phase 4, where parents complained about not getting enough information about the illness and treatment form the GP, feeling dismissed when expecting reassurance and guidance, and feeling lost when seeking further information and/or reassurance. As phase 4 interviews were conducted post-pandemic, this pronounced need for reassurance without feeling dismissed could also be due to difficulties getting GP appointments at this time, as well as increased time constraints on GPs due to increased demand (Wise, 2022). The need for reassurance was also a factor discussed by participants from the workshops (phase 3) who believed that what parents needed was more support on how to obtain more information regarding their child's illness, rather than more awareness on antibiotic use and ABR. This indicates that parental concerns are not being met when it comes to GP consultations. There was a strong expectation from all parents in the qualitative phases, to be given adequate information to feel reassured about their child's illness and diagnosis. However, their anxiety when their child had an infection, could potentially have been interpreted as an expectation for antibiotics, which could subsequently have resulted in precautionary antibiotic prescribing. This has been reported by many studies (Cabral et al., 2015; Cabral et al., 2016; Horwood et al., 2016; Williams, Halls et al., 2018; Bosley et al., 2021).

The lack of diagnostic test was reported in both phases 1 and 2 of this PhD study. Most survey respondents reported that they did not undergo a diagnostic test (55.8%, n=67), such as a blood test or throat swab, before being prescribed antibiotics; followed by 32.5% (n=39) who had had a diagnostic test. There were no statistically significant variations among those who had undergone a diagnostic test and those who did not. The Eurobarometer survey (2018) showed a similar trend, with 56% of the total percentage of respondents (55% from the UK) who said that they had not been tested before starting antibiotics. Other countries that showed similar trends included France (56%), Cyprus (55%), and Slovakia (55%) (EC, 2018). People aged 55 and over (especially those aged 75 or over) and retirees were more likely to be tested to confirm diagnosis, before being prescribed antibiotics (EC, 2018). This could be due to their significant risk of experiencing adverse consequences associated with inappropriate antibiotic therapy (Beckett et al., 2015; Pulia et al. 2020), and that the management of infections with antibiotics may be challenging in this age group due to the presence of co-morbidities, poly-pharmacotherapy, and age-related physiological changes (Beckett et al., 2015; Pulia et al., 2020). Therefore, diagnostic certainty is crucial for these patients before prescribing antibiotics (Beckett et al., 2015; Pulia et al., 2020).

The lack of diagnostic tests was reported by all mothers who recalled receiving precautionary antibiotics for their child. This lack of confirmation that antibiotics were indeed warranted to treat their child's infection, led to these mothers questioning their GP's diagnoses and decisions to prescribe antibiotics. There is evidence that diagnostic tests (point-of-care testing [POCT] and laboratory testing) increase diagnostic certainty and result in a decrease in antibiotic prescribing in primary care and are therefore a critical component of antibiotic stewardship (O'Neill, 2016; Lemiengre et al., 2018; Sydenham et al., 2021). However, diagnostic tests have certain shortcomings, such as their limitation in scope, accuracy, and speed, which prevent their optimal use in primary care (Hayward & Turner, 2021). For example, C-reactive protein tests (POCT) have low sensitivity and long detection time; PCR testing (lab testing) on the other hand require time and centralised services. Due to increasing pressure on the NHS, current GP budgets do not favour the purchase, implementation, and maintenance of novel POCT (Hayward & Turner, 2021). Furthermore, these tests would have been difficult to carry out during COVID-19, when phases 1 and 2 of the study was being undertaken.

There are barriers to implementing POCT in GP surgeries, despite the many advantages that the routine use of them could have, particularly in decreasing precautionary antibiotic prescribing and improve antibiotic stewardship (Eley et al., 2018; Burrowes et al., 2021; Hayward & Turner, 2021). These barriers include equipment cost, time, accessibility, training, and effects on clinical workflow (Eley, Sharma et al., 2018). A randomised controlled trial, conducted within high prescribing GP surgeries in the North of England, found little evidence that the use of POCT, for respiratory tract infections, led to a statistically significant decrease in antibiotic prescribing (Eley et al., 2020). This indicated that POCT may not have been used as recommended in these high-prescribing practices, which could have explained why little evidence to support the use of POCT was found in this RCT (Eley et al., 2020). Therefore, the use and potential benefits of POCT may vary across the country, with areas having high antibiotic prescribing rates (like the NW) needing better support to implement the routine use of this type of testing. Hence, more research is needed to better understand how to implement and optimise the use of POCT in areas having high antibiotic prescribing rates, which according to Eley et al. (2020) would require a clear action plan, better guidance and training for healthcare professionals, and better triage of patients who would be eligible for POCT. However, given the current NHS crisis, and increasing pressure on primary care, this may not be a priority.

Being part of the decision-making process regarding their child’s treatment was very important for all parents in the qualitative phases of this study. Mothers who felt they were not included in this process, felt uninformed and unheard, leading them to question the appropriateness of antibiotic treatment for their child. Many mothers were aware that antibiotics could cause health problems for their child if given unnecessarily, particularly to the child's microbiota, and this was mostly observed among mothers in phase 2. This was also observed in phase 1 findings where 47.5% of the respondents disagreed that antibiotics were safe drugs, and therefore were commonly used (12.5% were undecided). As shown in the literature, a child's microbiota is highly important for their normal development (Reyman et al., 2022; Thaulow et al., 2022), and antibiotics can cause lasting effects on the microbiota, which could later translate into allergies, asthma, obesity, colitis, IBS, IBD, among others (Ganguly, 2019; Thaulow et al., 2022). Mothers in phase 2, who were worried about the possible adverse consequences of antibiotics, and who also questioned prescribing behaviours, reported refusing antibiotics for their child on various occasions, and displayed mistrust in their GP (discussed below). In contrast, findings from Bosley et al.'s (2022) qualitative community case study, conducted in a large city in the South of England, showed that mothers saw antibiotics in a positive light, and these drugs were identified as symbolising healing, providing protection, and safety. Mothers in Bosley et al.'s (2022) study, shared similar demographic characteristics to parents in this PhD study, with most mothers being White (88%), educated to degree level (76%), and British (64%). One major factor that could have affected participants' views and perception on antibiotic prescription and antibiotic use was the context and setting of the study; Bosley et al.'s (2022) was conducted prior to the COVID-19 pandemic, in the South of the UK, where factors such as antibiotic prescribing rates, pressure on GPs, deprivation, and health literacy, are better compared to the North of the UK (Marmot, 2020; OHID, 2021). As previously established, these factors could influence parents' experience during medical consultation, the information they are given, and how often antibiotics might be prescribed to them.

Mistrust in the diagnosis and treatment regimen is a novel finding in this study, and to the authors knowledge has not previously been reported in the literature. This was determined by a number of factors (see section 4.2) and was particularly observed among mothers who believed that doctors overprescribed antibiotics, those who felt unheard by their GP, and those who reported previous negative experiences when their child had been prescribed antibiotics. These findings differ from those reported in other studies, where parents may be apprehensive of using antibiotics due to side effects and ABR, but highly trusted their doctor's decision to prescribe antibiotics when needed (Cantaro-Arevalo et al., 2017; Szymczak et al., 2017; Van Hecke et al, 2020; Bosley et al., 2022). In Bosley et al.'s (2022) study mothers trusted

GPs to prescribe antibiotics and accepted antibiotic prescriptions from GPs with relief and no hesitancy. McNulty et al. (2022) also reported high levels of trust in healthcare professionals (89% of respondents would trust a GP, 76% would trust nurses, and 71% would trust pharmacists), with only 21% of participants challenging a healthcare professional's decision not to prescribe antibiotics (most were from BAME groups). These results differed greatly from the findings in our study where the mothers in Phase 2 reported mistrusting GP diagnoses and challenged antibiotic prescribing decisions, which has not previously been identified in the literature. A number of factors could be at play here, such as parents not being given a satisfactory explanation for the precautionary antibiotic prescription, feeling unheard when it came to their child's diagnosis and treatment, having consultations online, or past negative experiences

Almost all parents in phase 2, who questioned GPs' diagnoses had more than 1 child. This could indicate that past parental experiences in dealing with ill children could result in them feeling more competent to question a GPs' diagnosis and refuse antibiotics for their child. Increased parental experience, particularly regarding their child's treatment, has been reported to increase enhance parental self-efficacy and confidence, and allow them to judge when antibiotics are needed (Ingram et al., 2013; Cabral et al., 2015; Neill et al., 2016; Bosley et al., 2018; Meherali et al., 2019). Niell et al.'s (2016) qualitative study in East Midlands (UK), showed that first-time parents, struggled to differentiate between infections that were self-limiting infections and those that required medical attention; they also experienced greater doubt and anxiety compared to more experienced parents. However, none of these studies have shown that increased parental experience led to questioning healthcare professional diagnosis and treatment choice or refusing to follow medical advice and guidance, which was only observed among mothers in phase 2

Communication challenges were an issue raised in all phases of this study, particularly the qualitative phases. Findings from phase 1 show that 36.7% of respondents reported not being given enough time to inquire about the antibiotics prescribed to them during consultations; a finding reiterated in the qualitative phases as well. However these challenges could have been due to different reasons; for example, the use of telehealth (online or telephone) during the pandemic for parents in phases 1, 2 and 3, could have affected the quality of care they received. Although, evidence post-pandemic suggests that telemedicine does not affect quality performance compared to in-person medical consultations (Tyler et al., 2021; Baughman et al., 2022; Luna et al., 2022; Murphy et al., 2023;). For example, Tyler et al. (2021) reported that the participants in their study preferred virtual (36.4%) to in-person consultations (26.9%), as they were less stressful. For parents in phase 4, communication challenges could have been due to the pressure on GP surgeries and GPs post-pandemic to meet the increased demand for medical consultations, leading to shorter and more rushed consultations affecting the quality-of-care patients receive (Cooksley, 2023). Communication issues between physicians and patients have been highlighted in various studies, where parents had concerns of being dismissed, and perceptions of being rushed to end the consultations (Kotwani et al., 2010; Vazquez-Lago et al., 2011; Gaarslev et al., 2016; Fletcher-Lartey et al., 2016); similar issues were reported in this PhD study. Experiencing time constraints during medical consultations, has been found to translate into patients feeling unworthy of the physician's time, feeling stressed, unheard, like a burden, and discouraged from seeking reassurance or ask questions (Rocque & Leanza, 2015). Previous studies have also found that physicians are perceived as being more disagreeable when faced with time pressures, ask fewer questions, seem disinterested, and utilise complex medical jargon to rapidly explain the condition, and subsequently end the consultation quickly (Rocque & Leanza, 2015). These results corroborate the findings from this PhD study, particularly among parents who expressed dissatisfaction with medical consultations and reported leaving the consultation feeling uniformed.

Dissatisfaction, lower quality of care, misuse of medical resources, and non-adherence to medical advice are consequences that may emerge from negative experiences during medical consultations (Rocque & Leanza, 2015), which could influence parents attitudes towards antibiotic prescribing, antibiotic use, and ABR. Rocque & Leanza's (2015) systematic review also found that patients who had unsatisfactory medical consultations would tend to seek medical advice elsewhere or sought a second or sometimes third opinion, which has also been seen with many parents in this PhD study, who reported seeking further information and advice from friends and family members, other doctors, as well as from the internet. Seeking supplementary information from other sources, such as online and from other people, could potentially lead to misconceptions arising about ABR and antibiotic use, and also to the spread of misinformation, which could potentially result in questionable antibiotic practices (Groshek et al., 2018; Krishna & Thompson, 2021). Examples of consequences of public health misinformation include vaccine hesitancy due to misinformed vaccine narratives (Steffens et al., 2019; Garett et al., 2021; Löffler et al., 2021), as well as low compliance with COVID-19 restrictions (Barua et al., 2020; Bridgman et al., 2020; Enders et al., 2020). Communication challenges may also be the reason for mistrust in GP's diagnosis and parents' reluctance to give their child the prescribed antibiotics, particularly where diagnostic explanations are lacking, leading to parents feeling uniformed and unheard about their child's diagnosis or treatment (Rocque & Leanza, 2015). Interventions to improve communication between health professionals (GPs and pharmacists) and patients have been conducted with positive results (Francis et al., 2009; Allison et al., 2020). In these studies, healthcare professionals underwent training and used tools (e.g., interactive booklet and antibiotic checklist) to improve communication with patients (Francis et al., 2009; Allison et al., 2020) (see Table 5, section 2.6). Therefore, similar interventions focusing on improving patient-clinician communication should potentially be implemented, particularly in a setting like GM, where language barriers may be more problematic and factors such as GP short consultation times and pressure more substantial.

Emotional disengagement about ABR was observed in many parents in this study, particularly among those who were unaware of ABR, and those who considered themselves as responsible antibiotic users. Emotional disengagement can lead to a lack of social responsibility and decrease in self-reflection, which can in turn lead to individuals taking less responsibility for their incompliant actions (Abel & McQueen, 2020), with regards to antibiotic use and ABR. These findings were consistent Van Hecke et al.'s (2020) qualitative findings, where parents described being responsible antibiotics users who were not contributing to ABR (Van Hecke et al, 2020). These findings could potentially explain why previous campaigns may not have successfully managed to fully engage with people who feel that ABR may not affect them, as detachment to ABR may not have been considered as being part of issue. Langdridge et al., (2019) assert that emotional engagement should be considered during the development of effective ABR public health interventions. This highlights the importance of understanding how parents may or may not be emotionally affected by ABR, to maximise their engagement with potential interventions on ABR that ultimately aim to achieve behavioural change (Wellcome Trust, 2015; Lum et al., 2017; Mendelson et al., 2017; Will & Kamenshchikova, 2020). Findings from this PhD study show that there is a crucial need for more awareness among the public, particularly regarding how ABR occurs and its wider consequences for the individual and community.

5.4 Recommendations for future research on interventions aimed at improving antibiotic awareness among parents (Objective 3).

All parents from the qualitative phases of this study (phases 2, 3, and 4) agreed that developing an intervention to improve awareness was necessary, although workshop participants questioned how accountable parents were for the overuse of antibiotics, as antibiotics can only be obtained with a GP prescription. However, as mentioned previously antibiotic stewardship is and should be a collective effort, whereby all stakeholders from all sectors and levels should be encouraged to develop societal advocacy against ABR (DoHSC, 2019b). As previously mentioned in the introduction to this study (section 1.4), the prevalence of infectious diseases tends to be increased in communities with lower SES, who also experience low health literacy levels (Davies, 2012; Hughes & Gorton, 2015; Furegato et al., 2016; Vaudrey et al., 2016; Davies 2018; Nguipdop-Djomo et al., 2020). With GM's high levels of deprivation compared to the national average (GMCA, 2020; Marmot et al., 2021) and low health literacy levels (see section 2.5.1.2, Figure 12), knowledge and understanding of ABR and the responsible use of antibiotics could be negatively affected, thus highlighting the need for better antibiotic stewardship awareness. This is of particular importance as given the current state of the UK Healthcare System; which has been described as 'a national emergency', as staff shortages are increasing and the growing demand for healthcare are worse in more deprived areas of the UK (Williams & Pagell, 2023; BMA, 2024; Campbell and Bawden, 2024). Therefore, reducing the pressure on the NHS, particularly at primary care level is crucial. Bombard et al.'s (2018) systematic review found that patient engagement can lead to reduced hospital admissions, improved efficiency and quality of health services, as well as enhanced quality and accountability of health services.

To ensure that an intervention developed for parents was inclusive to all parents in GM, regardless of their socio-demographic characteristics (e.g., SES), the need for a multi-pronged approach was highlighted by parents in this PhD study (phases 2 and 3), where schools, pharmacies, GP surgeries, and community centres are all involved in the dissemination of the intervention. Interventions in schools have been conducted in the UK in the past (see Table

5, section 2.6), with gamification being found improve ABR awareness among children (Ferrell et al., 2011; Eley et al., 2019), as well as through multi-media outlets such as plays and musicals (Ahmed et al., 2019; Hall et al., 2020) and science shows (Lecky et al., 2014; Tyrell et al. 2022). However, none of these interventions provided the opportunity for parents to join in, nor take away material for children to share with their family, which could be a promising approach for potential stewardship interventions targeting parents, in the future.

There was strong emphasis about parental empowerment from all qualitative phases, where parents wanted to be empowered to make the right choices when their child is sick, with constructive guidance on things they could do before seeking medical advice, such as how to treat self-limiting infections and alleviate symptoms from at home. Previous studies have shown that empowering parents is an effective way: to support their decision-making processes about seeking medical help for their child; can reduce expectations for antibiotics; and encourage the appropriate use of antibiotics (van de Maat et al., 2018; Hayes et al., 2021a; Alejandro et al., 2022). As suggested by the DoHSC (2019b), empowering people from the local communities to be more engaged with ABR could be more efficient than implementing a professional-led intervention. Involving parents in the development of interventions that target them is particularly important if the goal is to improve antibiotic stewardship among this targeted group, who are at the forefront of antibiotic stewardship for their children. One potential way of empowering parents is through shared lived experience, which almost all participants from phases 2, 3, and 4 reported valuing. They emphasised the need for a community where parents could share their experiences and struggles with managing self-limiting infections, finding information and guidance on treatments for their child, and accessing healthcare services. Hearing about other parents' experiences was considered a way to make ABR more relatable for these participants, while also improving emotional engagement. People with lived experience could play an important part in improving awareness and engagement, while also influencing the design and delivery of interventions (DoHSC, 2019b; Blatchford et al., 2020). Sharing experiences has been found to improve opportunities for learning and help people to feel less isolated and more empowered (Ziebland & Wyke, 2012; Lindblad et al., 2020). The value of first-person accounts, and being part of a community with similar peers, can greatly affect how empowered patients feel to manage their own health and learn health-related behaviours

(Ziebland & Wyke, 2012; Lindblad et al., 2020). Lindbald et al. (2020) found that patients with long-term conditions, who shared their experiences with each other, benefitted from more knowledge gained from other patients' lived experience, compared to knowledge gained from healthcare providers. Therefore, having a community where parents share their experiences could be an important tool in promoting better antibiotic practices and improving antibiotic stewardship. Parents in this PhD study reported valuing the experiences and views of their peers, particularly with dealing with certain childhood infections or using antibiotics, in some cases more than that of the GPs and other healthcare providers.

All parents in this study raised concerns regarding GP consultations (e.g., time pressure and feeling rushed during consultations), with phase 4 parents mainly complaining about the limited accessibility to healthcare services and long waiting times for patients to be seen by a clinician. However, it is important to note the considerable pressure on GPs both during and post-pandemic, could have influenced the findings vis-vis communication challenges reported in this PhD study. Given the current health crisis, this issue is predicted to be exacerbated by even more demand in the coming years (BMA, 2022; BMA, 2023; NHS Confederation, 2023; The Health Foundation, 2023; BMA, 2024; NHS, 2024b). This has the potential for antibiotic stewardship to worsen, especially as it has been documented that GPs tend to overprescribe antibiotics when working under pressure (see section 2.5.1.1), which would be dangerous for children. Additionally, the over prescription of antibiotics for children could lead to further long-term health conditions (see section 2.3.1), which could further exacerbate demand on the UK healthcare system. Alongside this, the national ABR burden could worsen if antibiotics continue to be prescribed unnecessarily, leading to increased mortality rates caused by antibiotic resistant infections, DALYs, loss of productivity, and increased economic costs (see Chapter 1 and section 2.4.1). These issues highlight the importance of improving antibiotic stewardship among GPs and the general public, including parents who are a critical link in the antibiotic stewardship chain as shown in this PhD study.

5.5 Contributions to the literature

This study has brought forth novel findings, which provide an important and original contribution to the existing literature relating to parents' knowledge, understanding, and attitudes towards antibiotic use, prescription advice, and ABR. These contributions are summarised below:

- This is the first study that has explored parents' knowledge, understanding, perceptions, and attitudes in GM, a socio-economically and culturally diverse area of England.
- This study has provided unique insight into a very educated sample, highlighting that high education levels did not necessarily translate into better health literacy levels and better antibiotic practices, contradicting what has been extensively evidenced in the literature.
- Phase 1 (objective 1) provided insight into the types of misunderstanding and misconceptions that are present among parents in GM. Overall this indicates that there is scope to improve parents' knowledge, understanding, and attitudes towards antibiotic use and ABR, particularly regarding their contribution to ABR, how ABR occurs, and how it can affect themselves, their family, and community.
- Phase 2 (objective 2) has shown a loss of trust in healthcare professionals, particularly GPs, who are perceived as overprescribing antibiotics, dismissive, and uninformative. Communication challenges were reported in phases 2 and 3, and these findings show that parents are unsatisfied with the GP services available to them. These findings illuminate the potential worsening of antibiotic stewardship behaviours, when patients lose trust in their GPs, which is a novel finding.
- Phase 2 and 4 (objective 2) showed that parents in GM want reassurance and advice from their GP and wanted to feel heard regarding their child's diagnosis and treatment and empowered during their child's treatment and recovery. Most importantly parents were confident to question antibiotic prescribing practices and at times refuse antibiotic prescriptions, particularly when diagnoses were not explained properly or when diagnostic tests were not performed, which is a novel finding.
- Phases 2 and 4 (objective 2) have also shown a lack of emotional engagement, cognitive dissonance, and behavioural inconsistencies among parents who were aware of the current guidance on the responsible use of antibiotics but had antibiotic practices that did not comply with the guidance. These parents did not equate their non-compliance to being irresponsible antibiotic users, or to contributing to ABR. The emotional disengagement observed in these parents posited ABR as a problem for others. This could

indicate that past ABR interventions and campaigns have not taken into consideration ways to encourage public emotional engagement with the issue.

- Phase 3 (objective 3) found that the participants wanted parents to participate and feel empowered by interventions, which could potentially lead to better outcomes, as using a participatory and a community-centred approach in the design of an intervention has been shown to encourage and empower the intended beneficiaries.
- The findings from all four phases of this study have shown that there is scope to improve antibiotic awareness and stewardship among parents in GM, as well as their engagement with ABR.
- Findings from this study, suggest that previous studies that have looked at ABR knowledge, understanding, and awareness in a deprived area, should be interpreted with caution, as how 'deprivation' or a 'deprived population' has been established is heterogenous, and in some cases just based on IMD. Assessing deprivation in this way, may have resulted in more educated participants from deprived areas taking part in previous studies, as was the case in this PhD study.
- The findings obtained from this study provide an in-depth understanding of parents in GM. This understanding, could help in the development of future interventions and campaigns aimed at parents to encourage better antibiotic stewardship in GM, or other regions that share similar characteristics with GM.

This study also shows that the narrative around accountability for ABR and responsible antibiotic use needs to change. Rather than focusing on the prescribers or the users, focus should be on shared accountability as members of the same society, given ABR is a global crisis, with the potential to affect everyone.

5.6 Strengths and limitations of the study

This study has several strengths. It provided in-depth and some novel findings regarding parents' knowledge, understanding, attitudes, and perceptions regarding antibiotic use, prescription advice, and ABR, in GM. This study also provided insights into the attitudes and views of a highly educated sample, one that that would be expected to have good health literacy levels and therefore responsible antibiotic practices. However, the findings in this study contradicted what has been evidenced in the literature, i.e., that educated samples have responsible antibiotic practices. This study also aimed to provide a voice for parents to share their experiences and expectations during medical consultations, together with their views on the kinds of interventions they would be most likely to engage with on ABR. Furthermore, this study highlights the importance of encouraging antibiotic stewardship behaviours among parents, not only to encourage better antibiotic practices when administering antibiotics for they child, but also to facilitate future responsible practices from their children.

There were several limitations to this study. As this study was mostly conducted during the COVID-19 pandemic, the research design needed to change in line with public health guidance in place at the time. This resulted in changes to the survey distribution, participant recruitment, and the conduction of telephone interviews and online workshops, rather than in person focus groups and workshops. These design changes, together with the use of convenience sampling will undoubtedly have introduced bias towards internet users and those who are digitally literate, as interactions with parents for this study was only conducted online (for the first 3 phases), and young, professional people (see section 3.2.1.4, Table 12) are more likely to complete the online surveys. Various studies have shown that digital exclusion increased during COVID-19, in the UK (Baker et al., 2020; Cullinane & Montacute, 2020; Watts, 2020); however, online questionnaire distribution was a method chosen to reach a large sample of potential participants (as mentioned in Chapter 3, section 3.2), and has been utilised in other studies (see section 3.2.1.4).

Digital recruitment has been found to enable access to a greater number of people, from various geographical locations, within a short time frame; thus, making this recruitment strategy widely used in research (Benedict et al., 2019; Frampton et al., 2020). However, while these strategies can be considered cost-effective and practical, in increasing reach and engagement, they exclude those who are digitally excluded and require offline recruitment strategies instead (Benedict et al., 2019; Frampton et al., 2020). The root causes of digital exclusion often reflect economic, social, and regional disparities (Honeyman et al., 2020; Holmes & Burgess, 2022); therefore, this group tends to be unemployed, of lower education levels, disabled, older, and/or socially isolated (Honeyman et al., 2020; Sanders, 2020; Holmes & Burgess, 2022). Although there has been a decline in the percentage of those who are digitally excluded across all UK regions, digital disparity persists in the UK, with trends being worse for those who are deprived and from ethnic minorities (ONS, 2019; Poole et al., 2021; Stone, 2021; House of Lords, 2023).

The quantitative phase (Phase 1) was used to inform Phases 2 & 4 (qualitative) of this study following an explanatory methodology, i.e. it was used to set the scene regarding parents' knowledge, understanding, and attitudes towards ABR, antibiotic use and antibiotic prescribing. Although this study was more focused on qualitative data collection, Phase 1 was valuable in providing a better understanding of the gaps in knowledge and understanding, and insight into the topics requiring further exploration during the subsequent phases, e.g. medical consultations, attitudes towards ABR, and self-reported antibiotic practices.

The quantitative survey had to be moved to online only, restricting the modes of distribution of the questionnaire. The use of an online recruitment tool appeared to result in a highly educated sample, with an interest in ABR, that was biased towards White parents of high SES. This sample does not reflect the characteristics of the GM population, most likely due to the method of recruitment and sample obtained, selection bias and digital exclusion, resulting in findings that are not generalisable to the parent population of GM. However, notwithstanding this, the findings were necessary to provide insight into what should be explored further in the qualitative phases, with questions designed to elicit a wide range of responses. Whilst socially desirable answers could have been given by parents during the interviews (social desirability bias), parents seemed genuinely open to sharing both positive and negative experiences and were forthcoming when they did not understand a question or were unsure about their responses. However, it is anticipated that with a more diverse and larger sample, other views and opinions may have been gathered, and greater confidence generated in the level of saturation achieved.

Regarding the analysis of the quantitative data obtained, certain analysis choices may have introduced bias in the findings, such as the use of univariate analysis and collapsing categories (see Chapter 3, section 3.2.1.5). Univariate data analysis was used to explore each variable in the data separately, to summarise and find patterns in the data (Arbogast & VanderWeele, 2013; Pallant, 2016; DeCarlo et al., 2020; Kinney et al., 2023). Although using univariate analysis allows a better understanding of what each variable looks like and can be used to identify associations between covariates and the exposure variables, there is an increased risk of obtaining an inflated Type 1 error, as more statistical tests are conducted (Arbogast & VanderWeele, 2013; Pallant, 2016; DeCarlo et al., 2020; Kinney et al., 2023). Furthermore, due to the large number of tests performed, some of the significant associations made using Chi-square tests were likely to be significant just by chance. Multivariate analysis would have been useful to conduct, to consider the confounding variables and adjust for the increased risk of Type 1 error; however, this requires a much larger (i.e. more cases in each category than there would be dependent variables) and diverse sample (Pallant, 2016). However, there were a small number of responses in Phase 1 of this study (n=120), and many categories were not selected by participants; therefore, conducting multivariate analysis was not possible. Nevertheless, the objective of this phase of the study (objective 1) was to investigate the knowledge, understanding, and attitudes of parents living in GM, regarding antibiotic use, antibiotic prescription advice, and ABR; therefore, the data analysis plan chosen for this phase aided in accomplishing objective 1 to a degree, whilst recognising limitations of the small and biased sample.

It is important to note that although many parents in Phase 4 (n=21; including fathers) were approached to participate, many parents deselected themselves from the study when they were given the participant information sheet and consent form. Reasons given for this deselection were mainly regarding not understanding or not knowing the research topic enough, even though parents showed interest in participation prior to being given the participant information sheet and consent form. A few mothers of Pakistani origin deselected themselves from the study when they were informed that they would have to sign a consent form to participate, and when they were informed that they would be audio-recorded. Which indicates the need for a more culturally sensitive methodology to obtain the views and opinions of participants who may be prone to deselecting because of the language and tools used.

The qualitative phases, informed by phase 1, involved a small sample of participants (n=18), also favouring certain socio-demographic characteristics (White ethnicity, females, highly educated, those who are not digitally excluded). This was disappointing, however, not unsurprising, as ethnic minorities and those experiencing deprivation are under-represented in research (particularly in those that utilise online recruitment methods), despite suffering from poorer health outcomes and experiencing more health and social care inequalities than other groups (Farooqi et al., 2018; Farooqi et al., 2022). This is attributed to barriers such as general accessibility to research, potential participants' literacy levels, language, cultural values, and beliefs (Farooqi et al., 2022; Darko, 2023). This highlights the need to improve representation, particularly among under-represented groups (Farooqi et al., 2018; Farooqi et al., 2022; Darko, 2023; NHS, 2023). Understanding the characteristics of the population to be included in a study is particularly important to ensure that under-represented groups are empowered to participate in research (NIHR, 2022; Darko, 2023; NHS, 2023). It is also important to consider issues of heterogeneity within ethnic groups (i.e., religious, regional, and national differences within these groups) (NIHR, 2022); for example, although a few participants of Asian ethnicity participated in this PhD study, all Pakistani mothers approached during recruitment deselected themselves, after initially agreeing to take part.

Research methodologies should be evaluated to ensure they are appropriate for the study and have the potential to capture a representative sample, including under-represented groups. However, in this study the sampling strategies were largely dictated by the COVID-19 pandemic, and appeared to prevent active engagement with ethnic minorities. Strategies that have been found to mitigate under-representation of ethnic minorities include: high penetration sampling, which involves sampling from areas where the target ethnic minority group represents a large proportion of the general population (NIHR, 2022); and snowball sampling, where potential participants are requested to suggest other people who fit the recruitment criteria (Farooqi et al., 2022). In this regard, the following strategies could potentially be incorporated into future studies to improve participation from under-represented groups, particularly ethnic minorities:

- Consulting with researchers, from within the community being studied, or who have a familiarity with the language and culture, could provide better cultural understanding, language skills, and contacts within the community (NIHR, 2022; Darko, 2023; NHS, 2023).
- Liaising and consulting with community leaders, organisations, or community workers during the recruitment process to help promote the study, could overcome participants' concerns and improve participation (Farooqi et al., 2022; NHS, 2023).

- Considering Patient and Public Involvement (PPI), with members of the group being studied, to help address recruitment issues; facilitate research, including helping to identify topics of particular relevance to this group which may not have been originally included in the interview guide (Farooqi et al., 2018; NIHR, 2022).
- Using variations of the participant information sheet and consent form to suit the population being studied, for example visual and interactive resources (e.g. DVDs), taking verbal consent, summarised or easy-to-read formats of the documents, or translated versions, which may help overcome language barriers and low literacy levels (Farooqi et al., 2018; NHS, 2023).
- Finding opportunities to learn from, listen to, and build trust with the community being studied (NHS, 2023).
- Attending in-person events, such as local fairs, celebrations, festivals, and other community events, to talk about the research, and identify potential participants with whom the researcher could build relationships and trust before recruitment (NHS, 2023).
- Furthermore, piloting the study first using participatory approaches, with a number of volunteers from under-represented groups, as a small-scale qualitative phase, could help improve the interview design and content (Farooqi et al., 2018; Farooqi et al., 2022).

While multiple strategies were employed to recruit participants with diverse backgrounds and experiences (including more fathers, younger parents, ethnic minorities, and those with varying levels of education), participants' demographic characteristics were largely homogenous. It is important to note while efforts were made during phase 4 to recruit participants from deprived areas, those that participated displayed atypical characteristics to a deprived sample and were mostly educated to a university level. Therefore, an in-depth understanding of how deprivation may be associated with participants' knowledge, perceptions, attitudes was not possible. Future similar studies should consider looking at SES rather than only level area deprivation, which should provide a better understanding of how SES affects antibiotic knowledge, awareness, attitudes, and behaviours, in a setting like GM.

Furthermore, this study was biased towards mothers, an issue that has been found with previous studies that have sought to engage men (see for example Newington & Metcalfe, 2014; Law et al., 2019; Ryan et al., 2019; Tully et al., 2021). While previous research has found that gender roles influence child health care (with mothers being the main carer, more likely to take a child to the doctor, and more involved in the child's treatment), changing trends are being observed with fathers playing a more influential role in this regard (Zvara et al., 2013; Livingston et al., 2019; Yogman et al., 2021; Rubin et al., 2022). Zvara et al.'s (2013) study found that fathers had greater engagement in child healthcare when mothers had more non-traditional beliefs about gender roles. This was also observed in other studies which report how fatherhood roles are changing, alongside socioeconomic and cultural changes (e.g., increase in women's educational attainment and economic power), which provides fathers with the opportunity to contribute more to childcare (Livingston et al., 2019; Yogman et al., 2021; Rubin et al., 2022). It is important to factor in gender roles when looking at research on health and social care, such as this PhD study, where gender roles may be deeply engrained in ethnic minority groups (Wight et al., 2014; Nandi & Platt, 2023). Therefore, if mothers generally have more engagement in child healthcare compared to fathers, it is important to ascertain how to include fathers in a study of this nature, to ensure their voices are not lost. Davison et al. (2018) and Tully et al. (2021) suggests that ensuring that fathers/males are explicitly invited to participate, could encourage them to participate in health promotion research. Targeting father-focused venues could also be useful, and Davison et al. (2018) suggests recruiting through community sports events, social service programmes, and via the internet (Davison et al., 2018); although these strategies were not possible for most of the study period, due to COVID-19.

5.7 Implications for future research

Several novel findings have emerged from this study, which would benefit from further investigations. Therefore, the following recommendations have been made:

- Further quantitative research is needed in GM and/or other areas of the UK, to establish relationships between knowledge, understanding, perceptions, attitudes and behaviours, and socio-demographic characteristics. Recommendations are for this to be carried out in paper form, in areas with different levels of deprivation, together with online, to capture a larger, and more diverse sample.

- Further qualitative research is needed in GM and/or other areas of the UK, having multiple deprivation levels, with more socio-economically and ethnically diverse populations, to enable further insights into parents' perceptions, attitudes and behaviours relating to ABR and antibiotic use, particularly considering the inequalities that have deepened after the pandemic. Area deprivation levels alone should be used with caution when evaluating populations living in deprived areas, with other measures of socio-economic status recommended to be used to establish 'deprivation' more accurately.
- More research is needed on how to foster more emotional engagement towards ABR, across diverse groups, to improve antibiotic stewardship.
- More investigation is needed on how parents could be central in the development of interventions that would target them as stakeholders, particularly to improve and encourage antibiotic stewardship among this population.
- It is also critical to explore attitudes and behaviours among clinicians in a setting like GM, particularly with regards to prescribing antibiotics for children, managing parental anxiety and need for reassurance while also curbing antibiotic expectations, to better determine how communication challenges can be mitigated. This is important given the current pressures on primary care that need to be addressed and reduced.
- Finally, further research is needed to explore how to improve trust between patients and clinicians, particularly in the post-pandemic era, and given the NHS crisis.

5.8 Conclusions

This 4-phased study, conducted in GM, has highlighted the importance of understanding parents' knowledge, understanding and attitudes towards ABR, and exploring with them ways to empower parents to make better choices regarding antibiotic use and ABR. This study has shown there is scope to improve antibiotic stewardship, attitudes, behaviours, and public engagement with ABR among parents. The findings show a need for awareness on ABR and antibiotic use, and that the lack of personal relevance prevents engagement with this issue. Therefore, future campaigns and interventions should aim to improve emotional engagement, while emphasising the consequences of increased ABR and its significance for children, their families, and society.

The findings also show the importance of improving clinician-patient relationships; to optimise medical consultations by empowering and supporting parents to manage self-limiting infections at home, by including parents in the treatment decisions for their child, and by providing clear and adequate information for why antibiotics are or are not being prescribed, so that parents feel more informed and reassured at the end of these consultations. These changes could not only improve the clinician-patient communications, but it could also increase trust in healthcare professionals, and potentially improve antibiotic stewardship among both clinicians and parents.

The findings, with respect to parents' attitudes towards public health information in a time of pandemic, may be useful to inform future ABR campaigns, as mistrust in public health information and health promotion messages could potentially influence the future uptake of these.

The COVID-19 pandemic has highlighted the dangers of being complacent about infection prevention and control. The need to change attitudes and behaviours is crucial, as ABR could be the next pandemic. Improving awareness and antibiotic stewardship among parents is only one piece of the ABR jigsaw puzzle. Stronger social movement and political commitment is needed, as we head towards a post-antibiotic era.

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Appendix 1: Tables showing quantitative results (including X^2 values and p-values)

Table 28: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on gender

Question	Gender (n,%)						Test
	Female			Male			
	T	F	DK	T	F	DK	
Antibiotics kill viruses*	6 (5.3)	106 (93.0)	2 (1.8)	2 (33.3)	4 (67.7)	0 (0.0)	X^2=5.97 P value=0.08
Antibiotics are effective against colds*	1 (0.9)	113 (99.1)	0 (0.0)	0 (0.0)	6 (100)	0 (0.0)	X^2= ** P value= 1.0
Unnecessary use of antibiotics makes them become ineffective*	108 (94.7)	6 (5.3)	0 (0.0)	5 (83.3)	1 (16.7)	0 (0.0)	X^2=** P value=0.31
Taking antibiotics often has side-effects such as diarrhoea*	78 (68.4)	14 (12.3)	22 (19.3)	2 (33.3)	1 (16.7)	3 (50.0)	X^2=3.92 P value=0.11
(When do you think you should stop taking antibiotics once you have begun a course of treatment?) When you feel better*	1 (0.9)	113 (99.1)	0 (0.0)	0 (0.0)	6 (100)	0 (0.0)	X^2=** P value=1.0
(When do you think you should stop taking antibiotics once you have begun a course of treatment?) When you have taken all of the antibiotics as directed by your doctor*	113 (99.1)	1 (0.9)	0 (0.0)	6 (100)	0 (0.0)	0 (0.0)	X^2=** P value=1.0
The improper use of antibiotics can lead to ineffective treatment*	111 (97.4)	1 (0.9)	2 (1.8)	6 (100)	0 (0.0)	0 (0.0)	X^2=2.06 P value=1.0
The improper use of antibiotics can lead to worsening of illness*	72 (63.2)	16 (14.0)	26 (22.8)	4 (66.7)	1 (16.7)	1 (16.7)	X^2=0.40 P value=1.0
The improper use of antibiotics can lead to emergence of bacterial resistance*	100 (87.7)	14 (12.3)	0 (0.0)	3 (50.0)	0 (0.0)	3 (50.0)	X^2=** P value=0.04
The improper use of antibiotics can lead to additional medical cost to the patient*	65 (57.0)	22 (19.3)	27 (23.7)	2 (33.3)	1 (16.7)	3 (50.0)	X^2=2.21 P value=0.33
Bacteria are germs that cause common cold and flu*	25 (21.9)	80 (70.2)	9 (7.9)	1 (16.7)	4 (66.7)	1 (16.7)	X^2=1.19 P value=0.61
Antibiotics are effective against bacteria*	88 (77.2)	22 (19.3)	4 (3.5)	4 (66.7)	2 (33.3)	0 (0.0)	X^2=1.23 P value=0.68
Antibiotic resistance can spread from animals to human*	30 (26.3)	51 (44.7)	33 (28.9)	3 (50.0)	2 (33.3)	1 (16.7)	X^2=1.53 P value=0.49
Antibiotic resistance can spread from human to human*	39 (34.2)	45 (39.5)	30 (26.3)	3 (50.0)	2 (33.3)	1 (16.7)	X^2=0.69 P value=0.76

*Fischer's exact test was used as one or more cells have expected counts less than 5

** No value obtained for Fischer's exact test

Table 29: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on age

Questions	Age (n,%)												Test
	16-29			30-39			40-49			50+			
	T	F	DK	T	F	DK	T	F	DK	T	F	DK	
Antibiotics kill viruses*	1 (10.0)	9 (90.0)	0	6 (8.5)	64 (90.1)	1 (1.4)	1 (2.9)	32 (94.1)	1 (2.9)	0	5 (100)	0	X^2=3.64 P=0.77

			(0.0)							(0.0)		(0.0)	
Antibiotics are effective against colds*	0 (0.0)	10 (100)	0 (0.0)	0 (0.0)	71 (100)	0 (0.0)	1 (2.9)	33 (97.1)	0 (0.0)	0 (0.0)	5 (100)	0 (0.0)	X^2=4.5 P=0.41
Unnecessary use of antibiotics makes them become ineffective*	9 (90.0)	1 (10.0)	1	69 (97.2)	2 (2.8)	1	31 (91.2)	3 (8.8)	0 (0.0)	4 (80.0)	1 (20.0)	0 (0.0)	X^2=5.0 P=0.15
Taking antibiotics often has side-effects such as diarrhoea*	8 (80.0)	0 (0.0)	2 (20.0)	48 (67.6)	10 (14.1)	13 (18.3)	20 (58.8)	4 (11.8)	10 (29.4)	5 (80.0)	1 (20.0)	0 (0.0)	X^2=4.28 P=0.62
When you feel better[1]*	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	71 (100.0)	0 (0.0)	1 (2.9)	33 (97.1)	0 (0.0)	0 (0.0)	5 (100)	0 (0.0)	X^2=4.5 P=0.41
When you have taken all of the antibiotics as directed by your doctor[1]*	10 (100.0)	0 (0.0)	0 (0.0)	71 (100.0)	0 (0.0)	0 (0.0)	33 (97.1)	1 (2.9)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=4.5 P=0.41
The improper use of antibiotics can lead to ineffective treatment*	8 (80.0)	1 (10.0)	1 (10.0)	71 (100.0)	0 (0.0)	0 (0.0)	33 (97.1)	0 (0.0)	1 (2.9)	5 (100)	0 (0.0)	0 (0.0)	X^2=13.1 P=0.02
The improper use of antibiotics can lead to worsening of illness*	7 (70.0)	1 (10.0)	2 (20.0)	43 (60.6)	11 (15.5)	17 (23.9)	22 (64.7)	4 (11.8)	8 (23.5)	4 (80.0)	1 (20.0)	0 (0.0)	X^2=1.9 P=0.96
The improper use of antibiotics can lead to emergence of bacterial resistance*	6 (60.0)	0 (0.0)	4 (40.0)	64 (90.1)	0 (0.0)	7 (9.9)	28 (82.4)	0 (0.0)	6 (17.6)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=6.4 P=0.07
The improper use of antibiotics can lead to additional medical cost to the patient*	7 (70.0)	1 (10.0)	2 (20.0)	41 (57.7)	15 (21.1)	15 (21.1)	17 (50.0)	6 (17.6)	11 (32.4)	2 (40.0)	1 (20.0)	2 (40.0)	X^2=3.3 P=0.79
Bacteria are germs that cause common cold and flu*	2 (20.0)	6 (60.0)	2 (20.0)	15 (21.1)	49 (69.00	7 (9.9)	7 (20.6)	26 (76.5)	1 (2.9)	2 (40.0)	3 (60.0)	0 (0.0)	X^2=4.6 P=0.54
Antibiotics are effective against bacteria*	6 (60.0)	3 (30.0)	1 (10.0)	55 (77.5)	13 (18.3)	3 (4.2)	28 (82.4)	6 (17.6)	0 (0.0)	3 (60.0)	2 (40.0)	0 (0.0)	X^2=5.9 P=0.37
Antibiotic resistance can spread from animals to human*	5 (50.0)	1 (10.0)	4 (40.0)	21 (29.6)	31 (43.7)	19 (26.8)	7 (20.6)	20 (58.8)	7 (20.6)	0 (0.0)	1 (20.0)	4 (80.0)	**X^2=13.2 P=0.02**
Antibiotic resistance can spread from human to human*	6 (60.0)	1 (10.0)	3 (30.0)	25 (30.0)	30 (42.3)	16 (22.5)	10 (29.4)	14 (41.2)	10 (29.4)	1 (20.0)	2 (40.0)	2 (40.0)	X^2=6.1 P=0.40

[1]Shortened question (*When do you think you should stop taking antibiotics once you have begun a course of treatment?*)
*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 30: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on ethnicity

Questions	Ethnicity (n,%)												Test
	White			Black			Asia			Mixed			
	T	F	DK	T	F	DK	T	F	DK	T	F	DK	
Antibiotics kill viruses*	8 (7.0)	105 (92.1)	1 (0.9)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.)	0 (0.0)	1 (100.0)	0 (0.0)-	X^2=15.9 P=0.06
Antibiotics are effective against colds*	0 (0.0)-	114 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	X^2=*** P= ***
Unnecessary use of antibiotics makes them become ineffective*	109 (95.6)	5 (4.4)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	**X^2=11.1 P=0.03**
Taking antibiotics often has side-effects such as diarrhoea*	76 (66.7)	14 (12.3)	24 (21.1)	3 (75.0)	0 (0.0)	1 (25.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=6.1 P=0.50
When you feel better[1]*	0 (0.0)	114 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	X^2=*** P=***
When you have taken all of the antibiotics as directed by your doctor[1]*	114 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)-	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=*** P=***
The improper use of antibiotics can lead to ineffective treatment*	112 (98.2)	1 (0.9)	1 (0.9)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	**X^2=21.4 P=0.05**
The improper use of antibiotics can lead to worsening of illness*	73 (64.0)	15 (13.2)	26 (22.8)	3 (75.0)	1 (25.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=8.7 P=0.10
The improper use of antibiotics can lead to emergence of bacterial resistance*	98 (86.0)	0 (0.0)	16 (14.0)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=4.9 P=0.34
The improper use of antibiotics can lead to additional medical cost to the patient*	64 (56.1)	21 (18.4)	29 (25.4)	3 (75.00	1 (25.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=7.2 P=0.20

Bacteria are germs that cause common cold and flu*	23 (20.2)	81 (71.1)	10 (8.8)	1 (25.0)	3 (75.00	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=8.1 P=0.20
Antibiotics are effective against bacteria*	88 (77.2)	22 (19.3)	4 (3.5)	2 (50.0)	2 (50.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=7.1 P=0.59
Antibiotic resistance can spread from animals to human*	29 (25.4)	53 (46.5)	32 (28.1)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=11.0 P=0.003
Antibiotic resistance can spread from human to human*	38 (33.3)	46 (40.4)	30 (26.3)	3 (75.0)	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=6.6 P=0.20

[1]Shortened question (*When do you think you should stop taking antibiotics once you have begun a course of treatment?*)
*Fischer's exact test was used as one or more cells have expected counts less than 5
** Cannot be computed due to insufficient memory

Table 31: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on place of birth

Questions	Place of Birth (n,%)						Test
	Born in the UK			Born outside the UK			
	T	F	DK	T	F	DK	
Antibiotics (ABs) kill viruses*	8 (7.3)	100 (91.7)	1 (0.9)	0 (0.0)	10 (90.9)	1 (9.1)	X^2=3.64 P=0.20
Antibiotics are effective against colds*	0 (0.0)	109 (100.0)	0 (0.0)	1 (9.1)	10 (90.9)	0 (0.0)	X^2=** P=0.09
Unnecessary use of antibiotics makes them become ineffective*	104 (95.4)	5 (4.6)	0 (0.0)	9 (81.0)	2 (18.2)	0 (0.0)	X^2=** P=0.13
Taking antibiotics often has side-effects such as diarrhoea*	71 (65.1)	14 (12.8)	24 (22.0)	9 (81.8)	1 (9.1)	1 (9.1)	X^2=0.96 P=0.71
When you feel better[1]*	0 (0.0)	109 (100.0)	0 (0.0)	1 (9.1)	10 (90.9)	0 (0.0)	X^2=** P=0.09
When you have taken all of the antibiotics as directed by your doctor[1]*	109 (100.0)	0 (0.0)	0 (0.0)	10 (90.9)	1 (9.1)	0 (0.0)	X^2=** P=0.09
The improper use of antibiotics can lead to ineffective treatment*	107 (98.2)	1 (0.9)	1 (0.9)	10 (90.9)	0 (0.0)	1 (9.1)	X^2=4.37 P=0.25
The improper use of antibiotics can lead to worsening of illness*	68.0 (62.4)	15 (13.8)	26 (23.9)	8 (72.7)	2 (18.2)	1 (9.1)	X^2=1.26 P=0.65
The improper use of antibiotics can lead to emergence of bacterial resistance*	93 (85.0)	0 (0.0)	16 (14.7)	10 (90.9)	0 (0.0)	1 (9.1)	X^2=** P=1.0
The improper use of antibiotics can lead to additional medical cost to the patient*	60 (55.0)	20 (18.3)	29 (26.6)	7 (63.6)	3 (27.3)	1 (9.1)	X^2=1.79 P=0.42
Bacteria are germs that cause common cold and flu*	23 (21.1)	76 (69.7)	10 (9.2)	3 (27.3)	8 (72.7)	0 (0.0)	X^2=0.74 P=0.67
Antibiotics are effective against bacteria*	83 (76.1)	22 (20.2)	4 (3.7)	9 (81.8)	2 (18.2)	0 (0.0)	X^2=0.15 P=1.0
Antibiotic resistance (ABR) can spread from animals to human*	28 (25.7)	49 (45.0)	32 (29.4)	5 (45.5)	4 (36.4)	2 (18.2)	X^2=1.88 P=0.44
Antibiotic resistance can spread from human to human*	36 (33.0)	43 (39.4)	30 (27.5)	6 (54.5)	4 (36.4)	1 (9.1)	X^2=2.44 P=0.32

[1]Shortened question (*When do you think you should stop taking antibiotics once you have begun a course of treatment?*)
*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 32: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on educational attainment

Questions	Educational Attainment (n,%)																														Test
	GCSEs[2]			Apprenticeship			A-Levels[3]			Certificate of Higher Education			Diploma of Higher Education			Undergraduate Degree			Master's Degree			Doctorate			Professional Qualification			Other[4]			
	T	F	DK	T	F	DK	T	F	DK	T	F	DK	T	F	DK	T	F	DK	T	F	DK	T	F	DK	T	F	DF	T	F	DK	
Abs kill viruses *	1 (20.00	4 (80.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (14.3)	6 (85.7)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	1 (16.7)	5 (83.3)	0 (0.0)	3 (7.9)	35 (92.1)	0 (0.0)	1 93.4)	27 (93.1)	1 (3.4)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	15 (93.8)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	X^2=22.76 P=0.20
ABs are effective against colds*	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	38 (96.6)	0 (0.0)	1 (3.4)	28 (96.6)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	X^2=14.10 P=0.68
Unnecessary use of ABs makes them become ineffective*	3 (60.0)	2 (40.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	37 (97.4)	1 (2.6)	0 (0.0)	25 (86.2)	4 913.8)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.00	0 (0.0)	0 (0.0)	X^2=11.75 P=0.13
Taking Abs often has side-effects such as diarrhoea*	3 (60.0)	1 (20.0)	1 (20.0)	1 (100.0)	0 (0.0)	0 (0.0)	2 (28.6)	4 (57.1)	1 (14.3)	3 (75.00	1 (25.00	0 (0.0)	5 (83.3)	0 (0.0)	1 (16.7)	23 (60.5)	3 (7.9)	12 (31.6)	20 (69.0)	3 (10.3)	6 (20.7)	9 (90.0)	1 (10.0)	0 (0.0)	10 (62.5)	2 (12.5)	4 (25.0)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=19.13 P=0.25
When you feel better[1] *	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	38.0 (100.0)	0 (0.0)	1 (3.4)	28 (96.6)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (10.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	X^2=14.10 P=0.68
When you have taken all of the ABs	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	38 (100.0)	0 (0.0)	0 (0.0)	28 (96.6)	1 (3.4)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=14.10 P=0.68

as directed by your doctor[1]*																															
The improper use of ABs can lead to ineffective treatment*	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	5 (83.3)	0 (0.0)	1 (16.1)	38 (100.0)	0 (0.0)	0 (0.0)	28 (96.6)	0 (0.0)	1 (3.4)	10 (100.0)	0 (0.0)	0 (0.0)	15 (93.8)	1 (6.3)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=27.70 P=0.31
The improper use of ABs can lead to worsening of illness*	4 (80.0)	1 (20.00	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	5 (71.4)	2 (28.6)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	4 (66.7)	0 (0.0)	2 (33.3)	22 (57.9)	6 (15.8)	10 (26.3)	17 (58.6)	4 (13.8)	8 (27.6)	7 (70.0)	1 (10.0)	2 (20.0)	10 (62.5)	2 (12.5)	4 (25.)	3 (75.0)	0 (0.0)	1 (25.0)	X^2=9.28 P=0.98
The improper use of ABs can lead to emergence of bacterial resistance*	2 (40.0)	0 (0.0)	3 (60.0)	0 (0.0)	0 (0.0)	1 (100.0)	6 (85.7)	0 (0.0)	1 (14.3)	4 (100.0)	0 (0.0)	0 (0.0)	5 (83.3)	0 (0.0)	1 (16.7)	33 (86.8)	0 (0.0)	5 (13.2)	26 (89.7)	0 (0.0)	3 (10.3)	9 (90.0)	0 (0.0)	1 (10.0)	14 (87.5)	0 (0.0)	2 (12.5)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=11.50 P=0.15
The improper use of ABs can lead to additional	2 (40.0)	1 (20.0)	1 (20.0)	0 (0.0)	1 (100.0)	0 (0.0)	4 (57.1)	3 (42.9)	0 (0.0)	3 (75.0)	0 (0.0)	1 (25.0)	3 (50.0)	0 (0.0)	3 (50.0)	21 (55.3)	5 (13.2)	12 (31.6)	21 (72.4)	4 (13.8)	4 (13.8)	4 (40.0)	3 (30.0)	3 (30.0)	7 (43.8)	5 (31.3)	4 (25.0)	2 (50.0)	0 (0.0)	2 (50.0)	X^2=20.33 P=0.21

medical cost to the patient *																															
Bacteria are germs that cause common cold and flu*	1 (20.0)	3 (60.0)	1 (20.0)	0 (0.0)	1 (100.0)	0 (0.0)	3 (42.9)	4 (57.1)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	2 (33.3)	2 (33.3)	2 (33.3)	9 (23.7)	27 (71.1)	2 (5.3)	5 (17.2)	22 (75.9)	2 (6.9)	1 (10.0)	9 (90.0)	0 (0.0)	2 (12.5)	11 (68.8)	3 (18.8)	2 (50.0)	2 (50.0)	0 (0.0)	X^2=16.80 P=0.43
ABs are effective against bacteria*	3 (60.0)	1 (20.0)	1 (20.0)	0 (0.0)	1 (100.0)	0 (0.0)	4 (57.1)	3 (42.9)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	3 (50.0)	3 (50.0)	0 (0.0)	32 (84.2)	4 (10.5)	2 (5.3)	24 (82.8)	4 (13.8)	1 (3.4)	9 (90.0)	1 (10.0)	0 (0.0)	11 (68.8)	5 (31.3)	0 (0.0)	2 (50.0)	2 (50.0)	0 (0.0)	X^2=23.20 P=0.10
ABR can spread from animals to human *	0 (0.0)	4 (80.0)	1 (20.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (14.3)	5 (71.4)	1 (14.3)	2 (50.0)	1 (25.00	1 (25.0)	0 (0.0)	4 (66.7)	2 (33.3.)	13 (34.2)	14 (36.8)	11 (28.9)	11 (37.9)	11 (37.9)	7 (24.1)	2 (20.0)	5 (50.0)	3 (30.0)	3 (18.8)	6 (37.5)	7 (43.8)	1 (25.0)	2 (50.0)	1 (25.0)	X^2=13.95 P=0.75
ABR can spread from human to human *	0 (0.0)	4 (80.0)	1 (20.0)	0 (0.0)	1 (100.0)	0 (0.0)	2 (28.6)	3 (42.9)	2 (28.6)	2 (50.0)	2 (50.0)	0 (0.0)	0 (0.0)	5 (83.3)	1 (16.7)	16 (42.1)	11 (28.9)	11 (28.9)	11 (37.9)	12 (41.4)	6 (20.7)	5 (50.0)	1 (10.0)	4 (40.0)	5 (31.3)	6 (37.50	5 (31.3)	1 (25.0)	2 (50.0)	1 (25.0)	X^2=18.13 P=0.38

[1]Shortened question (*When do you think you should stop taking antibiotics once you have begun a course of treatment?*)
[2] Including O-levels and CSEs
[3] Including Higher School Certificate and Advanced Diploma
[4] Including other vocational/work-related qualifications and foreign qualifications
* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 33: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on number of children

Questions	Number of children (n,%)												Test
	1			2			3			4 or more			
	T	F	DK	T	F	DK	T	F	DK	T	F	DK	
Antibiotics kill viruses*	3 (6.4)	44 (93.6)	0 (0.0)	3 (5.5)	51 (92.7)	1 (1.8)	1 (7.7)	11 (84.6)	1 (7.7)	1 (20.0)	4 (80.0)	0 (0.0)	X^2=6.58 P=0.32
Antibiotics are effective against colds*	0 (0.0)	47 (100.0)	0 (0.0)	1 (1.8)	54 (98.20	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.00	0 (0.0)	X^2=3.19 P=1.0
Unnecessary use of antibiotics makes them become ineffective*	43 (91.5)	4 (8.5)	0 (0.0)	53 (96.4)	2 (3.6)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	4 (80.0)	1 (20.0)	0 (0.0)	X^2=3.56 P=0.24
Taking antibiotics often has side-effects such as diarrhoea*	27 (57.4)	7 (14.9)	13 (27.7)	41 (74.5)	6 (10.9)	8 (14.5)	8 861.5)	2 915.4)	3 (23.1)	4 (80.00	0 (0.0)	1 (20.00	X^2=4.42 P=0.59
When you feel better[1]*	0 (0.0)	47 (100.00	0 (0.0)	1 (1.8)	54 (98.2)	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	X^2=3.19 P=1.0
When you have taken all of the antibiotics as directed by your doctor[1]*	47 (100.0)	0 (0.0)	0 (0.0)	54 (98.2)	1 (1.8)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=3.19 P=1.0
The improper use of antibiotics can lead to ineffective treatment*	46 (97.9)	1 (2.1)	0 (0.0)	53 (96.4)	0 (0.0)	2 (3.6)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=6.19 P=0.60
The improper use of antibiotics can lead to worsening of illness*	34 (72.3)	5 (10.6)	8 (17.0)	32 (58.2)	9 (16.4)	14 (25.5)	8 (61.5)	1 (7.7)	4 (30.8)	2 (40.0)	2 (40.0)	1 (20.0)	X^2=5.70 P=0.42
The improper use of antibiotics can lead to emergence of bacterial resistance*	40 (85.1)	0 (0.0)	7 (14.9)	47 (85.5)	0 (0.0)	8 (14.5)	12 (92.3)	0 (0.0)	1 (7.7)	4 (80.0)	0 (0.0)	1 (20.0)	X^2=0.85 P=0.89
The improper use of antibiotics can lead to additional medical cost to the patient*	28 (59.6)	8 (17.0)	11 (23.4)	28 (50.9)	12 (21.8)	15 (27.3)	8 (61.5)	1 (7.7)	4 (30.8)	3 (60.0)	2 (40.0)	0 (0.0)	X^2=4.11 P=0.66
Bacteria are germs that cause common	11 (23.4)	32 (68.1)	4 (8.5)	10 (18.2)	40 (72.7)	5 (9.1)	3 (23.1)	9 (69.2)	1 (7.7)	2 (40.0)	3 (60.0)	0 (0.0)	X^2=1.96 P=0.95

cold and flu*													
Antibiotics are effective against bacteria*	36 (76.6)	10 (21.3)	1 (2.1)	42 (76.4)	10 (18.2)	3 (5.5)	9 (69.2)	4 (30.8)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=3.22 P=0.78
Antibiotic resistance can spread from animals to human*	14 (29.8)	19 (40.4)	14 (29.8)	13 (23.6)	25 (45.5)	17 (30.9)	5 (38.5)	6 (46.2)	2 (15.4)	1 (20.0)	3 (60.0)	1 (20.0)	X^2=2.61 P=0.88
Antibiotic resistance can spread from human to human*	20 (42.6)	16 (34.0)	11 (23.4)	14 (25.5)	24 (43.6)	17 (30.9)	7 (53.8)	4 (30.8)	2 (15.4)	1 (20.0)	3 (60.0)	1 (20.0)	X^2=6.22 P=0.39

[1]Shortened question (*When do you think you should stop taking antibiotics once you have begun a course of treatment?*)
*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 34: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on number of children aged between 3 months and 6 years old

Questions	Number of children aged between 3 months and 6 years old (n,%)												Test
	1			2			3			4 or more			
	T	F	DK	T	F	DK	T	F	DK	T	F	DK	
Antibiotics kill viruses*	6 (7.9)	70 (92.1)	0 (0.0)	2 (5.3)	35 (92.1)	1 (2.6)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	0 (0.0)	X^2=10.05 P=0.17
Antibiotics are effective against colds*	0 (0.0)	76 (100.0)	0 (0.0)	1 (2.6)	37 (97.4)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	X^2=5.91 P=0.37
Unnecessary use of antibiotics makes them become ineffective*	72 (94.7)	4 (5.3)	0 (0.0)	36 (94.7)	2 (5.3)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	1 (50.00	1 (50.0)	0 (0.0)	X^2=4.92 P=0.19
Taking antibiotics often has side-effects such as diarrhoea*	47 (61.8)	10 (13.2)	19 (25.0)	29 976.3)	4 (10.5)	5 (13.2)	2 950.0)	1 (25.0)	1 (25.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=4.68 P=0.52
When you feel better[1]*	0 (0.0)	76 (100.0)	0 (0.0)	1 (2.6)	37 (97.4)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	X^2=5.91 P=0.37
When you have taken all of the antibiotics as directed by your doctor[1]*	76 (100.0)	0 (0.0)	0 (0.0)	37 (97.4)	1 (2.6)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=5.91 P=0.37
The improper use of antibiotics can lead to ineffective treatment*	74 (97.4)	1 (1.3)	1 (1.3)	37 (97.4)	0 (0.0)	1 (2.6)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=7.89 P=1.0
The improper use of antibiotics can lead to	50 (65.8)	22 (57.9)	16 (21.1)	22 (57.9)	6 (15.8)	10 (26.3)	3 (75.0)	0 (0.0)	1 (25.0)	1 (50.0)	1 (50.0)	0 (0.0)	X^2=3.50 P=0.72

worsening of illness*													
The improper use of antibiotics can lead to emergence of bacterial resistance*	67 (88.2)	0 (0.0)	9 (11.8)	31 (81.6)	0 (0.0)	7 (18.4)	3 (75.0)	0 (0.0)	1 (25.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=2.09 P=0.55
The improper use of antibiotics can lead to additional medical cost to the patient*	43 (56.6)	14 (18.4)	19 (25.0)	21 (55.3)	8 (21.1)	9 (23.7)	2 (50.0)	0 (0.0)	2 (50.0)	1 (50.00	1 (50.0)	0 (0.0)	X^2=3.29 P=0.79
Bacteria are germs that cause common cold and flu*	19 (25.0)	50 (65.8)	7 (9.2)	7 (18.4)	29 (76.3)	2 (5.3)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	0 (0.0)	X^2=4.30 P=0.60
Antibiotics are effective against bacteria*	56 (73.7)	17 (22.4)	3 (3.9)	31 (81.6)	6 (15.8)	1 (2.6)	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=3.10 P=0.89
Antibiotic resistance can spread from animals to human*	18 (23.7)	34 (44.7)	24 (31.6)	13 (34.2)	15 (39.5)	10 (26.3)	2 (50.0)	2 (50.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	X^2=4.92 P=0.54
Antibiotic resistance can spread from human to human*	28 (36.8)	29 (38.2)	19 (25.0)	12 (31.6)	15 (39.5)	11 (28.9)	2 (50.0)	1 (25.0)	1 (25.0)	0 (0.0)	2 (100.0)	0 (0.0)	X^2=3.17 P=0.87

[1]Shortened question (*When do you think you should stop taking antibiotics once you have begun a course of treatment?*)
*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 35: Frequency distribution of answers regarding knowledge of antibiotic resistance and antibiotic use, based on deprivation

Question	Deprivation (n,%)						Test
	More deprived			Less deprived			
	T	F	DK	T	F	DK	
Antibiotics kill viruses	3 (2.5)	45 (37.5)	1 (0.8)	5 (4.2)	65 (54.2)	1 (0.8)	X^2=0.11 P=0.95
Antibiotics are effective against colds*	1 (0.8)	48 (40.0)	0 (0.0)	0 (0.0)	71 (59.2)	0 (0.0)	X^2=1.46 P=0.41
Unnecessary use of antibiotics makes them become ineffective*	46 (38.3)	3 (2.5)	0 (0.0)	67 (55.8)	4 (3.3)	0 (0.0)	X^2=0.01 P=1.0
Taking antibiotics often has side-effects such as diarrhoea	30 (25.0)	8 (6.7)	11 (9.2)	50 (41.7)	7 (5.8)	14 (11.7)	X^2=1.44 P=0.49
(When do you think you should stop taking antibiotics once you have begun a course of treatment?) When you feel better*	1 (0.8)	48 (40.0)	0 (0.0)	0 (0.0)	71 (59.2)	0 (0.0)	X^2=1.46 P=0.41

(When do you think you should stop taking antibiotics once you have begun a course of treatment?) When you have taken all of the antibiotics as directed by your doctor*	48 (40.0)	1 (0.8)	0 (0.0)	71 (59.2)	0 (0.0)	0 (0.0)	X^2=1.46 P=0.41
The improper use of antibiotics can lead to ineffective treatment	48 (40.0)	0 (0.0)	1 (0.8)	69.0 (57.5)	1 (0.8)	1 (0.8(	X^2=0.76 P=0.68
The improper use of antibiotics can lead to worsening of illness	32 (26.7)	7 (5.8)	10 (8.3)	44 (36.7)	10 (8.3)	17 (14.2)	X^2=0.21 P=0.90
The improper use of antibiotics can lead to emergence of bacterial resistance*	39 (32.5)	0 (0.0)	10 (8.3)	64 (53.3)	0 (0.0)	7 (5.8)	X^2=2.65 P=0.12
The improper use of antibiotics can lead to additional medical cost to the patient	25 (20.8)	12 (10.0)	12 (10.0)	42 (35.0)	11 (9.2)	18 (15.0)	X^2=1.58 P=0.46
Bacteria are germs that cause common cold and flu	13 (10.8)	33 (27.5)	3 (2.5)	13 (10.8)	51 (42.5)	7 (5.8)	X^2=1.47 P=0.48
Antibiotics are effective against bacteria	35 (29.2)	11 (9.2)	3 (2.5)	57 (47.5)	13 10.8)	1 (0.8)	X^2=2.48 P=0.29
Antibiotic resistance can spread from animals to human	12 (10.0)	20 (16.7)	17 (14.2)	21 (17.5)	33 (27.5)	17 (14.2)	X^2=1.67 P=0.44
Antibiotic resistance can spread from human to human	17 (14.2)	17 (14.2)	15 (12.5)	25 (20.8)	30 (25.0)	16 (13.3)	X^2=1.16 P=0.56

*Fischer's exact test was used as one or more cells have expected counts less than 5

** No value obtained for Fischer's exact test

Table 36: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on gender

Question	Gender (n,%)						Test
	Female			Male			
	A	U	D	A	U	D	
ABR is an important and serious public health issue worldwide*	108 (94.7)	5 (4.4)	1 (0.9)	6 (100.0)	0 (0.0)	0 (0.0)	X^2=1.49 P=1.0
ABR is an important and serious public health issue in this country*	106 (93.0)	7 (6.1)	1 (0.9)	6 (100.0)	0 (0.0)	0 (0.0)	X^2=1.39 P=1.0
When I have a cold, I should take ABs to prevent getting a more serious illness*	2 (1.8)	0 (0.0)	112 (98.2)	2 (33.3)	0 (0.0)	4 (66.7)	X^2=17.64 P=0.01
When I get fever, ABs help me to get better more quickly*	2 (1.8)	14 (12.3)	98 (86.0)	0 (0.0)	1 (16.7)	5 (83.3)	X^2=1.22 P=0.61
Whenever I take ABs, I contribute to the development of antibiotic resistance*	56 (49.1)	25 (21.9)	33 (28.9)	6 (100.0)	0 (0.0)	0 (0.0)	X^2=4.53 P=0.05
Skipping one or two doses does not contribute to the development of ABR*	19 (16.7)	30 (26.3)	65 (57.0)	0 (0.0)	3 (50.0)	3 (50.0)	X^2=1.73 P=0.43
ABs are safe drugs; hence they can be commonly used*	46 (40.4)	13 (11.4)	55 (48.2)	2 (33.3)	2 (33.3)	2 (33.3)	X^2=2.51 P=0.27
If a child suffers from a cold or flu, it will be cured faster if they are given ABs*	2 (1.8)	2 (1.8)	110 (96.5)	0 (0.0)	0 (0.0)	6 (100.0)	X^2=1.48 P=1.0
If the doctor did not prescribe ABs often enough for your child, you would change doctor or go to another healthcare professional*	4 (3.5)	5 (4.4)	105 (92.1)	0 (0.0)	2 (33.3)	4 (66.7)	X^2=6.07 P=0.05
You would re-use an AB which you had used in the past if your child presents the same symptoms*	10 (8.8)	9 (7.9)	95 (83.3)	1 (16.7)	1 (16.7)	4 (66.7)	X^2=2.27 P=0.28

Most of the URTIs will be self-cured even without the use of ABs*	103 (90.4)	5 (4.4)	6 (5.3)	5 (83.3)	1 (16.7)	0 (0.0)	X^2=2.34 P=0.48
You expect your doctor to prescribe ABs if your child was suffering from an URTI*	22 (19.3)	14 (12.3)	78 (68.4)	1 (16.70	1 (16.70	4 (66.7)	X^2=0.56 P=0.83
You would ask your doctor for AB therapy if your child suffers from recurrent URTIs*	16 (14.0)	33 (28.9)	65 (57.0)	2 (33.3)	1 (16.7)	3 (50.0)	X^2=1.85 P=0.42
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how long to take it for, and the possible side effects that could occur while taking it?*	92 (80.7)	11 (9.6)	11 (9.6)	4 (66.7)	0 (0.0)	2 (33.3)	X^2=2.97 P=0.22
During consultations with a healthcare professional, you are given time to inquire about the ABs prescribed to you*	54 (47.4)	18 (15.8)	42 (36.8)	3 (50.0)	1 (16.7)	2 (33.3)	X^2=0.31 P=1.0
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs and are given enough information on how to treat the symptoms that you or your child are presenting*	89 (78.1)	9 (7.9)	16 (14.0)	3 (50.0)	1 (16.7)	2 (33.3)	X^2=3.38 P=0.17

*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 37: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on age

Questions	Age (n,%)												Test
	16-29			30-39			40-49			50+			
	A	U	D	A	U	D	A	U	D	A	U	D	
ABR is an important and serious public health issue worldwide*	9 (90.0)	1 (10.0)	0 (0.0)	69 (97.2)	1 (1.4)	1 (1.4)	31 (91.2)	3 (8.8)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=7.80 P=0.27
ABR is an important and serious public health issue in this country*	9 (90.0)	1 (10.0)	0 (0.0)	68 (85.8)	2 (2.8)	1 (1.4)	30 (88.2)	4 (11.8)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=7.11 P=0.35
When I have a cold, I should take ABs to prevent getting a more serious illness*	0 (0.0)	0 (0.0)	10 (100.0)	1 (1.4)	0 (0.0)	70 (98.6)	3 (8.8)	0 (0.0)	31 (91.2)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=3.80 P=0.30
When I get fever, ABs help me to get better more quickly*	0 (0.0)	3 (30.0)	7 (70.0)	1 (1.4)	7 (9.9)	63 (88.7)	1 (2.9)	5 (14.7)	28 (82.4)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=5.62 P=0.47
Whenever I take ABs, I contribute to the	3 (30.0)	4 (40.0)	3 (30.0)	41 (57.7)	14 (19.7)	16 (22.5)	16 (47.1)	7 (20.6)	11 (32.4)	2 (40.0)	0 (0.0)	3 (60.0)	X^2=6.82 P=0.31

development of ABR*													
Skipping one or two doses does not contribute to the development of ABR*	2 (20.0)	3 (30.0)	5 (50.0)	9 (12.7)	15 (21.1)	47 (66.2)	8 (23.5)	11 (32.4)	15 (44.1)	0 (0.0)	4 (80.0)	1 (20.0)	X^2=10.75 P=0.07
ABs are safe drugs; hence they can be commonly used*	4 (40.0)	2 (20.0)	4 (40.0)	30 (42.3)	7 (9.9)	34 (47.9)	14 (41.2)	6 (17.6)	14 (41.2)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=6.83 P=0.30
If a child suffers from a cold or flu, it will be cured faster if they are given ABs*	0 (0.0)	1 (10.0)	9 (90.0)	0 (0.0)	1 (1.4)	70 (98.6)	2 (5.9)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=9.45 P=0.12
If the doctor did not prescribe ABS often enough for your child, you would change doctor or go to another healthcare professional*	0 (0.0)	1 (10.0)	9 (90.0)	1 (1.4)	2 (2.8)	68 (95.8)	3 (8.8)	4 (11.8)	27 (79.4)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=8.32 P=0.14
You would re-use an AB which you had used in the past if your child presents the same symptoms*	0 (0.0)	1 (10.0)	9 (90.0)	4 (5.6)	6 (8.5)	61 (85.9)	7 (20.6)	2 (5.9)	25 (73.5)	0 (0.0)	1 (20.0)	4 (80.0)	X^2=7.54 P=0.19
Most of the URTIs will be self-cured even without the use of ABs*	9 (90.0)	0 (0.0)	1 (10.0)	66 (93.0)	3 (4.2)	2 (2.8)	28 (82.4)	3 (8.8)	3 (8.8)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=4.69 P=0.49
You expect your doctor to prescribe ABs if your child was suffering from an URTI*	3 (30.0)	2 (20.0)	5 (50.0)	12 (16.9)	9 (12.7)	50 (70.4)	7 (20.6)	4 (11.8)	23 (67.6)	1 (20.0)	0 (0.0)	4 (80.0)	X^2=2.85 P=0.84
You would ask your doctor for AB therapy if your child suffers from recurrent URTIs*	2 (20.0)	4 (40.0)	4 (40.0)	8 (11.3)	24 (33.8)	39 (54.9)	7 (20.6)	6 (17.6)	21 (61.8)	1 (20.0)	0 (0.0)	4 (80.0)	X^2=7.20 P=0.26
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how	7 (70.0)	2 (20.0)	1 (10.0)	57 (80.3)	7 (9.9)	7 (9.9)	28 (82.4)	1 (2.9)	5 (14.7)	4 (80.0)	1 (20.0)	0 (0.0)	X^2=5.10 P=0.44

long to take it for, and the possible side effects that could occur while taking it?*													
During consultations with a healthcare professional, you are given time to inquire about the ABs prescribed to you*	2 (20.0)	2 (20.0)	6 (60.0)	37 (52.1)	9 (12.7)	25 (35.2)	15 (44.1)	7 (20.6)	12 (35.3)	3 (60.0)	1 (20.0)	1 (20.0)	X^2=5.69 P=0.43
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs and are given enough information on how to treat the symptoms that you or your child are presenting*	7 (70.0)	1 (10.0)	2 (20.0)	55 (77.5)	5 (7.0)	11 (15.5)	26 (76.5)	3 (8.8)	5 (14.7)	4 (80.0)	1 (20.0)	0 (0.0)	X^2=2.70 P=0.85

*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 38: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on ethnicity

Questions	Ethnicity (n,%)												Test
	White			Black			Asia			Mixed			
	A	U	D	A	U	D	A	U	D	A	U	D	
ABR is an important and serious PH issue worldwide*	109 (95.6)	4 (3.5)	1 (0.9)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=17.14 P=0.14
ABR is an important and serious PH issue in this country*	107 (93.9)	6 (5.3)	1 (0.9)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=15.70 P=0.17
When I have a cold, I should take ABs to prevent getting a more serious illness*	3 (2.6)	0 (0.0)	111 (97.4)	0 (0.0)	0 (0.0)	4 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=10.52 P=0.07
When I get fever, ABs help me to	1 (0.9)	14 (12.3)	99 (86.8)	0 (0.0)	0 (0.0)	4 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	X^2=18.72 P=0.01

get better more quickly*													
Whenever I take ABs, I contribute to the development of ABR*	60 (52.6)	25 (21.9)	29 (25.4)	2 (50.0)	0 (0.0)	2 (50.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=6.40 P=0.28
Skipping one or two doses does not contribute to the development of ABR*	17 (14.9)	31 (27.2)	66 (57.9)	1 (25.0)	2 (50.0)	1 (25.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=7.19 P=0.21
ABs are safe drugs; hence they can be commonly used*	44 (38.6)	15 (13.2)	55 (48.2)	2 (50.0)	0 (0.0)	2 (50.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=4.29 P=0.83
If a child suffers from a cold or flu, it will be cured faster if they are given ABs*	0 (0.0)	2 (1.8)	112 998.2)	1 (25.0)	0 (0.0)	3 (75.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=26.08 P=0.003
If the doctor did not prescribe ABs often enough for your child, you would change doctor or go to another healthcare professional*	2 (1.8)	7 (6.1)	105 (92.1)	1 (25.0)	0 (0.0)	3 (75.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=17.35 P=0.02
You would re-use an AB which you had used in the past if your child presents the same symptoms*	9 (7.9)	10 (8.8)	95 (83.3)	1 (25.0)	0 (0.0)	3 (75.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=9.89 P=0.20
Most of the URTIs will be self-cured even without the use of ABs*	103 (90.4)	6 (5.3)	5 (4.4)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=11.57 P=0.23
You expect your doctor to prescribe ABs if your child was suffering from an URTI*	21 (18.4)	15 (13.2)	78 (69.4)	1 (25.0)	0 (0.0)	3 (75.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=5.50 P=0.60
You would ask your doctor for AB therapy if your child suffers from	15 (13.2)	33 (28.9)	66 (57.9)	2 (50.0)	1 (25.0)	1 (25.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=8.81 P=0.82

recurrent URTIs*													
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how long to take it for, and the possible side effects that could occur while taking it?*	91 (79.8)	11 (9.6)	12 (10.5)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=7.44 P=0.43
During consultations with a healthcare professional, you are given time to inquire about the ABs prescribed to you*	54 (47.4)	19 (16.7)	41 (36.0)	2 (50.0)	0 (0.0)	2 (50.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=3.97 P=0.89
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs and are given enough information on how to treat the symptoms that you or your child are presenting*	88 (77.2)	10 (8.8)	16 (14.0)	3 (75.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=7.18 P=0.37

*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 39: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on place of birth

Questions	Place of Birth (n,%)						Test
	Born in the UK			Born outside the UK			
	A	U	D	A	U	D	
ABR is an important and serious PH issue worldwide*	104 (95.4)	4 (3.7)	1 (0.9)	10 (90.9)	1 (9.1)	0 (0.0)	X^2=2.19 P=0.45
ABR is an important and serious PH issue in this country*	103 (94.5)	5 (4.6)	1 (0.9)	9 (81.8)	2 (18.2)	0 (0.0)	X^2=4.03

							P=0.21
When I have a cold, I should take ABs to prevent getting a more serious illness*	3 (2.8)	0 (0.0)	106 (97.2)	1 (9.1)	0 (0.0)	10 (90.9)	X^2=1.25 P=0.32
When I get fever, ABs help me to get better more quickly*	1 (0.9)	15 (13.8)	93 (85.3)	1 (9.1)	0 (0.0)	10 (90.9)	X^2=4.45 P=0.10
Whenever I take ABs, I contribute to the development of ABR*	54 (49.5)	25 (22.9)	30 (27.5)	8 (72.7)	0 (0.0)	3 (27.3)	X^2=3.52 P=0.18
Skipping one or two doses does not contribute to the development of ABR*	17 (15.6)	30 (27.5)	62 (56.9)	2 (18.2)	3 (27.3)	6 (54.5)	X^2=0.28 P=1.0
ABs are safe drugs; hence they can be commonly used*	45 (41.3)	14 (12.8)	50 (45.9)	3 (27.3)	1 (9.1)	7 (63.6)	X^2=1.12 P=0.62
If a child suffers from a cold or flu, it will be cured faster if they are given ABs*	0 (0.0)	2 (1.8)	107 (98.2)	2 (18.2)	0 (0.0)	9 (81.8)	X^2=9.99 P=0.02
If the doctor did not prescribe ABs often enough for your child, you would change doctor or go to another healthcare professional*	2 (1.8)	7 (6.4)	100 (91.7)	2 (18.2)	0 (0.0)	9 (81.8)	X^2=5.69 P=0.06
You would re-use an AB which you had used in the past if your child presents the same symptoms*	8 (7.3)	10 (9.2)	91 (83.5)	3 (27.3)	0 (0.0)	8 (72.7)	X^2=4.21 P=0.11
Most of the URTIs will be self-cured even without the use of ABs*	99 (90.8)	5 (4.6)	5 (4.6)	9 (81.8)	1 (9.1)	1 (9.1)	X^2=2.04 P=0.30
You expect your doctor to prescribe ABs if your child was suffering from an URTI*	20 (18.3)	14 (12.8)	75 (68.8)	3 (27.3)	1 (9.1)	7 (63.6)	X^2=0.72 P=0.80
You would ask your doctor for AB therapy if your child suffers from recurrent URTIs*	15 (13.8)	31 (28.4)	63 (57.8)	3 (27.3)	3 (27.3)	5 (45.5)	X^2=1.70 P=0.50
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how long to take it for, and the possible side effects that could occur while taking it?*	88 (80.7)	11 (10.1)	10 (9.2)	8 (72.7)	0 (0.0)	3 (27.3)	X^2=3.40 P=0.16
During consultations with a healthcare professional, you are given time to inquire about the ABs prescribed to you*	53 (48.6)	18 (16.5)	38 (34.9)	4 (36.4)	1 (9.1)	6 (54.5)	X^2=1.49 P=0.52
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs and are given enough information on how to treat the symptoms that you or your child are presenting*	86 (78.9)	10 (9.2)	13 (11.9)	6 (54.5)	0 (0.0)	5 (45.5)	X^2=6.86 P=0.02

*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 40: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on educational attainment

Questions	Educational Attainment (n,%)																														Test
	GCSEs[1]			Apprenticeship			A-Levels[2]			Certificate of Higher Education			Diploma of Higher Education			Undergraduate Degree			Master's Degree			Doctorate			Professional Qualification			Other[3]			
	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D	A	U	D	
ABR is an important and serious PH issue worldwide*	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	5 (71.4)	2 (28.6)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	4 (66.7)	1 (16.7)	1 (16.7)	38 (100.0)	0 (0.0)	0 (0.0)	28 (96.6)	1 (3.4)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	15 (93.8)	1 (6.3)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=30.70 P=0.03
ABR is an important and serious PH issue in this country*	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	5 (71.4)	2 (28.6)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	4 (66.7)	1 (16.7)	1 (16.7)	37 (97.4)	1 (2.6)	0 (0.0)	27 (93.1)	2 (6.9)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	15 (93.8)	1 (6.3)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=26.73 P=0.16
When I have a cold, I should take ABs to prevent getting a more serious illness*	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)	3 (7.9)	0 (0.0)	35 (92.1)	1 (3.4)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=5.99 P=0.90
When I get fever, ABs help me to get better more quickly*	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 9100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	1 (16.7)	5 (83.3)	0 (0.0)	6 (15.8)	32 (84.2)	1 (3.4)	5 (17.2)	23 (79.3)	0 (0.0)	1 (10.0)	9 (90.0)	1 (6.3)	2 (12.5)	13 (81.3)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=13.82 P=0.97
Whenever I take ABs, I contribute to the development of ABR*	2 (40.0)	2 (40.00	1 (20.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (28.6)	5 (71.4)	3 (75.0)	1 (25.0)	0 (0.0)	2 (33.3)	3 (50.0)	1 (16.7)	21 (55.3)	6 (15.8)	11 (28.9)	17 (58.6)	4 (13.8)	8 (27.6)	7 (70.0)	1 (10.0)	2 (20.0)	7 (43.8)	6 (37.5)	3 (18.8)	2 (50.0)	0 (0.0)	2 (50.0)	X^2=21.84 P=0.14
Skipping one or two doses	0 (0.0)	4 (80.0)	1 (20.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	3 (42.9)	4 (57.1)	2 (50.0)	0 (0.0)	2 (50.0)	0 (0.0)	2 (33.3)	4 (66.7)	8 (21.1)	8 (21.1)	22 (57.9)	4 (13.8)	8 (27.6)	17 (60.0)	1 (10.0)	3 (30.0)	6 (60.0)	4 (25.0)	3 (18.8)	9 (56.3)	0 (0.0)	1 (25.0)	3 (75.)	X^2=16.45 P=0.49

does not contribute to the development of ABR*																														
ABs are safe drugs; hence they can be commonly used*	2 (40.0)	2 (20.0)	1 (20.0)	1 (100.0)	0 (0.0)	0 (0.0)	4 (57.1)	0 (0.0)	3 (42.9)	1 (25.0)	0 (0.0)	3 (75.0)	2 (33.3)	0 (0.0)	4 (66.7)	14 (36.8)	7 (18.4)	17 (44.7)	11 (37.9)	3 (10.3)	15 (51.7)	4 (40.0)	0 (0.0)	6 (60.0)	7 (43.8)	3 (18.8)	6 (37.5)	2 (50.0)	0 (0.0)	2 (50.0)	X^2=11.89 P=0.88
If a child suffers from a cold or flu, it will be cured faster if they are given ABs*	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	1 (25.0)	0 (0.0)	3 (75.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	2 (5.3)	36 (94.7)	1 (3.4)	0 (0.0)	28 (96.6)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.)	X^2=22.91 P=0.48
If the doctor did not prescribe ABs often enough for your child, you would change doctor or go to another healthcare professional*	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	1 (25.0)	0 (0.0)	3 (75.0)	0 (0.0)	0 (0.0)	6 (100.0)	1 (2.6)	5 (13.2)	32 (84.2)	1 (3.4)	1 (3.4)	27 (93.1)	0 (0.0)	1 (10.0)	9 (90.0)	1 (6.3)	0 (0.0)	15 (93.8)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=14.55 P=0.76
You would re-use an AB which you had used in the past if your child presents the same symptoms*	0 (0.0)	1 (20.0)	4 (80.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (14.3)	6 (85.7)	2 (50.0)	1 (25.0)	1 (25.0)	0 (0.0)	0 (0.0)	6 (100.0)	4 (10.5)	3 (7.9)	31 (81.6)	3 (10.3)	3 (10.3)	23 (79.3)	0 (0.0)	0 (0.0)	10 (100.0)	2 (12.5)	1 (6.3)	13 (81.3)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=14.96 P=0.56

Most of the URTIs will be self-cured even without the use of ABs*	3 (60.0)	2 (40.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	6 (85.7)	1 (14.3)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	5 (83.3)	0 (0.0)	1 (16.7)	37 (97.4)	0 (0.0)	1 (2.6)	24 (82.8)	2 (6.9)	3 (10.3)	10 (100.0)	0 (0.0)	0 (0.0)	14 (87.5)	1 (6.3)	1 (6.3)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=20.12 P=0.21
You expect your doctor to prescribe ABs if your child was suffering from an URTI*	1 (20.0)	2 (40.0)	2 (40.0)	0 (0.0)	0 (0.0)	1 (100.0)	2 (28.6)	0 (0.0)	5 (71.4)	1 (25.0)	1 (25.0)	2 (50.0)	2 (33.3)	1 (16.7)	3 (50.0)	6 (15.8)	2 (5.3)	30 (78.9)	6 (20.7)	4 (13.8)	19 (65.5)	2 (20.7)	1 (100.0)	7 970.0)	2 (12.5)	4 (25.0)	10 (62.5)	1 (25.0)	0 (0.0)	3 (75.0)	X^2=14.39 P=0.65
You would ask your doctor for AB therapy if your child suffers from recurrent URTIs*	4 (80.0)	0 (0.0)	1 (20.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (14.3)	2 (28.6)	4 (57.1)	2 (50.0)	2 (50.0)	0 (0.0)	1 (16.7)	1 (16.7)	4 (66.7)	2 (5.3)	8 (21.1)	28 (73.7)	4 (13.8)	11 (37.9)	14 (48.2)	0 (0.0)	3 (30.0)	7 (70.0)	3 (18.8)	5 (31.3)	8 (50.0)	1 (25.0)	2 (50.0)	1 (25.0)	X^2=28.62 P=0.01
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how long to take it for, and the possible side effects that	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	6 (85.7)	0 (0.0)	1 (14.3)	4 (100.0)	0 (0.0)	0 (0.0)	5 (83.3)	0 (0.0)	1 (16.7)	32 (84.2)	3 (7.9)	3 (7.9)	23 (79.3)	1 (3.4)	5 (17.2)	7 (70.0)	1 (10.0)	2 (20.0)	11 (68.8)	4 (25.0)	1 (6.3)	2 (50.0)	2 (50.0)	0 (0.0)	X^2=16.18 P=0.45

could occur while taking it?*																															
During consultations with a healthcare professional, you are given time to inquire about the ABs prescribed to you*	5 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	3 (42.9)	0 (0.0)	4 (57.1)	2 (50.0)	1 (25.0)	1 (25.0)	2 (33.3)	1 (16.7)	3 (50.0)	22 (57.9)	5 (13.2)	11 (28.9)	12 (41.4)	5 (17.2)	12 (41.4)	7 (70.0)	0 (0.0)	3 (30.0)	4 (25.0)	6 (37.5)	6 (37.5)	0 (0.0)	1 (25.0)	3 (75.0)	X^2=23.24 P=0.09
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs and are given enough information on how to treat the symptoms that you or your child are presenting*	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	6 (85.7)	1 (14.3)	0 (0.0)	3 (75.0)	0 (0.0)	1 (25.0)	4 (66.7)	0 (0.0)	2 (33.3)	33 (86.8)	3 (7.9)	2 (5.3)	22 (75.9)	1 (3.4)	6 (20.7)	7 (70.0)	0 (0.0)	3 (30.0)	11 (68.8)	3 (18.8)	2 (12.5)	0 (0.0)	2 (50.0)	2 (50.0)	X^2=26.30 P=0.03

[1] Including O-levels and CSEs
[2] Including Higher School Certificate and Advanced Diploma
[3] Including other vocational/work-related qualifications and foreign qualifications
* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 41: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on number of children

Questions	Number of children (n,%)												Test
	1			2			3			4 or more			
	A	U	D	A	U	D	A	U	D	A	U	D	
ABR is an important and serious PH issue worldwide*	46 (97.9)	1 2.1)	0 (0.0)	51 (92.7)	3 (5.5)	1 (1.8)	12 (92.3)	1 (7.7)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=5.07 P=0.68
ABR is an important and serious PH issue in this country*	46 (97.9)	1 (2.1)	0 (0.0)	50 (90.9)	4 (7.3)	1 (1.8)	11 (84.6)	2 (15.4)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=6.89 P=0.34
When I have a cold, I should take ABs to prevent getting a more serious illness*	3 (6.4)	0 (0.0)	44 (93.6)	1 (1.8)	0 (0.0)	54 (98.2)	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=1.99 P=0.54
When I get fever, ABs help me to get better more quickly*	0 (0.0)	7 (14.9)	40 (85.1)	2 (3.6)	7 (12.7)	46 (83.6)	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	1 (20.0)	4 (80.0)	X^2=5.23 P=0.53
Whenever I take ABs, I contribute to the development of ABR*	25 (53.2)	8 917.0)	14 (29.8)	29 (52.7)	13 (23.6)	13 (23.6)	6 (46.2)	2 (15.4)	5 (38.5)	2 (40.0)	2 (40.0)	1 (20.0)	X^2=3.09 P=0.82
Skipping one or two doses does not contribute to the development of ABR*	8 (17.0)	12 (25.5)	27 (57.4)	10 (18.2)	16 (29.1)	29 (52.7)	0 (0.0)	4 (20.8)	9 (69.2)	1 (20.0)	1 (20.0)	3 (60.0)	X^2=3.48 P=0.76
ABs are safe drugs; hence they can be commonly used*	18 (38.3)	5 (10.6)	24 (51.1)	24 (43.60	7 (12.7)	24 (43.6)	4 (30.8)	2 (15.4)	7 (53.8)	2 (40.0)	1 (20.0)	2 (40.0)	X^2=2.14 P=0.93
If a child suffers from a cold or flu, it will be cured faster if they are given ABs*	1 (2.1)	2 (4.3)	44 (93.6)	1 (1.8)	0 (0.0)	54 (98.2)	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=4.98 P=0.72
If the doctor did not prescribe ABs often enough for your child, you would change doctor or go to another healthcare professional*	1 (2.1)	5 (10.6)	41 (87.2)	3 (5.5)	1 (1.8)	51 (92.7)	0 (0.0)	1 (7.7)	12 (92.3)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=5.13 P=0.45
You would re-use an AB	7 (14.9)	4 (8.5)	36 (76.6)	4 (7.3)	3 (5.5)	48 (87.3)	0 (0.0)	2 (15.4)	11 (84.6)	0 (0.0)	1 (20.0)	4 (80.0)	X^2=5.77 P=0.37

which you had used in the past if your child presents the same symptoms*												
Most of the URTIs will be self-cured even without the use of ABs*	45 (95.7)	1 (2.1)	1 (2.1)	48 (87.3)	5 (9.1)	2 (3.6)	11 (84.6)	0 (0.0)	2 (15.4)	4 (80.0)	0 (0.0)	1 (20.0)	X^2=8.59 P=0.13
You expect your doctor to prescribe ABs if your child was suffering from an URTI*	7 (14.9)	9 (19.1)	31 (66.0)	9 (16.4)	6 (10.9)	40 (72.7)	4 (30.8)	0 (0.0)	9 (69.2)	3 (60.0)	0 (0.0)	2 (40.0)	X^2=8.72 P=0.14
You would ask your doctor for AB therapy if your child suffers from recurrent URTIs*	6 (12.8)	14 (29.8)	27 (57.4)	9 (16.4)	15 (27.3)	31 (56.4)	2 (15.4)	3 (23.1)	8 (61.5)	1 (20.0)	2 (40.0)	2 (40.0)	X^2=1.68 P=0.97
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how long to take it for, and the possible side effects that could occur while taking it?*	36 (76.6)	5 (10.6)	6 (12.8)	45 (81.8)	4 (7.3)	6 (10.9)	10 (76.9)	2 (15.4)	1 (7.7)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=1.91 P=0.95
During consultations with a healthcare professional, you are given time to inquire about the ABs prescribed to you*	23 (48.9)	9 (19.1)	15 (31.9)	26 (47.3)	8 (14.5)	21 (38.2)	4 (30.8)	1 (7.7)	8 (61.5)	4 (80.0)	1 (20.0)	0 (0.0)	X^2=6.87 P=0.30
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs	32 (68.1)	4 (8.5)	11 (23.4)	46 (83.6)	3 (5.5)	6 (10.9)	9 (69.2)	3 (23.1)	1 (7.7)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=7.63 P=0.20

and are given enough information on how to treat the symptoms that you or your child are presenting*												

*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 42: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on number of children aged between 3 months and 6 years old

Questions	Number of children aged between 3 months and 6 years old (n,%)												Test
	1			2			3			4 or more			
	A	U	D	A	U	D	A	U	D	A	U	D	
ABR is an important and serious PH issue worldwide*	72 (94.7)	3 (3.9)	1 (1.3)	36 (94.7)	2 (5.3)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=6.11 P=1.0
ABR is an important and serious PH issue in this country*	71 (93.4)	4 (5.3)	1 (1.3)	35 (92.1)	3 (7.9)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=5.86 P=0.86
When I have a cold, I should take ABs to prevent getting a more serious illness*	3 (3.9)	0 (0.0)	73 (96.1)	1 (2.6)	0 (0.0)	37 (97.4)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=1.78 P=1.0
When I get fever, ABs help me to get better more quickly*	1 (1.3)	11 (14.5)	64 (84.2)	1 (2.6)	3 (7.9)	34 (89.5)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	1 (50.0)	1 (50.0)	X^2=6.97 P=0.40
Whenever I take ABs, I contribute to the development of ABR*	38 (50.0)	16 (21.1)	22 (28.9)	20 (52.6)	7 (18.4)	11 (28.9)	3 (75.0)	1 925.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	X^2=3.20 P=0.83
Skipping one or two doses does not contribute to the development of ABR*	12 (15.8)	23 (30.3)	41 (53.9)	7 (18.4)	9 (23.7)	22 (57.9)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=2.18 P=0.95
ABs are safe drugs; hence they can be commonly used*	27 (35.5)	8 (10.5)	41 (53.9)	19 (50.0)	6 (15.8)	13 (34.2)	2 (50.0)	0 (0.0)	2 (50.0)	0 (0.0)	1 (50.0)	1 (50.0)	X^2=7.35 P=0.22
If a child suffers from a cold or flu, it will be cured faster if they are given ABs*	0 (0.0)	2 (2.6)	74 (97.4)	2 (5.3)	0 (0.0)	36 (94.7)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=9.53 P=0.36

If the doctor did not prescribe ABs often enough for your child, you would change doctor or go to another healthcare professional*	1 (1.3)	7 (9.2)	68 (89.5)	3 (7.9)	0 (0.0)	35 (92.1)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=8.88 P=0.18
You would re-use an AB which you had used in the past if your child presents the same symptoms*	7 (9.2)	9 (11.8)	60 (78.9)	4 (10.5)	1 (2.6)	33 (86.8)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=3.79 P=0.66
Most of the URTIs will be self-cured even without the use of ABs*	70 (92.1)	4 (5.3)	2 (2.60	34 (89.5)	2 (5.3)	2 (5.3)	2 (50.0)	0 (0.0)	2 (50.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=10.78 P=0.09
You expect your doctor to prescribe ABs if your child was suffering from an URTI*	16 (21.1)	12 (15.8)	48 (63.2)	5 (13.2)	3 (7.9)	30 (78.9)	1 (25.0)	0 (0.0)	3 (75.0)	1 (50.0)	0 (0.0)	1 (50.0)	X^2=5.06 P=0.46
You would ask your doctor for AB therapy if your child suffers from recurrent URTIs*	12 (15.8)	23 (30.3)	41 (53.9)	5 (13.2)	9 (23.7)	24 (63.2)	1 (25.0)	1 (25.0)	2 (50.0)	0 (0.0)	1 (50.0)	1 (50.0)	X^2=2.66 P=0.89
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how long to take it for, and the possible side effects that could occur while taking it?*	61 (80.3)	7 (9.2)	8 (10.5)	30 (78.9)	3 (7.9)	5 (13.2)	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=2.78 P=0.81
During consultations with a healthcare professional, you are given time to inquire about the ABs	36 (47.4)	13 (17.1)	27 (35.5)	16 (42.1)	6 (15.8)	16 (42.1)	3 (75.0)	0 (0.0)	1 (25.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=3.10 P=0.85

prescribed to you*													
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs and are given enough information on how to treat the symptoms that you or your child are presenting*	57 (75.0)	6 (7.9)	13 (17.1)	30 (78.9)	3 (7.9)	5 (13.2)	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=3.03 P=0.79

*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 43: Frequency distribution of answers regarding parents' attitudes towards AMR, antibiotic prescribing & prescription advice, based on deprivation

Question	Deprivation (n,%)						Test
	More deprived			Less deprived			
	A	U	D	A	U	D	
ABR is an important and serious public health issue worldwide	46 (38.3)	2 (1.7)	1 (0.8)	68 (56.7)	3 (2.5)	0 (0.0)	X^2=1.46 P=0.48
ABR is an important and serious public health issue in this country	44 (36.7)	4 (3.3)	1 (0.8)	68 (56.7)	3 (2.5)	0 (0.0)	X^2=2.33 P=0.31
When I have a cold, I should take ABs to prevent getting a more serious illness*	3 (2.5)	0 (0.0)	46 (38.3)	1 (0.8)	0 (0.0)	70 (58.3)	X^2=1.99 P=0.30
When I get fever, ABs help me to get better more quickly	2 (1.7)	5 (4.2)	42 (35.0)	0 (0.0)	10 (8.3)	61 (50.8)	X^2=3.25 P=0.20
Whenever I take ABs, I contribute to the development of antibiotic resistance	24 (20.0)	6 (5.0)	19 (15.8)	38 (31.7)	19 (15.8)	14 (11.7)	X^2=6.88 P=0.03
Skipping one or two doses does not contribute to the development of ABR	5 (4.2)	19 (15.8)	25 (20.8)	14 (11.7)	14 (11.7)	43 (35.8)	X^2=5.95 P=0.05
ABs are safe drugs; hence they can be commonly used	18 (15.0)	6 (5.0)	25 (20.8)	30 (25.0)	9 (7.5)	32 (26.7)	X^2=0.44 P=0.80
If a child suffers from a cold or flu, it will be cured faster if they are given ABs	2 (1.7)	2 (1.7)	45 (37.5)	0 (0.0)	0 (0.0)	71 (59.2)	X^2=5.99 P=0.05
If the doctor did not prescribe ABs often enough for your child, you would change doctor or go to another healthcare professional	2 (1.7)	6 (5.0)	41 (34.2)	2 (1.7)	1 (0.8)	68 (56.7)	X^2=6.44 P=0.04
You would re-use an AB which you had used in the past if your child presents the same symptoms	5 (4.2)	2 (1.7)	42 (35.0)	6 (5.0)	8 (6.7)	57 (47.5)	X^2=1.99 P=0.37
Most of the URTIs will be self-cured even without the use of ABs	44 (36.7)	3 (2.5)	2 (1.7)	64 (53.3)	3 (2.5)	4 (3.3)	X^2=0.35 P=0.84
You expect your doctor to prescribe ABs if your child was suffering from an URTI	13 (10.8)	5 (4.2)	31 (25.8)	10 (8.3)	10 (8.3)	52 (42.5)	X^2=3.0 P=0.22

You would ask your doctor for AB therapy if your child suffers from recurrent URTIs	7 (5.8)	13 (10.8)	29 (24.2)	11 (9.2)	21 (17.5)	39 (32.5)	X^2=0.22 P=0.89
When ABs are prescribed for you or your child, you are given enough information regarding how to take the ABs, how long to take it for, and the possible side effects that could occur while taking it?	39 (32.5)	4 (3.3)	6 (5.0)	57 (47.5)	7 (5.8)	7 (5.8)	X^2=0.25 P=0.89
During consultations with a healthcare professional, you are given time to inquire about the ABs prescribed to you	23 (19.2)	10 (8.3)	16 (13.3)	34 (28.3)	9 (7.5)	28 (23.3)	X^2=1.46 P=0.48
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing ABs and are given enough information on how to treat the symptoms that you or your child are presenting	42 (35.0)	3 (2.5)	4 (3.3)	50 (41.7)	7 (5.8)	14 (11.7)	X^2=3.95 P=0.14

*Fischer's exact test was used as one or more cells have expected counts less than 5

Table 44: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on gender

Question	Gender (n,%)						Test
	Female			Male			
	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?*	38 (33.3)	73 (64.0)	3 (2.6)	2 (33.3)	3 (50.0)	1 (16.7)	X^2=3.43 P=0.26
Have you given any antibiotics to your child in the last 12 months?*	42 (36.8)	72 (63.2)	0 (0.0)	4 (66.7)	2 (33.3)	0 (0.0)	X^2=** P=0.20

* Fisher's exact test was used as one or more cells have expected counts less than 5
** no value obtained

Table 45: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on age

Questions	Age (n,%)												Test
	16-29			30-39			40-49			50+			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?*	3 (30.0)	7 (70.0)	0 (0.0)	24 (33.8)	22 (63.4)	2 (2.8)	10 (29.4)	22 (64.7)	2 (5.9)	3 (60.0)	2 (40.0)	0 (0.0)	X^2=3.20 P=0.80
Have you given any antibiotics to your child in	5 (50.0)	5 (50.0)	0 (0.0)	30 (42.3)	41 (57.7)	0 (0.0)	11 (32.4)	23 (67.6)	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	X^2=4.45 P=0.22

the last 12 months?*													

* Fisher's exact test was used as one or more cells have expected counts less than 5

Table 46: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on ethnicity

Questions	Ethnicity (n,%)												Test
	White			Black			Asia			Mixed			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?*	37 (32.5)	73 (64.0)	4 (3.5)	1 (25.0)	3 (75.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=7.71 P=0.44
Have you given any antibiotics to your child in the last 12 months?*	43)37.7)	71 (62.3)	0 (0.0)	2 (50.0)	2 (50.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	X^2=2.51 P=0.56

* Fisher's exact test was used as one or more cells have expected counts less than 5

Table 47: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on place of birth

Questions	Place of Birth (n,%)						Test
	Born in the UK			Born outside the UK			
	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?*	36 (33.0)	69 (63.3)	4 (3.7)	4 (36.4)	7 (63.6)	0 (0.0)	X^2=0.20 P=1.0
Have you given any antibiotics to your child in the last 12 months?*	40 (36.7)	69 (63.3)	0 (0.0)	6 (54.5)	5 (45.5)	0 (0.0)	X^2=** P=0.33

* Fisher's exact test was used as one or more cells have expected counts less than 5

** No value obtained

Table 48: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on educational attainment

Questions	Educational Attainment (n,%)																														Test
	GCSEs[1]			Apprenticeship			A-Levels[2]			Certificate of Higher Education			Diploma of Higher Education			Undergraduate Degree			Master's Degree			Doctorate			Professional Qualification			Other[3]			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months? *	4 (80.0)	1 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	2 (28.6)	4 (57.1)	1 (14.3)	2 (50.0)	2 50.0)	0 (0.0)	2 (33.3)	4 (66.7)	0 (0.0)	8 (21.1)	28 (73.7)	2 (5.3)	12 (41.4)	17 (58.6)	0 (0.0)	3 (30.0)	7 (70.0)	0 (0.0)	6 (37.5)	10 ((62.5)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	X^2=** P=**
Have you given any antibiotics to your child in the last 12 months? *	2 (40.0)	3 (60.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	3 (42.9)	4 (57.1)	0 (0.0)	2 (50.0)	2 (50.0)	0 (0.0)	2 (33.3)	4 (66.7)	0 (0.0)	14 (36.8)	24 (63.2)	0 (0.0)	9 (31.0)	20 (69.0)	0 (0.0)	3 (30.0)	7 (70.0)	0 (0.0)	8 (50.0)	8 (50.0)	0 (0.0)	2 (50.0)	2 (50.0)	0 (0.0)	X^2=4.58 P=0.92

* Fisher's exact test was used as one or more cells have expected counts less than 5

** No value found; cannot be computed because there is insufficient memory

Table 49: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on number of children

Questions	Number of children (n,%)												Test
	1			2			3			4 or more			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?*	13 (27.7)	33 (70.2)	1 (2.1)	19 (34.5)	34 (61.8)	2 (3.6)	5 (38.5)	8 (61.5)	0 (0.0)	3 (60.0)	1 (20.0)	1 (20.0)	X^2=7.41 P=0.24
Have you given any antibiotics to your child in the last 12 months?*	16 (34.0)	31 (66.0)	0 (0.0)	23 (41.8)	32 (58.2)	0 (0.0)	4 (30.8)	9 (69.2)	0 (0.0)	3 (60.0)	2 (40.0)	0 (0.0)	X^2=1.99 P=0.59

* Fisher's exact test was used as one or more cells have expected counts less than 5

Table 50: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on number of children aged between 3 months and 6 years old

Questions	Number of children aged between 3 months and 6 years old (n,%)												Test
	1			2			3			4 or more			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?*	22 (28.9)	51 (67.1)	3 (3.9)	15 (39.5)	22 (57.9)	1 (2.6(	1 (25.0)	3 (75.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=6.44 P=0.40
Have you given any antibiotics to your child in the last 12 months?*	25 (32.9)	51 (67.1)	0 (0.0)	18 (47.4)	20 (52.6)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=5.26 P=0.12

* Fisher's exact test was used as one or more cells have expected counts less than 5

Table 51: Frequency distribution of responses for questions 22 & 23; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on deprivation

Questions	Deprivation (n,%)						Test
	More deprived			Less deprived			
	Y	N	DK	Y	N	DK	
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?*	18 (15.0)	30 (25.0)	1 (0.8)	22 (18.3)	46 (38.3)	3 (2.5)	X^2=0.76 P=0.68
Have you given any antibiotics to your child in the last 12 months?*	20 (16.7)	29 (24.2)	0 (0.0)	26 (21.7)	45 (37.5)	0 (0.0)	X^2=0.22

							P=0.74

* Fisher's exact test was used as one or more cells have expected counts less than 5

** No value obtained

Table 52: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on gender

Question	Gender (n,%)						Test
	Female			Male			
	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?*	36 (31.6)	65 (57.0)	13 (11.4)	3 (50.0)	2 (33.3)	1 (16.7)	X^2=1.82 P=0.37
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*	22 (19.3)	75 (65.8)	17 (14.9)	2 (33.3)	1 (16.7)	3 (50.0)	X^2=6.76 P=0.02
In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?*	61 (53.5)	50 (43.9)	3 (2.6)	3 (50.0)	2 (33.3)	1 (16.7)	X^2=3.32 P=0.23
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?	34 (29.8)	71 (62.3)	9 (7.9)	1 (16.7)	5 (83.3)	0 (0.0)	X^2=0.59 P=0.79

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 53: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on age

Questions	Age (n,%)												Test
	16-29			30-39			40-49			50+			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?*	2 (20.0)	8 (80.8)	0 (0.0)	23 (32.4)	37 (52.1)	11 (15.5)	11 (32.4)	20 (58.8)	3 (8.8)	3 (60.0)	2 (40.0)	0 (0.0)	X^2=4.57 P=0.58
Did your child have a test to find out what	2 (20.0)	5 (50.0)	3 (30.0)	12 (16.9)	48 (67.6)	11 (15.5)	10 (29.4)	19 (55.9)	5 (14.7)	0 (0.0)	4 (80.0)	1 (20.0)	X^2=5.0 P=0.51

was causing the illness before or at the same time as they were given antibiotics?*													
In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?*	5 (50.0)	5 (50.0)	0 (0.0)	37 (52.1)	32 (45.1)	2 (2.8)	20 (58.8)	12 (35.3)	2 (5.9)	2 (40.0)	3 (60.0)	0 (0.0)	X^2=2.92 P=0.83
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?*	2 (20.0)	8 (80.0)	0 (0.0)	22 (31.0)	42 (59.2)	7 (9.9)	10 (29.4)	22 (64.7)	2 (5.9)	1 (20.0)	4 (80.0)	0 (0.0)	X^2=1.97 P=0.93

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 54: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on ethnicity

Questions	Ethnicity (n,%)												Test
	White			Black			Asia			Mixed			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?*	36 (31.6)	64 (56.1)	14 (12.3)	2 (50.0)	2 (50.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=4.52 P=0.74
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*	22 (19.3)	73 (64.0)	19 (16.7)	2 (50.0)	1 (25.0)	1 (25.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	X^2=5.58 P=0.52
In the last 12 months, do you remember getting any	60 (52.6_	51 (44.7)	3 (2.6)	2 (50.0)	1 (25.0)	1 (25.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=9.37 P=0.22

information about not taking antibiotics unnecessarily, for example for a cold?*													
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?*	33 (28.9)	72 (63.2)	9 (7.9)	2 (50.0)	2 (50.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	X^2=4.10 P=0.88

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 55: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on place of birth

Questions	Place of Birth (n,%)						Test
	Born in the UK			Born outside the UK			
	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?*	37 (33.9)	58 (53.2)	14 (12.8)	2 (19.2)	9 (81.8)	0 (0.0)	X^2=2.78 P=0.24
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*	21 (19.3)	70 (64.2)	18 (16.5)	3 (27.3)	6 (54.5)	2 (18.2)	X^2=0.83 P=0.66
In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?*	57 (52.3)	49 (45.0)	3 (2.8)	7 (63.6)	3 (27.3)	1 (9.1)	X^2=2.69 P=0.26
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?*	30 (27.5)	70 (64.2)	9 (8.3)	5 (45.5)	6 (54.5)	0 (0.0)	X^2=1.59 P=0.44

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 56: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on educational attainment

Questions	Educational Attainment (n,%)																														Test
	GCSEs[1]			Apprenticeship			A-Levels[2]			Certificate of Higher Education			Diploma of Higher Education			Undergraduate Degree			Master's Degree			Doctorate			Professional Qualification			Other[3]			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?*	2 (40.0)	3 (60.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	4 (57.1)	2 (28.6)	1 (14.3)	2 (50.0)	2 (50.0)	0 (0.0)	1 (16.7)	5 (83.3)	0 (0.0)	13 (34.2)	18 (47.4)	7 (18.4)	7 (24.1)	18 (62.1)	4 (13.8)	3 (30.0)	7 (70.0)	0 (0.0)	5 (31.3)	10 (62.5)	1 (6.3)	2 (50.0)	2 (50.0)	0 (0.0)	X^2=14.19 P=0.69
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*	1 (20.0)	4 (80.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	5 (71.4)	2 (28.6)	2 (50.0)	1 (25.0)	1 (25.0)	1 (16.7)	5 (83.3)	0 (0.0)	8 (21.1)	22 (57.9)	8 (21.1)	4 (13.8)	20 (69.0)	5 (17.2)	1 (10.0)	8 (80.0)	1 (10.0)	5 (31.3)	9 (56.3)	2 (12.5)	2 (50.0)	1 (25.0)	1 (25.0)	X^2=14.66 P=0.64
In the last 12 months, do you	1 (20.0)	4 (80.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	3 (42.9)	4 (57.1)	0 (0.0)	2 (50.0)	1 (25.0)	1 (25.0)	2 (33.3)	4 (66.7)	0 (0.0)	24 (63.2)	12 (31.6)	2 (5.3)	16 (55.2)	12 (41.4)	1 (3.4)	8 (80.0)	2 (20.0)	0 (0.0)	6 (37.5)	10 (62.5)	0 (0.0)	2 (50.0)	2 (50.0)	0 (0.0)	X^2=20.0 P=0.30

remember getting any information about not taking antibiotics unnecessarily, for example for a cold?*																															
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?*	2 (40.0)	2 (40.0)	1 (20.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (14.3)	5 (71.4)	1 (14.3)	2 (50.0)	2 (50.0)	0 (0.0)	3 (50.0)	2 (33.3)	1 (16.7)	13 (34.2)	24 (63.2)	1 (2.6)	8 (27.6)	19 (65.5)	2 (6.9)	1 (10.0)	8 (80.0)	1 (10.0)	4 (25.0)	10 (62.5)	2 (12.5)	1 (25.0)	3 (75.0)	0 (0.0)	X^2=14.20 P=0.69

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 57: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on number of children

Questions	Number of children (n,%)												Test
	1			2			3			4 or more			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?*	19 (40.4)	23 (48.9)	5 (10.6)	15 (27.3)	32 (58.2)	8 (14.5)	4 (30.8)	8 (61.5)	1 (7.7)	1 (20.0)	4 (80.0)	0 (0.0)	X^2=3.13 P=0.81
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*	6 (12.8)	26 (55.3)	15 (31.9)	14 (25.5)	37 (67.3)	4 (7.3)	4 (30.8)	8 (61.5)	1 (7.7)	0 (0.0)	5 (100.0)	0 (0.0)	X^2=14.08 P=0.02
In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?*	21 (44.7)	24 (51.1)	2 (4.3)	35 (63.6)	19 (34.5)	1 (1.8)	6 (46.2)	7 (53.8)	0 (0.0)	1 (40.0)	2 (40.0)	1 (20.0)	X^2=8.0 P=0.20
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?*	15 (31.9)	30 (63.8)	2 (4.3)	14 (25.5)	40 (72.2)	1 (1.8)	5 (38.5)	5 (38.5)	3 (23.1)	1 (20.0)	1 (20.0)	3 (60.0)	X^2=19.53 P=0.001

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 58: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on number of children aged between 3 months and 6 years old

Questions	Number of children aged between 3 months and 6 years old (n,%)												Test
	1			2			3			4 or more			
	Y	N	DK	Y	N	DK	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?*	28 (36.8)	42 (55.3)	6 (7.9)	7 (18.4)	23 (60.5)	8 (21.1)	3 (75.0)	1 (25.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	X^2=9.94 P=0.08
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?*	14 (18.4)	46 (60.5)	16 (21.1)	10 (26.3)	25 (65.8)	3 (7.9)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	1	X^2=5.25 P=0.45
In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?*	38 (50.0)	36 (47.4)	2 (2.6)	23 (60.5)	13 (34.2)	2 (5.3)	2 (50.0)	2 (50.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	X^2=4.38 P=0.72
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?*	26 (34.2)	45 (59.2)	5 (6.6)	9 (23.7)	27 (71.1)	2 (5.3)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	1 (50.0)	1 (50.0)	X^2=8.51 P=0.15

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 59: Frequency distribution of responses for questions 28, 29, 30, & 32; answers regarding parents' self-reported practices towards antibiotic use, antibiotic prescribing & prescription advice, based on deprivation

Questions	Deprivation (n,%)						Test
	More deprived			Less deprived			
	Y	N	DK	Y	N	DK	
Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?	14 (11.7)	30 (25.0)	5 (4.2)	25 (20.8)	37 (30.8)	9 (7.5)	X^2=0.98 P=0.61
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?	11 (9.2)	30 (25.0)	8 (6.7)	13 (10.8)	46 (38.3)	12 (10.0)	X^2=0.31 P=0.86
In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?	28 (23.3)	19 (15.8)	2 (1.7)	36 (30.0)	33 (27.5)	2 (1.7)	X^2=0.76 P=0.68
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?	17 (14.2)	30 (25.0)	2 (1.7)	18 (15.0)	46 (38.3)	7 (5.8)	X^2=2.22 P=0.33

*Fisher's exact test was used as one or more cells have expected counts less than 5

Table 60: Frequency distribution of answers for Q34 & 35, based on gender

Question	Gender (n,%)						Test
	Female			Male			
	A	S	N	A	S	N	
Do you stop taking the further treatment?	2 (1.8)	5 (4.4)	107 (93.9)	0 (0.0)	2 (33.3)	4 (66.7)	X^2=6.60 P=0.06
Do you save the remaining antibiotics for the next time you get sick?	3 (2.6)	3 (2.6)	108 (94.7)	0 (0.0)	2 (33.3)	4 (66.7)	X^2=7.93 P=0.03
Do you discard the remaining, leftover medication?	49 (43.0)	5 (4.4)	60 (52.6)	2 (33.3)	1 (16.7)	3 (50.0)	X^2=2.31 P=0.33
Do you give the leftover antibiotics to your child or children if they get sick?	1 (0.9)	0 (0.0)	113 (99.1)	0 (0.0)	0 (0.0)	6 (100.0)	X^2= ** P=1.0
Do you complete the full course of treatment?	111 (97.4)	3 (2.6)	0 (0.0)	4 (66.7)	2 (33.3)	0 (0.0)	X^2=** P=0.02
Do you stop giving them further treatment?	1 (0.9)	4 (3.5)	109 (95.6)	0 (0.0)	0 (0.0)	6 (100.0)	X^2=1.60 P=1.0
Do you save the remaining antibiotics for the next time they get sick?	2 (1.8)	2 (1.8)	110 (96.5)	0 (0.0)	0 (0.0)	6 (100.0)	X^2=1.48 P=1.0
Do you discard the remaining, leftover medication?	51 (44.7)	4 (3.5)	59 (51.8)	2 (33.3)	0 (0.0)	4 (66.7)	X^2=0.69 P=0.75
Do you give the leftover antibiotics to your other children or family members if they get sick?	2 (1.8)	2 (1.8)	110 (96.5)	0 (0.0)	0 (0.0)	6 (100.0)	X^2=1.48 P=1.0
Do you follow the full course of treatment for your child?	111 (97.4)	2 (1.8)	1 (0.9)	6 (100.0)	0 (0.0)	0 (0.0)	X^2=2.06 P=1.0

* Fischer's exact test was used as one or more cells have expected counts less than 5

** no value, cannot be computed because there is insufficient memory

Table 61: Frequency distribution of answers for Q34 & 35, based on age

Questions	Age (n,%)												Test
	16-29			30-39			40-49			50+			
	A	S	N	A	S	N	A	S	N	A	S	N	
Do you stop taking the further treatment?	0 (0.0)	0 (0.0)	10 (100.0)	1 (1.3)	3 (4.2)	67 (94.4)	1 92.9)	4 (11.8)	29 (85.3)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=4.67 P=0.60
Do you save the remaining antibiotics for the next time you get sick?	0 (0.0)	0 (0.0)	10 (100.0)	2 (2.8)	2 (2.8 0	67 (94.4)	1 (2.9)	3 (8.8)	30 (88.2)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=3.50 P=0.78
Do you discard the remaining, leftover medication ?	5 (50.0)	V	5 (50.0)	30 (42.3)	5 (7.0)	36 (50.7)	15 (44.1)	1 (2.9)	18 (52.9)	1 (20.0)	0 (0.0)	4 (80.0)	X^2=2.34 P=0.89
Do you give the leftover antibiotics to your child or children if they get sick?	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	71 (100.0)	0 (0.0)	0 (0.0)	34 (100.0)	1 (20.0)	0 (0.0)	4 (80.0)	X^2=8.32 P=0.06
Do you complete the full course of treatment?	10 (100.0)	0 (0.0)	0 (0.0)	69 (97.2)	2 (2.8)	0 (0.0)	31 (91.2)	3 (8.8)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=2.34 P=0.56
Do you stop giving them further treatment?	0 (0.0)	0 (0.0)	10 (100.0)	1 (1.4)	1 (1.4)	69 (97.2)	0 (0.0)	3 (8.8)	31 (91.2)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=6.77 P=0.44
Do you save the remaining antibiotics for the next time they get sick?	0 (0.0)	0 (0.0)	10 (100.0)	2 (2.8)	0 (0.0)	69 (97.2)	0 (0.0)	2 (5.9)	32 (94.1)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=6.94 P=0.39
Do you discard the remaining, leftover medication ?	5 (50.0)	0 (0.0)	5 (50.0)	31 (43.7)	4 (5.6)	36 (50.7)	16 (47.1)	0 (0.0)	18 (52.9)	1 (20.0)	0 (0.0)	4 (80.0)	X^2=3.59 P=0.73
Do you give the leftover antibiotics to your other children or family members if	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	1 (1.4)	70 (98.6)	1 (2.9)	1 (2.9)	32 (94.1)	1 (20.0)	0 (0.0)	4 (80.0)	X^2=9.45 P=0.12

they get sick?													
Do you follow the full course of treatment for your child?	10 (100.0)	0 (0.0)	0 (0.0)	70 (98.6)	1 (1.4)	0 (0.0)	33 (97.1)	1 (2.9)	0 (0.0)	4 (80.0)	0 (0.0)	1 (20.0)	X^2=10.36 P=0.11

* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 62: Frequency distribution of answers for Q34 & 35, based on ethnicity

Questions	Ethnicity (n,%)												Test
	White			Black			Asia			Mixed			
	A	S	N	A	S	N	A	S	N	A	S	N	
Do you stop taking the further treatment?	1 (0.9)	6 (5.3)	107 (93.9)	0 (0.0)	1 (25.0)	3 (75.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=18.92 P=0.02
Do you save the remaining antibiotics for the next time you get sick?	2 (1.8)	4 (3.5)	108 (94.7)	0 (0.0)	1 (25.0)	3 (75.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=18.48 P=0.02
Do you discard the remaining, leftover medication?	48 (42.1)	6 (5.3)	60 (52.6)	2 (50.0)	0 (0.0)	2 (50.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=5.17 P=0.92
Do you give the leftover antibiotics to your child or children if they get sick?	1 (0.9)	0 (0.0)	113 (99.1)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=** P=**
Do you complete the full course of treatment?	110 (96.5)	4 (3.5)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=9.52 P=0.09
Do you stop giving them further treatment?	1 (0.9)	3 (2.6)	110 996.5)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=18.15 P=0.12
Do you save the remaining antibiotics for the next time they get sick?	2 (1.8)	1 (0.9)	111 (97.4)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=19.42 P=0.07
Do you discard the remaining,	49 (43.0)	4 (3.5)	61 (53.5)	3 (75.0)	0 (0.0)	1 (25.0)	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=7.24 P=0.41

leftover medication?													
Do you give the leftover antibiotics to your other children or family members if they get sick?	1 (0.9)	1 (0.90	112 (98.2)	1 (25.0)	0 (0.0)	3 (75.0)	0 (0.0)	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	X^2=24.70 P=0.01
Do you follow the full course of treatment for your child?	112 (98.2)	1 (0.9)	1 (0.9)	4 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	X^2=21.39 P=0.05

* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 63: Frequency distribution of answers for Q34 & 35, based on place of birth

Questions	Place of Birth (n,%)						Test
	Born in the UK			Born outside the UK			
	A	S	N	A	S	N	
Do you stop taking the further treatment?	0 (0.0)	6 (5.5)	103 (94.5)	2 (18.2)	1 (9.1)	8 (72.7)	X^2=10.60 P=0.01
Do you save the remaining antibiotics for the next time you get sick?	2 (1.8)	4 (3.7)	103 (94.5)	1 (9.1)	1 (9.1)	9 (81.8)	X^2=3.95 P=0.16
Do you discard the remaining, leftover medication?	44 (40.4)	6 (5.5)	59 (54.1)	7 (63.6)	0 (0.0)	4 (36.4)	X^2=1.86 P=0.33
Do you give the leftover antibiotics to your child or children if they get sick?	1 (0.9)	0 (0.0)	108 (99.1)	0 (0.0)	0 (0.0)	11 (100.0)	X^2=** P=1.0
Do you complete the full course of treatment?	106 (97.2)	3 (2.8)	0 (0.0)	9 (81.8)	2 (18.2)	0 (0.0)	X^2=** P=0.06
Do you stop giving them further treatment?	0 (0.0)	3 (2.8)	106 (97.2)	1 (9.1)	1 (9.1)	9 (81.8)	X^2=7.39 P=0.03
Do you save the remaining antibiotics for the next time they get sick?	2 (1.8)	1 (0.9)	106 (97.2)	0 (0.0)	1 (9.1)	10 (90.9)	X^2=3.87 P=0.32
Do you discard the remaining, leftover medication?	45 (41.3)	4 (3.7)	60 (55.0)	8 (72.7)	0 (0.0)	3 (27.3)	X^2=3.58 P=0.17
Do you give the leftover antibiotics to your other children or family members if they get sick?	1 (0.9)	1 (0.9)	107 (98.2)	1 (9.1)	1 (9.1)	9 (81.8)	X^2=7.22 P=0.04
Do you follow the full course of treatment for your child?	107 (98.2)	1 (0.9)	1 (0.9)	10 (90.9)	1 (9.1)	0 (0.0)	X^2=4.37 P=0.25

* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 64: Frequency distribution of answers for Q34 & 35, based on educational attainment

Questions	Educational Attainment (n,%)																														Test
	GCSEs[1]			Apprenticeship			A-Levels[2]			Certificate of Higher Education			Diploma of Higher Education			Undergraduate Degree			Master's Degree			Doctorate			Professional Qualification			Other[3]			
	A	S	N	A	S	N	A	S	N	A	S	N	A	S	N	A	S	N	A	S	N	A	S	N	A	S	N	A	S	N	
Do you stop taking the further treatment?	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	1 (25.0)	3 (75.0)	1 (16.7)	0 (0.0)	5 (83.3)	0 (0.0)	5 (13.2)	33 (86.8)	1 (3.4)	1 (3.4)	27 (93.1)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=20.34 P=0.40
Do you save the remaining antibiotics for the next time you get sick?	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	1 (25.0)	0 (0.0)	3 (75.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	5 (13.2)	33 (86.8)	1 (3.4)	0 (0.0)	28 (96.6)	1 910.0)	0 (0.0)	9 (90.0)	0 (0.0)	0 (0.0)	16 9100.0)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=21.12 P=0.25
Do you discard the remaining, leftover medication?	2 (40.0)	0 (0.0)	3 (60.0)	0 (0.0)	1 (100.0)	0 (0.0)	2 (28.6)	0 (0.0)	5 (71.4)	0 (0.0)	1 (25.0)	3 (75.0)	4 (66.7)	0 (0.0)	2 (33.3)	14 (36.8)	4 (10.5)	20 (52.6)	12 (41.4)	0 (0.0)	17 (58.6)	8 (80.0)	0 (0.0)	2 (20.0)	8 (50.0)	0 (0.0)	8 (50.0)	1 (25.0)	0 (0.0)	3 (75.0)	X^2=23.93 P=0.08
Do you give the leftover antibiotics to your child or children if they get sick?	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	38 (100.0)	1 (3.4)	0 (0.0)	28 (96.6)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.)	X^2=14.05 P=0.68
Do you complete the	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	5 (83.3)	1 (16.7)	0 (0.0)	36 (94.7)	2 (5.3)	0 (0.0)	28 (96.6)	1 (3.4)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=8.96 P=0.41

full course of treatment?																														
Do you stop giving them further treatment?	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (10.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	1 (16.7)	0 (0.0)	5 (83.3)	0 (0.0)	1 (2.6)	37 (97.4)	0 (0.0)	2 (6.9)	27 (93.1)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	1 (6.3)	15 (93.8)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=23.11 P=0.61
Do you save the remaining antibiotics for the next time they get sick?	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.)	1 (25.0)	0 (0.0)	3 (75.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	1 (2.6)	37 (97.4)	0 (0.0)	1 (3.4)	28 (96.6)	1 (10.0)	0 (0.0)	9 (90.0)	0 (0.0)	0 (0.0)	16 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	X^2=24.14 P=0.33
Do you discard the remaining, leftover medication?	1 (20.0)	0 (0.0)	4 (80.0)	1 (100.0)	0 (0.0)	0 (0.0)	2 (28.6)	0 (0.0)	5 (71.4)	0 (0.0)	1 (25.0)	3 (75.0)	4 (66.7)	0 (0.0)	2 (33.3)	15 (39.5)	3 (7.9)	20 (52.6)	13 (44.8)	0 (0.0)	16 (55.2)	8 (80.0)	0 (0.0)	2 (20.0)	8 (50.0)	0 (0.0)	8 (50.0)	1 (25.0)	0 (0.0)	3 (75.0)	X^2=24.13 P=0.20
Do you give the leftover antibiotics to your other children or family members if they get sick?	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	38 (100.0)	1 (3.4)	1 (3.4)	27 (93.1)	0 (0.0)	0 (0.0)	10 (100.0)	0 (0.0)	0 (0.0)	16 (100.0)	1 (25.0)	0 (0.0)	3 (75.0)	X^2=26.58 P=0.13

Do you follow the full course of treatment for your child?	5 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	7 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	38 (100.)	0 (0.0)	0 (0.0)	27 (93.1)	1 (3.4)	1 (3.4)	10 (100.0)	0 (0.0)	0 (0.0)	15 (93.8)	1 (6.3)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	X^2=24.60 P=0.74

[1] Including O-levels and CSEs
[2] Including Higher School Certificate and Advanced Diploma
[3] Including other vocational/work-related qualifications and foreign qualifications
* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 65: Frequency distribution of answers for Q34 & 35, based on number of children

Questions	Number of children (n,%)												Test
	1			2			3			4 or more			
	A	S	N	A	S	N	A	S	N	A	S	N	
Do you stop taking the further treatment?	1 (2.1)	4 (8.5)	42 (89.4)	1 (1.8)	1 (1.8)	53 (96.4)	0 (0.0)	1 (7.7)	12 (92.3)	0 (0.0)	1 (20.0)	4 (80.0)	X^2=6.60 P=0.32
Do you save the remaining antibiotics for the next time you get sick?	1 (2.1)	2 (4.3)	44 (93.6)	1 (1.8)	1 (1.8)	53 (96.4)	0 (0.0)	1 (7.7)	12 (92.3)	1 (20.0)	1 (20.0)	3 (60.0)	X^2=9.56 P=0.08
Do you discard the remaining, leftover medication?	21 (44.7)	2 (4.3)	24 (51.1)	18 (32.7)	3 (5.5)	34 (61.8)	8 (61.5)	0 (0.0)	5 (38.5)	4 (80.0)	1 (20.0)	0 (0.0)	X^2=11.05 P=0.06
Do you give the leftover antibiotics to your child or children if they get sick?	1 (2.1)	0 (0.0)	46 (97.9)	0 (0.0)	0 (0.0)	55 (100.0)	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=3.50 P=0.54
Do you complete the full course of treatment?	43 (91.5)	4 (8.5)	0 (0.0)	54 (98.2)	1 (1.8)	0 (0.0)	13 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=2.84 P=0.39
Do you stop giving them further treatment?	1 (2.1)	1 (2.1)	45 (95.7)	0 (0.0)	1 (1.8)	54 (98.2)	0 (0.0)	2 (15.4)	11 984.6)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=8.44 P=0.21
Do you save the remaining antibiotics for the next time they get sick?	1 (2.1)	0 (0.0)	46 (97.9)	0 (0.0)	1 (1.8)	54 (98.2)	0 (0.0)	1 (7.7)	12 (92.3)	1 (20.0)	0 (0.0)	4 (80.0)	X^2=10.51 P=0.06
Do you discard the remaining, leftover medication?	21 (44.7)	1 (2.1)	25 (53.2)	20 (36.4)	3 (5.5)	32 (58.2)	8 (61.5)	0 (0.0)	5 (38.5)	4 (80.0)	0 (0.0)	1 (20.0)	X^2=6.0 P=0.40
Do you give the leftover antibiotics to your other children or family members if they get sick?	1 (2.1)	1 (2.1)	45 (95.7)	0 (0.0)	1 (1.8)	54 (98.2)	1 (7.7)	0 (0.0)	12 (92.3)	0 (0.0)	0 (0.0)	5 (100.0)	X^2=6.08 P=0.43
Do you follow the	46 (97.9)	0 (0.0)	1 (2.1)	54 (98.2)	1 (1.8)	0 (0.0)	12 (92.3)	1 97.7)	0 (0.0)	5 (100.0)	0 (0.0)	0 (0.0)	X^2=7.65 P=0.34

full course of treatment for your child?													

* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 66: Frequency distribution of answers for Q34 & 35, based on number of children aged between 3 months and 6 years old

Questions	Number of children aged between 3 months and 6 years old (n,%)												Test
	1			2			3			4 or more			
	A	S	N	A	S	N	A	S	N	A	S	N	
Do you stop taking the further treatment?	1 (1.3)	1 (2.6)	69 (90.8)	1 (2.6)	1 (2.6)	36 (94.7)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=5.22 P=0.68
Do you save the remaining antibiotics for the next time you get sick?	1 (1.3)	4 (5.3)	71 (93.4)	1 (2.6)	1 (2.6)	36 (94.7)	0 (0.0)	0 (0.0)	4 (100.0)	1 (50.0)	0 (0.0)	1 (50.0)	X^2=9.66 P=0.19
Do you discard the remaining, leftover medication?	33 (43.4)	4 (5.3)	39 (51.3)	13 (34.2)	2 (5.3)	23 (60.5)	3 (75.0)	0 (0.0)	1 (25.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=5.85 P=0.46
Do you give the leftover antibiotics to your child or children if they get sick?	1 (1.3)	0 (0.0)	75 (98.7)	0 (0.0)	0 (0.0)	38 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=4.53 P=1.0
Do you complete the full course of treatment?	72 (94.7)	4 (5.3)	0 (0.0)	37 (97.4)	1 (2.6)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=1.62 P=0.74
Do you stop giving them further treatment?	1 (1.3)	2 (2.6)	73 (96.1)	0 (0.0)	1 (2.6)	37 (97.4)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=9.93 P=0.26
Do you save the remaining antibiotics for the next time they get sick?	1 (1.3)	1 (1.3)	74 (97.4)	0 (0.0)	1 (2.6)	37 (97.4)	0 (0.0)	0 (0.0)	4 (100.0)	1 (50.0)	0 (0.0)	1 (50.0)	X^2=12.59 P=0.12
Do you discard the remaining, leftover medication?	33 (43.4)	2 (2.6)	41 (53.9)	15 (39.5)	2 (5.3)	21 (55.3)	3 (75.0)	0 (0.0)	1 (25.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=5.97 P=0.47
Do you give the leftover antibiotics to your	1 (1.3)	1 (1.3)	74 (97.4)	1 (2.6)	1 (2.6)	36 (94.7)	0 (0.0)	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	X^2=6.75 P=1.0

other children or family members if they get sick?													
Do you follow the full course of treatment for your child?	75 (98.7)	0 (0.0)	1 (1.3)	37 (97.4)	1 (2.6)	0 (0.0)	3 (75.0)	1 (25.0)	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	X^2=13.75 P=0.12

* Fischer's exact test was used as one or more cells have expected counts less than 5

Table 67: Frequency distribution of answers for Q34 & 35, based on deprivation

Questions	Deprivation (n,%)						Test
	More deprived			Less deprived			
	A	S	N	A	S	N	
Do you stop taking the further treatment?	1 (0.8)	4 (3.3)	44 (36.7)	1 (0.8)	3 (2.5)	67 (55.8)	X2=0.91 P=0.64
Do you save the remaining antibiotics for the next time you get sick?	1 (0.8)	3 (2.5)	45 (37.5)	2 (1.7)	2 (1.7)	67 (55.8)	X^2=0.85 P=0.65
Do you discard the remaining, leftover medication?	21 (17.5)	1 (0.8)	27 (22.5)	30 (25.0)	5 (4.2)	36 (30.0)	X^2=1.56 P=0.46
Do you give the leftover antibiotics to your child or children if they get sick?	1 (0.8)	0 (0.0)	48 (40.0)	0 (0.0)	0 (0.0)	71 (59.2)	X^2=1.46 P=0.23
Do you complete the full course of treatment?*	47 (39.2)	2 (1.7)	0 (0.0)	68 (56.7)	3 (2.5)	0 (0.0)	X^2=0.001 P=1.00
Do you stop giving them further treatment?	0 (0.0)	3 (2.5)	46 (38.3)	1 (0.8)	1 (0.8)	69 (57.5)	X^2=2.66 P=0.27
Do you save the remaining antibiotics for the next time they get sick?	0 (0.0)	2 (1.7)	47 (39.2)	2 (1.7)	0 (0.0)	69 (57.5)	X^2=4.28 P=0.12
Do you discard the remaining, leftover medication?	21 (17.5)	2 (1.7)	26 (21.7)	32 (26.7)	2 (1.7)	37 (30.8)	X^2=0.18 P=0.92
Do you give the leftover antibiotics to your other children or family members if they get sick?	1 (0.8)	1 (0.8)	47 (39.2)	1 (0.8)	1 (0.8)	69 (57.5)	X^2=0.14 P=0.93
Do you follow the full course of treatment for your child?	47 (39.2)	1 (0.8)	1 (0.8)	70 (58.3)	1 (0.8)	0 (0.0)	X^2=1.5 P=0.46

* Fischer's exact test was used as one or more cells have expected counts less than 5

Appendix 2: Health profile and inequalities per GM borough

Boroughs (IMD 2019 score)	Health inequalities (Compared to England average)	Children (Levels compared to England average)	Adults (Rates compared to England average)
England	• Average life expectancy men: 78.7 years • Average life expectancy women: 82.8 years • Percentage of population reporting bad health: 5.3%		TB incidence (3 year average) 7.8 per 100,000 Employment: 75.7% Unemployment: 3.7%
Bolton (30.7)	• Population health is generally worse. • Part of 20% most deprived authorities in England. • 20.1% (n=12,120) of children live in low-income families. • Life Expectancy (LE) is 11.3 years lower for men and 8.9 years lower for women in most deprived areas of the borough compared to least deprived areas. • Percentage of population reporting bad health: 6.7%	Levels of GCSE attainment, breastfeeding, and smoking in pregnancy are worse.	Rates of TB (11.9 per 100,000 people) and hip fractures are worse. Rates of violent crimes, homelessness, and employment are worse. Under 75 mortality rates for cardiovascular diseases and cancer are worse. Rates of STIs are better. Employment: 69.3% Unemployment: 6%
Bury (23.7)	• Population health? • 14.7% (n=5,615) of children live in low-income families. • LE for women & men is lower • LE is 12.6 years lower for men and 8.5 years lower for women in most deprived areas of the borough compared to least deprived areas. • Percentage of population reporting bad health: 5.8%	Level of GCSE attainment and breastfeeding are worse.	Under 75 mortality rates for cardiovascular diseases are worse. Rates of homelessness are worse. Rates of STIs are better. TB incidence is 7.0 per 100,000 people Employment: 79.3% Unemployment: 2.7%
Manchester (40.0)	• Population health is generally worse. • Part of 20% most deprived authorities. • 27.1% (n=29,510) of children live in low-income families. • LE for women & men is lower. • LE is 7.3 years lower for men and 7.8 years lower for women in most deprived areas of the borough compared to least deprived areas. • Percentage of population reporting bad health: 8.8%	Levels of GCSE attainment, teenage pregnancy, and breastfeeding are worse. Levels of smoking in pregnancy are better.	Rates of TB (21.1 per 100,000 people) and STIs are worse. Rates of violent crimes, homelessness, and employment are worse. Under 75 mortality rates for cardiovascular diseases and cancer are worse. Levels of smoking prevalence are worse. Employment: 67.8% Unemployment: 6%
Oldham (33.2)	• Population health is generally worse. • Part of 20% most deprived authorities.	Levels of GCSE attainment, teenage pregnancy, breastfeeding, and	Rates of TB (16.7 per 100,000 people) are worse. Rates of STIs are better.

Boroughs (IMD 2019 score)	Health inequalities (Compared to England average)	Children (Levels compared to England average)	Adults (Rates compared to England average)
	• 22% (n=11,755) of children live in low-income families. • LE for women & men is lower. • LE is 12 years lower for men and 10.3 years lower for women in most deprived areas compared to least deprived areas of the borough. • Percentage of population reporting bad health: 7.1%	smoking in pregnancy are worse.	Rates of violent crimes, homelessness, and employment are worse. Under 75 mortality rates for cardiovascular diseases and cancer are worse. Levels of smoking prevalence are worse. Employment: 73.7% Unemployment: 3.1%
Rochdale (34.4)	• Population health is generally worse. • Part of 20% most deprived authorities. • 21.2% (n=9,745) of children live in low-income families. • LE for women & men is lower. • LE is 10.9 years lower for men and 6.8 years lower for women in most deprived areas of the borough compared to least deprived areas. • Percentage of population reporting bad health: 7.0%	Levels of GCSE attainment, teenage pregnancy, breastfeeding, and smoking in pregnancy are worse.	Rates of TB (8.7 per 100,000 people) are worse. Rates of STIs are better. Rates of violent crimes and employment are worse. Under 75 mortality rates for cardiovascular diseases and cancer are worse. Employment: 67.2% Unemployment: 2.8%
Salford (34.2)	• Population health is generally worse. • Part of 20% most deprived authorities. • 21.1% (n=10,460) of children live in low-income families. • LE for women & men is lower. • LE is 11.9 years lower for men and 8 years lower for women in most deprived areas of the borough compared to least deprived areas. • Percentage of population reporting bad health: 7.4%	Levels of GCSE attainment, teenage pregnancy, and breastfeeding, are worse.	Rates STIs are worse. Rates of violent crimes and homelessness are worse. Under 75 mortality rates for cardiovascular diseases and cancer are worse. Levels of smoking prevalence are worse. TB rate is 8.6 per 100,000 Employment: 69.7% Unemployment: 7.1%
Stockport (20.8)	• Population? • 13.5% (n=7,105) of children live in low-income families. • LE for men & women is similar to national average. • is 11.2 years lower for men and 9.8 years lower for women in most deprived areas compared to least deprived areas of the borough. • Percentage of population reporting bad health: 5.2%	Levels of GCSE attainment and smoking in pregnancy are better. Levels of breastfeeding are worse.	Rates of statutory homelessness and violent crimes are worse. Rates of TB (2.0 per 100,000 people), STIs, and employment are better Employment: 78.6% Unemployment: 5.1%
Tameside (31.4)	• Population health is generally worse.	Levels of GCSE attainment, teenage pregnancy,	Rates of STIs are better. Rates of violent crimes and levels of smoking

Boroughs (IMD 2019 score)	Health inequalities (Compared to England average)	Children (Levels compared to England average)	Adults (Rates compared to England average)
	• Part of 20% most deprived authorities. • 18.9% (n=8,850) of children live in low-income families. • LE for women & men is lower. • LE is 9.5 years lower for men and 9.0 years lower for women in most deprived areas of the borough compared to least deprived areas. • Percentage of population reporting bad health: 7.0%	breastfeeding, and smoking in pregnancy are worse.	prevalence are worse. Under 75 mortality rates for cardiovascular diseases and cancer are worse. TB rate is 8.3 per 100,000 Employment: 75.6% Unemployment: 3.7%
Trafford (16.1)	• Population health is generally better. • 11.6% (n=5,085) of children live in low-income families. • LE for women & men is higher. • LE is 9.3 years lower for men and 7.4 years lower for women in most deprived areas of the borough compared to least deprived areas • Percentage of population reporting bad health: 4.8%	Levels of GCSE attainment, teenage pregnancy, and smoking in pregnancy are better.	Rates of STIs and employment are better TB rate is 7.9 per 100,000 Employment: 73.7% Unemployment: 4.5%
Wigan (25.7)	• 15.1% (n=8,800) of children live in low-income families. • LE for women & men is lower. • LE is 11.1 years lower for men and 8.8 years lower for women in most deprived areas of the borough compared to least deprived areas. • Percentage of population reporting bad health: 6.3%	Levels of GCSE attainment, teenage pregnancy, breastfeeding, and smoking in pregnancy are worse.	Rates of statutory homelessness and violent crimes are worse. Rates of TB (2.2 per 100,000) & STIs are better. Under 75 mortality rates for cardiovascular diseases and cancer are worse. Rates of hip fractures are worse. Employment: 76.0% Unemployment: 5.9%

(Adapted from: PHE, 2020b; GMCA, 2023; Office of Health Improvement and Disparities, 2024)

Appendix 3: Characteristics of the 6 biggest cities in England (excluding London).

Characteristics	Cities					
	Manchester	**Birmingham**	**Leicester**	**Liverpool**	**Leeds**	**Newcastle upon Tyne**
Population size	551,900	1,1144,900	368,600	486,100	812,000	300,100
IMD 2019 score	40.0	38.1	30.9	42.4	27.3	29.8
Median age of population	31 years of age	34 years of age	33 years of age	35 years of age	36 years of age	34 years of age
Percentage of households with dependent children	16.9%	19.3%	21.3%	14.4%	18.3%	16.6%
Unemployment (excluding full-time students)	4.0%	4.7%	3.6%	3.4%	3.0%	3.0%
Country of birth	England: 66.1% Pakistan: 5.6% Nigeria: 1.9% India: 1.6% Middle East: 1.4%	England: 72.0% Pakistan: 5.9% India: 2.4% Bangladesh: 1.7% Romania: 1.1%	England: 57.9% India: 16.2% South and Eastern Africa: 3.4% Poland: 2.4% Kenya: 1.7%	England: 82.2% Poland: 1.2% Northern Ireland: 1.2% Wales: 1.2% Middle East: 1.1%	England: 82.2% Pakistan: 1.3% India: 1.3% Poland: 1.2% Scotland: 1.1%	England: 79.7% Scotland: 1.7% India: 1.5% EU countries (1.1%) Pakistan (1.1%)
Self-reported health status	V. good health: 43.2% Good Health: 32.3% Fair health: 15.8% Bad health: 6.6% V. bad health: 2.2%	V. good health: 42.3% Good Health: 34.6% Fair health: 15.7% Bad health: 5.6% V. bad health: 1.8%	V. good health: 42.8% Good Health: 34.7% Fair health: 15.6% Bad health: 5.2% V. bad health: 1.6%	V. good health: 44.6% Good Health: 31.3% Fair health: 14.9% Bad health: 6.9% V. bad health: 2.3%	V. good health: 46.6% Good Health: 34.2% Fair health: 13.5% Bad health: 4.4% V. bad health: 1.3%	V. good health: 44.6% Good Health: 33.0% Fair health: 15.0% Bad health: 5.7% V. bad health: 1.8%
Ethnicity	White: 56.8% Asian: 20.9% Black: 11.9% Mixed: 5.3% Others: 5.1%	White: 48.6% Asian: 31.0% Black: 11.0% Mixed: 4.8% Others: 4.5%	White: 40.9.0% Asian: 43.4% Black: 7.8% Mixed: 3.8% Others: 4.1%	White: 84.0% Asian: 5.7% Black: 3.5% Mixed: 3.5% Others: 3.3%	White: 79.0% Asian: 9.7% Black: 5.6% Mixed: 3.4% Others: 2.3%	White: 80.0% Asian: 11.4% Black: 3.3% Mixed: 2.3% Others: 3.1%

Characteristics	Cities					
	Manchester	Birmingham	Leicester	Liverpool	Leeds	Newcastle upon Tyne
Percentage of population with Level 4 or above education (Higher National Certificate, Higher National Diploma, bachelor's degree, or post-graduate qualifications)	37.6%	29.9%	26.8%	30.8%	34.7%	34.6%
Household deprivation (in 4 dimensions - employment, education, health and disability, and household overcrowding)	0.4%	0.4%	0.5%	0.3%	0.3%	0.2%
Child mortality rate (Data obtained from UKHSA Fingertip 2018-2020)	13.5	13.2	13.3	14.0	13.4	15.0
Total number of prescribed antibiotic items per 1000 resident individuals by quarter (2021, quarter 1; Crude rate – per 1,000)	124.2	111.4	94.0	125.8	104.1	121.8
Twelve-month rolling percentage of prescribed antibiotic items from cephalosporin, quinolone, and co-amoxiclav class (March, 2022; proportion - %)	26,917	51,011	14,288	25,687	27,975	23,313
Antibiotic resistance: MRSA bacteraemia all rates (financial year 2021/2022) crude rate – per 100,000	1.6	1.9	0.3	1.6	1.3	0.8

(Sources: ONS, 2023; UKHSA Fingertips, 2023)

Appendix 4: Eurobarometer Report 480 – AMR survey

QUESTIONNAIRE

Q1 Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?
(ONE ANSWER ONLY)

Yes	1,
No	2,
Refusal (SPONTANEOUS)	3,
DK	4

ASK Q2 AND Q3 IF "YES", CODE 1 IN Q1 – OTHERS GO TO Q5

Q2 How did you obtain the last course of antibiotics that you used?
(SHOW SCREEN – READ OUT – ROTATE - ONE ANSWER ONLY)

From a medical prescription	1,
Administered by a medical practitioner	2,
You had some left over from a previous course	3,
Without prescription from a pharmacy	4,
Without prescription from elsewhere	5,
Don't remember (SPONTANEOUS)	6,
Refusal (SPONTANEOUS)	7,
DK	8

Q3 What was the reason for last taking the antibiotics that you used?
(SHOW SCREEN – READ OUT – ROTATE - MULTIPLE ANSWERS POSSIBLE)

Pneumonia (an infection causing an inflammation of one or both lungs)	1,
Bronchitis (inflammation and swelling of the bronchi, the airways that carry airflow from the trachea into the lungs)	2,
Rhino pharyngitis (inflammation of the mucous membrane of the nose and pharynx)	3,
Flu	4,
Cold	5,
Sore throat	6,
Cough	7,
Fever	8,
Headache	9,
Diarrhea	10,
Urinary tract infection	11,
Skin or wound infection	12,
Other (SPONTANEOUS)	13,
Do not wish to answer (SPONTANEOUS)	14,
Refusal (SPONTANEOUS)	15,
DK	16

Q4 Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics ?
(ONE ANSWER ONLY)

Yes	1,
No	2,
Don't remember (SPONTANEOUS)	3,

Do not wish to answer (SPONTANEOUS)	4,
Refusal (SPONTANEOUS)	5,
DK	6

ASK ALL

Q5 For each of the following statements, please tell me whether you think it is true or false.
(SHOW SCREEN – READ OUT – ONE ANSWER PER LINE)

		True	False	DK
1	Antibiotics kill viruses	1	2	3
2	Antibiotics are effective against colds (M)	1	2	3
3	Unnecessary use of antibiotics makes them become ineffective	1	2	3
4	Taking antibiotics often has side-effects such as diarrhea	1	2	3

Q6 When do you think you should stop taking antibiotics once you have begun a course of treatment?
(READ OUT – ONE ANSWER ONLY)

When you feel better	1,
When you have taken all of the antibiotics as directed by your doctor (M)	2,
Other (SPONTANEOUS)	3,
DK	4

Q7 In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold? (M)
(ONE ANSWER ONLY)

Yes	1
No	2
DK	3

ASK Q8 AND Q9 IF "YES", CODE 1 IN Q7 – OTHERS GO TO Q11

Q8 Where did you get this information about not taking antibiotics unnecessarily?
(SHOW SCREEN – READ OUT – MULTIPLE ANSWERS POSSIBLE)

From a doctor	1,
From a pharmacist	2,
From another health professional (e.g. nurse or physio-therapist)	3,
From a family member or friend	4,
From a TV advertisement	5,
On the Internet or in online social networks	6,
In a leaflet or on a poster	7,
In a newspaper	8,
On the TV news or other programmes	9,
On the radio	10,
Other (SPONTANEOUS)	11,
DK	12

Q9 Did the information that you received change your views on using antibiotics?
(ONE ANSWER ONLY)

Yes	1,

	No	2,
	DK	3

ASK Q10 IF "YES", CODE 1 IN Q9 – OTHERS GO TO Q11

Q10	**On the basis of the information you received, how do you now plan to use antibiotics? (M)**	
	(SHOW SCREEN – READ OUT – ROTATE - MULTIPLE ANSWERS POSSIBLE)	
	You will always consult a doctor when you think you need antibiotics	1,
	You will no longer self-medicate with antibiotics	2,
	You will no longer take antibiotics without a prescription from a doctor	3,
	You will no longer keep left over antibiotics for next time you are ill	4,
	You will give left-over antibiotics to your relatives or friends when they are ill	5,
	Other (SPONTANEOUS)	6,
	None (SPONTANEOUS)	7,
	Do not wish to answer (SPONTANEOUS)	8,
	DK	9

ASK ALL

READ OUT: Antimicrobial Resistance is the ability of micro-organisms to resist antimicrobial treatments, especially antibiotics.

Q11	**On which topics, if any, would you like to receive more information?**	
	(SHOW SCREEN – READ OUT – ROTATE - MULTIPLE ANSWERS POSSIBLE)	
	Resistance to antibiotics	1,
	How to use antibiotics	2,
	Medical conditions for which antibiotics are used	3,
	Prescription of antibiotics	4,
	Links between the health of humans, animals and the environment	5,
	Other (SPONTANEOUS)	6,
	None (SPONTANEOUS)	7,
	I don't want to receive more information on these issues (SPONTANEOUS)	8,
	DK	9

Q12	**Which of the following sources of information would you use in order to get trustworthy information on antibiotics?**	
	(SHOW SCREEN – READ OUT – MAX. 3 ANSWERS)	
	A doctor	1,
	A nurse	2,
	A pharmacy	3,
	A hospital	4,
	Another health care facility	5,
	Family or friends	6,
	An official health-related website (e.g. a website set up by the national government/ public health body/ European Union)	7,
	A health-related personal blog	8,
	Another health-related website	9,
	Online social networks	10,
	TV	11,
	Newspapers or magazines	12,
	The radio	13,
	Other (SPONTANEOUS)	14,

Q3

You are not interested in finding information on antibiotics (SPONTANEOUS)	15
DK	16

Q13 At what level do you believe it is most effective to tackle resistance to antibiotics?

(READ OUT – ONE ANSWER ONLY)

At individual level or within the family	1
At regional level	2
At national level	3
At EU level	4
At global level	5
Action at all levels is needed (SPONTANEOUS)	6
DK	7

READ OUT: Now, let's talk about the use and effects of antibiotics in farm animals, i.e. animals used for consumption (meat, dairy products, etc.).

Q14 To what extent do you agree or disagree that sick farm animals should be treated with antibiotics if this is the most appropriate treatment?

(ONE ANSWER ONLY)

Totally agree	1
Tend to agree	2
Tend to disagree	3
Totally disagree	4
DK	5

Q15 Did you know that using antibiotics to stimulate growth in farm animals is banned within the EU?

(ONE ANSWER ONLY)

Yes	1
No	2
DK	3

Q4

Appendix 5: Phase 1 invitation letter for online questionnaire

[Researcher's name]
The University of Salford
Salford, Greater Manchester,
United Kingdom

Tel:
Email:

Date:

Hello,

Research on parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic resistance, and prescription advice

We are writing to request your aid in recruiting parents to take part in a study to evaluate parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic resistance, and prescription advice. This study will be carried out as part of a PhD study on antimicrobial resistance and antibiotic uses among parents. We would like parents of children aged between 3 months and 6 years of age, who are living in Greater Manchester, to complete an online questionnaire.

There is no pressure at all for you to help us recruit participants for this study, and you are free to say no. However, recruiting participants through your social media platform will help us get a better understanding of parents' knowledge and understanding of antimicrobial resistance which is an important public health issue these days. The goal for this part of project is to carry out an online survey which will give us an indication of what parents know or do not know about antimicrobial resistance, and antibiotic use for their child/children. The data obtained from the online survey will then inform a series of focus groups/interviews involving parents, which would eventually help us design and develop an intervention that could help raise better awareness on antimicrobial resistance among parents in Greater Manchester and the efficient use of antibiotics.

Your role in participant recruitment would be straightforward. We would simply ask you to share the link to the online survey in a post on your social media page. We would also kindly request that you add a short message to the post encouraging only parents of children aged between 3 months and 6 years, living in Greater Manchester to complete the online survey.

I have attached an information sheet to give you more details on the study, as well as more information regarding participant confidentiality and their right to withdraw from the study. If you are happy to help us in our endeavour, please e-mail me at [email address] or phone me on [office number]. If you would like any more information, please do not hesitate to get in touch.

Yours sincerely,

[researchers name]

Appendix 6: Phase 1 Twitter message for online questionnaire

Parents in MCR, please help us understand attitudes to antibiotic use & resistance, to ease pressure on the NHS. If you have children (3m - 6yr) please complete this @SalfordUni questionnaire:
https://salford.onlinesurveys.ac.uk/antibiotic-resistance-survey
Please RT. Thank you!

Antimicrobial resistance (#AMR) is a public health issue that strains healthcare systems globally. Understanding attitudes to AMR is crucial. This survey will evaluate parents' knowledge, understanding, and attitudes towards antibiotic prescription, use and resistance.

This survey is part of a PhD study on AMR at Salford University supervised by @margcoffey1 and @DrJoeLatimer.

Appendix 7: Phase 1 Facebook invitation message for online questionnaire

<u>Research on Antibiotic Resistance in Greater Manchester:</u>

Hello,

I am carrying out some important research at the University of Salford and I think your social media platform would be a great way to reach out to parents in Greater Manchester. The results will tell us what parents know about antibiotics, and how they use them. With the current COVID-19 pandemic this is important because antibiotic resistance could add even more strain on our healthcare systems.

Parents of children aged between 3 months and 6 years, living in Greater Manchester, would be asked to complete an online questionnaire. Later, I hope to hold some telephone interviews with parents, to help design a practical intervention that could help raise better awareness of antimicrobial resistance, and the efficient use of antibiotics.

I'm sure you appreciate how important this issue is, so we are asking if you would be kind enough to share a link to the online survey in a post on your social media page?

If you are happy to help us with this, or if you would like to find out more about the study, I'd love to talk to you. Please feel free to contact me here or e-mail me at c.poolaymootien@edu.salford.ac.uk.

Yours sincerely,

Cynthia Poolay Mootien
PhD Candidate (Public Health)
University of Salford, School of Health and Society

Appendix 8: Phase 1 participant information sheet for questionnaire

Title of study: The development of a novel health promotion intervention to improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester.

Name of Researcher:
You are invited to take part in a study on antimicrobial resistance and antimicrobial drugs. Participation in this study is entirely voluntary. If you do want to take part now, but change your mind later, you can pull out of the study at any time.

This information sheet will provide some important information regarding the study and will help you make an informed decision regarding your participation in this research project. With this information sheet, we will explain why we are doing the study and what your participation would involve. You may take some time to read this information sheet and decide whether you would like to participate in this study.

If you agree to take part in this study, please complete the survey attached. If you are completing the online version of the questionnaire, the link provided will take you to an online questionnaire which will take approximately 15-20 minutes to complete.
By completing the online questionnaire, you agree that the data you provide will be used in this study. If you agree to take part in this study and are completing the paper questionnaire, please return the completed questionnaire in the questionnaire deposit box at the reception area.

This document is 3 pages long, please make sure you have read and understood all the pages before proceeding to complete the online questionnaire.

<u>What is the purpose of the study?</u>

This part of our study will last 5 months and will aim to evaluate parents' knowledge and understanding of antibiotic resistance, antibiotic use, and prescription advice, in Greater Manchester. The participants chosen for this study will be parents living in Greater Manchester who have children aged between 3 months and 6 years of age.

<u>Why have I been invited to take part?</u>

You have been invited to take part in this study, as you are eligible to participate in this research project as a parent living in Greater Manchester and having a child aged between 3 months and 6 years of age.

<u>Do I have to take part?</u>

Participation in this study is completely voluntary. You are under no obligation to participate in this study.

<u>What will my participation in the study involve?</u>

Your participation will simply involve completing the online questionnaire or paper questionnaire, and by answering the questions provided truthfully and to the best of your ability. The questionnaire can be completed at your convenience.

Expenses and payments?

You will not incur any costs or expenses to participate in this study, as the online or paper questionnaires can be completed at your convenience. As this is a student-led research, the researcher will not be providing any payments or remuneration for participation in the study.

What are the possible disadvantages and risks of taking part?

Participation in this study will take 15-20 minutes of your time, and access to a computer/internet is essential for the completion of the online questionnaire. The paper questionnaires will be distributed in day-care and community centres, and the researcher will be present to help you complete the questionnaire if you have any difficulties. The paper questionnaires will take 15-20 minutes of your time to complete.

What are the possible benefits of taking part?

Your participation will help the researcher gather data regarding antimicrobial resistance and antibiotic use among parents in Greater Manchester. The data you provide by completing the questionnaire will help develop a tool to raise better awareness among parents in Greater Manchester.

What if there is a problem?

If you have concerns or questions about any aspect of this study, please contact the researcher by email (email address of researcher) who will do their best to answer your questions.

If you have any other issues or complaints, you may also contact the research supervisor Dr Margaret Coffey by email (m.coffey@salford.ac.uk).

If the matter is still not resolved, please forward your concerns to Dr Andrew Clark, Chair of the Ethics Panel, Room L521, Allerton Building, Frederick Road Campus, University of Salford, Salford, M6 6PU. Tel: 0161 29 54109. Email: a.clark@salford.ac.uk

This study will aim to collect data from participants in a safe and confidential manner. However, please note that since this is a student-led study involving voluntary participation, there will be no compensation or indemnity schemes available.

Will my taking part in the study be kept confidential?

Completing the online or paper questionnaire will not require you to provide your name or any other identifiers. Therefore, the data obtained from the questionnaire will be anonymous. To ensure confidentiality, the information that you provide will be stored on encrypted and password-protected equipment and will only be accessible to the researcher and research supervisor.

What will happen if I don't carry on with the study?

Participation in the study is voluntary. You are free to decline to participate, or to withdraw from the research at any time, without any consequences. However, the information/data that you anonymously provide in the survey will not be destroyed as this information is anonymised and cannot be linked back to specific participants.

What will happen to the results of the research study?

The study will be available to the participants to read after the study has been completed. The study will end in January 2023, after which participants can contact the researcher to enquire about the results. The data collected will be stored for up to 5 years and will be accessible to the researcher only, in the event of further research on the topic. If the data is not needed after 5 years, they will be destroyed.

Who is organising or sponsoring the research?

This study is a non-sponsored, student-led research for the completion of a Doctorate degree at the University of Salford.

Further information and contact details:

If you have any queries, concerns or complaints about the study at any stage, you may contact:

Researcher - (Name of researcher, and email address)
Research Supervisor – Dr Margaret Coffey, m.coffey@salford.ac.uk

Appendix 9: Copy of questionnaire

Dear participant,

This questionnaire is designed to find out about your understanding of antibiotics and antibiotic resistance for you and your child.

Please rest assured that your responses will be treated with the utmost confidentiality. This study is entirely anonymous, and no form of identity is required. Your participation in this study is voluntary, and any refusal to participate will be respected.

By completing this questionnaire, you are agreeing that you have read and understood the above information and agree to participate in this research project.

If you do not agree with the above statement, please do not continue with completing this questionnaire.

Please answer all the questions truthfully and to the best of your ability.

Please do not hesitate to contact the researcher if you have further questions regarding the questionnaire or the research study.

(Researcher's email address: c.poolaymootien@edu.salford.ac.uk)

Part 1: Knowledge on antibiotics

Q1. For each of the following statements, please tell me whether you think it is true or false. One answer only.

(a) Antibiotics kill viruses	True/False/Don't know
(b) Antibiotics are effective against colds	True/False/Don't know
(c) Unnecessary use of antibiotics makes them become ineffective	True/False/Don't know
(d) Taking antibiotics often has side-effects such as diarrhoea	True/False/Don't know

Q2. When do you think you should stop taking antibiotics once you have begun a course of treatment? (one answer only)

When you feel better
When you have taken all of the antibiotics as directed by your doctor
Other
Do not know

Q3. The improper use of antibiotics can lead to

(a) Ineffective treatment	True/False/Don't know
(b) Worsening of illness	True/False/Don't know
(c) Emergence of bacterial resistance	True/False/Don't know
(d) Additional medical cost to the patient	True/False/Don't know

Q4. Which statements do you agree with

(a) Bacteria are germs that cause common cold and flu	True/False/Don't know
(b) Antibiotics are effective against bacteria	True/False/Don't know
(c) Antibiotics resistance can spread from animals to humans	True/False/Don't know
(d) Antibiotic resistance can spread from human to human	True/False/Don't know

Part 2: Attitudes towards antibiotic resistance and antibiotic prescribing

Please tick the answer you most agree with

Q5. Antibiotic resistance is an important and serious public health issue worldwide

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q6. Antibiotic resistance is an important and serious public health issue in this country.

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q7. When I have a cold, I should take antibiotics to prevent getting a more serious illness

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q8. When I get fever, antibiotics help me to get better more quickly.

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q9. Whenever I take antibiotics, I contribute to the development of antibiotic resistance

Strongly agree
Somewhat agree
Undecided

Somewhat disagree
Strongly disagree

Q10. Skipping one or two doses does not contribute to the development of antibiotic resistance

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q11. Antibiotics are safe drugs; hence they can be commonly used.

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q12. If a child suffers from a cold or flu, it will be cured faster if they are given antibiotics.

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q13. If the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional.

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q14. You would re-use an antibiotic which you had used in the past if your child presents the same symptoms.

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q15. Most of the Upper Respiratory Infections (e.g. common cold, sinusitis, tonsillitis, or laryngitis) will be self-cured even without the use of antibiotics?

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q16. You expect your doctor to prescribe antibiotics if your child was suffering from an Upper Respiratory Tract Infection (e.g. common cold, sinusitis, tonsillitis, or laryngitis).

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q17. You would ask your doctor for antibiotic therapy if your child suffers from recurrent Upper Respiratory Tract Infections (e.g. common cold, sinusitis, tonsillitis, or laryngitis).

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q18. Which of the following symptoms would make you visit a doctor for your child? (multiple answers)
Cough
Fever
Runny nose
Ear pain
Sore throat
Hoarseness
Other
None of the above

If you have chosen other, please give examples of which other symptoms

Q19. When antibiotics are prescribed for you or your child, you are given enough information regarding how to take the antibiotics, how long to take it for, and the possible side effects that could occur while taking it?

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q20. During consultations with a healthcare professional (e.g.: nurse, GP, paediatrician, pharmacist), you are given time to inquire about the antibiotics prescribed to you.

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

Q21. During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing antibiotics and are given enough information on how to treat the symptoms that you or your child are presenting

Strongly agree
Somewhat agree
Undecided
Somewhat disagree
Strongly disagree

<u>Part 3: Self-reported practices/use of antibiotics</u>

Q22. Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months? (One answer only)

Yes
No
Do not know
Do not wish to answer

Q23. Have you given any antibiotics to your child in the last 12 months? (One answer only)

Yes
No
Do not know
Do not wish to answer

Q24. How did you obtain the last course of antibiotics that you used? (one answer only)

From a medical prescription
Administered by a medical practitioner

You had some left over from a previous course
Without prescription from a pharmacy
Without prescription from elsewhere
Don’t remember
Do not know
Do not wish to answer

If you have chosen “without prescription from elsewhere” please can you provide more information on how and from where you obtained the antibiotics.

Q25. How did you obtain the last course of antibiotics for your child? (one answer only)

From a medical prescription
Administered by a medical practitioner
You had some left over from a previous course of antibiotics for your child
You had some left over from a previous course of antibiotics for you
Without prescription from a pharmacy
Without prescription from elsewhere
Don’t remember
Do not know
Do not wish to answer

If you have chosen “without prescription from elsewhere” please can you provide more information on how and from where you obtained the antibiotics.

Q26. What was the reason for last taking the antibiotics that you used? (multiple answers possible)

Pneumonia (an infection causing an inflammation of one or both lungs)
Bronchitis (inflammation and swelling of the bronchi, the airways that carry airflow from the trachea into the lungs)
Rhino pharyngitis (inflammation of the mucous membrane of the nose and pharynx)
Flu
Cold
Sore throat
Cough
Fever
Headache
Diarrhoea
Urinary tract infection
Skin or wound infection
Other
Do not know
Do not wish to answer

Q27. What was the reason for last giving your child antibiotics? (multiple answers possible)

Pneumonia (an infection causing an inflammation of one or both lungs)
Bronchitis (inflammation and swelling of the bronchi, the airways that carry airflow from the trachea into the lungs)
Rhino pharyngitis (inflammation of the mucous membrane of the nose and pharynx)
Flu
Cold
Sore throat
Cough
Fever
Headache
Diarrhoea
Urinary tract infection
Skin or wound infection
Other
Do not know
Do not wish to answer

Q28. Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics? (one answer only)
Yes
No
Do not remember
Do not know
Do not wish to answer

Q29. Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics? (one answer only)

Yes
No
Do not remember
Do not know
Do not wish to answer

Q30. In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold? (one answer only)

Yes
No
Do not know

Q31. If you have ever been given information about not taking antibiotics unnecessarily or giving your child unnecessary antibiotics, where did you get this information from? (multiple answers possible)

From a doctor

From a pharmacist
From another health professional (e.g. nurse or physio-therapist)
From a family member or friend
From a TV advertisement
On the Internet or in online social networks
In a leaflet or on a poster
In a newspaper
On the TV news or other programmes
On the radio
Other
Do not know

Q32. Did the information that you received change your views on using antibiotics or giving antibiotics to your child? (one answer only)

Yes
No
Do not know

Q33. On the basis of the information you received, how do you now plan to use antibiotics? (multiple answers possible)

You will always consult a doctor when you think you need antibiotics
You will no longer self-medicate with antibiotics
You will no longer take antibiotics without a prescription from a doctor
You will no longer keep left over antibiotics for next time you are ill
You will give left-over antibiotics to your relatives or friends when they are ill
Other
None
Do not know
Do not wish to answer

Q34. The doctor prescribes a course of antibiotic for you. After taking 2–3 doses you start feeling better.

(a) Do you stop taking the further treatment?

Always
Usually
Sometimes
Seldom
Never

(b) Do you save the remaining antibiotics for the next time you get sick?

Always
Usually
Sometimes

Seldom
Never

(c) Do you discard the remaining, leftover medication?

Always
Usually
Sometimes
Seldom
Never

(d) Do you give the leftover antibiotics to your child or children if they get sick?

Always
Usually
Sometimes
Seldom
Never

(e) Do you complete the full course of treatment?

Always
Usually
Sometimes
Seldom
Never

Q35. The Doctor prescribes a course of antibiotic for your child. After taking 2–3 doses your child starts feeling better.

(a) Do you stop giving them further treatment?

Always
Usually
Sometimes
Seldom
Never

(b) Do you save the remaining antibiotics for the next time they get sick?

Always
Usually
Sometimes
Seldom
Never

(c) Do you discard the remaining, leftover medication?

Always
Usually

Sometimes
Seldom
Never

(d) Do you give the leftover antibiotics to your other children or family members if they get sick?

Always
Usually
Sometimes
Seldom
Never

(e) Do you follow the full course of treatment for your child?

Always
Usually
Sometimes
Seldom
Never

Part 4: Demographic Info

Q36. What gender are you?

Male
Female
Other

Q37. What is your age:

18-19
20-29
30-39
40-49
50-59
60-69
70+

Q38. What is your ethnicity?

White British
Black/African/Caribbean/Black British
Asian/Asian British
Mixed/Multiple ethic groups
Other ethnic group
Prefer not to say

Q39. Were you born in the UK?

Yes
No
Do not wish to answer

(a). If no, what country were you born in?

Q40. What is the highest qualification you have? If your UK qualification is not listed, tick the box that contains the nearest equivalent. If you have a qualification gained outside the UK, tick the 'Foreign qualifications' box or the nearest UK equivalent (if known).

O-Levels/CSEs/GCSEs
Apprenticeship
A-Levels/Higher School Certificate/Advanced Diploma
Certificate of higher education
Diploma of higher education
Undergraduate degree (e.g. BA, BSc)
Master’s degree (e.g. MA, MSC)
Doctorate (e.g. PhD)
Professional qualification (e.g. teaching, nursing, accountancy)
Other vocational/work-related qualifications
Foreign qualifications
No qualifications

Q41. How many children do you have that live at home with you or who you have regular responsibility for?

None
1
2
3
4
5 or more

Q42. How many of these children are aged between 3 month and 6 years old?

None
1
2
3
4
5 or more

Q43. What is the first part of your postcode? (Open question)

Part 5: (Questions 45 & 46 were taken from the Special Eurobarometer Report 478, 2018)

Q44. We would like to invite you to take part in a focus group/interview. If you are willing to participate in this next phase of our study, please leave your contact information (e.g. email address or phone number) below.

Antimicrobial Resistance is the ability of micro-organisms to resist antimicrobial treatments, especially antibiotics.

Q45. On which topics, if any, would you like to receive more information? (multiple answers possible)

Resistance to antibiotics
How to use antibiotics
Medical conditions for which antibiotics are used
Prescription of antibiotics
Links between the health of humans, animals and the environment
Other
None
I don't want to receive more information on these issues
Don't know

Q46. Which of the following sources of information would you use in order to get trustworthy information on antibiotics? (multiple answers)

A doctor
A nurse
A pharmacy
A hospital
Another health care facility
Family or friends
An official health-related website (e.g. a website set up by the national government/ public health body/ European Union)
A health-related personal blog
Another health-related website
Online social networks
TV
Newspapers or magazines
The radio
Other
You are not interested in finding information on antibiotics
Do not know

Final Page:

For more information on antibiotic resistance and its consequences, please follow the links below:

https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance

https://www.gov.uk/government/publications/health-matters-antimicrobial-resistance/health-matters-antimicrobial-resistance

https://www.nhs.uk/conditions/antibiotics/antibiotic-antimicrobial-resistance/?gclid=CK-ppNCRkOgCFY-AhQod0fUM6A

https://www.gov.uk/government/collections/antimicrobial-resistance-amr-information-and-resources

This survey was informed by validated questionnaires from the following sources:

André, M., Vernby, Å., Berg, J., & Lundborg, C. (2010). A survey of public knowledge and awareness related to antibiotic use and resistance in Sweden.

European Commission. (2018). Special Eurobarometer 478 – November 2018 "Antimicrobial Resistance".

Khan, A., Gausia, B., & Reshma, K. (2013). Antibiotic Resistance and Usage—A Survey on the Knowledge, Attitude, Perceptions and Practices among the Medical Students of a Southern Indian Teaching Hospital. Journal of Clinical and Diagnostic Research

Panagakou, S. G., Theodoridou, M. N., Papaevangelou, V., Papastergiou, P., Syrogiannopoulos, G. A., Goutziana, G. P., & Hadjichristodoulou, C. S. (2009). Development and assessment of a questionnaire for a descriptive cross-sectional study concerning parents' knowledge, attitudes and practises in antibiotic use in Greece.

Vallin, M., Polyzoi, M., Marrone, G., Rosales-Klintz, S., Tegmark Wisell, K. & Stålsby Lundborg, C. (2016) Knowledge and Attitudes towards Antibiotic Use and Resistance - A Latent Class Analysis of a Swedish Population-Based Sample.

For further information or questions, please contact researcher:

[Email address of researcher]

Thank you for your participation

Appendix 10: Coding for questionnaire

(Correct answers have been highlighted wherever relevant)

Question/Statements	Coding
Antibiotics kill viruses	True = 1 **False** = 2 Don't' know = 3
Antibiotics are effective against colds	True = 1 **False** = 2 Don't' know = 3
Unnecessary use of antibiotics makes them become ineffective	**True** = 1 False = 2 Don't' know = 3
Taking antibiotics often has side-effects such as diarrhoea	**True** = 1 False = 2 Don't' know = 3
When do you think you should stop taking antibiotics once you have begun a course of treatment? When you feel better	True = 1 **False** = 2 Don't' know = 3
When do you think you should stop taking antibiotics once you have begun a course of treatment? When you have taken all of the antibiotics as directed by your doctor	**True** = 1 False = 2 Don't' know = 3
The improper use of antibiotics can lead to ineffective treatment	**True** = 1 False = 2 Don't' know = 3
The improper use of antibiotics can lead to worsening of illness	**True** = 1 False = 2 Don't' know = 3
The improper use of antibiotics can lead to the emergence of bacterial resistance	**True** = 1 False = 2 Don't' know = 3
The improper use of antibiotics can lead to additional medical cost to the patient	**True** = 1 False = 2 Don't' know = 3
Bacteria are germs that cause common cold and flu	True = 1 **False** = 2 Don't' know = 3
Antibiotics are effective against bacteria	**True** = 1 False = 2 Don't' know = 3
Antibiotic resistance can spread from animals to humans	**True** = 1 False = 2 Don't' know = 3
Antibiotic resistance can spread from human to human	**True** = 1 False = 2 Don't' know = 3
Antibiotic resistance is an important and serious public health issue worldwide	**Agree** = 1 Undecided = 2 Disagree = 3
Antibiotic resistance is an important and serious public health issue in this country	**Agree** = 1 Undecided = 2 Disagree = 3

When I have a cold, I should take antibiotics to prevent getting a more serious illness	Agree = 1 Undecided = 2 **Disagree** = 3
When I get fever, antibiotics help me to get better more quickly	Agree = 1 Undecided = 2 **Disagree** = 3
Whenever I take antibiotics, I contribute to the development of antibiotic resistance	**Agree** = 1 Undecided = 2 Disagree = 3
Skipping one or two doses does not contribute to the development of antibiotic resistance	Agree = 1 Undecided = 2 **Disagree** = 3
Antibiotics are safe drugs; hence they can be commonly used.	Agree = 1 Undecided = 2 **Disagree** = 3
If a child suffers from a cold or flu, it will be cured faster if they are given antibiotics.	Agree = 1 Undecided = 2 **Disagree** = 3
If the doctor did not prescribe antibiotics often enough for your child, you would change doctor or go to another healthcare professional	Agree = 1 Undecided = 2 **Disagree** = 3
You would re-use an antibiotic which you had used in the past if your child presents the same symptoms.	Agree = 1 Undecided = 2 **Disagree** = 3
Most of the Upper Respiratory Infections (e.g. common cold, sinusitis, tonsillitis, or laryngitis) will be self-cured even without the use of antibiotics	**Agree** = 1 Undecided = 2 Disagree = 3
You expect your doctor to prescribe antibiotics if your child was suffering from an Upper Respiratory Tract Infection	Agree = 1 Undecided = 2 **Disagree** = 3
You would ask your doctor for antibiotic therapy if your child suffers from recurrent Upper Respiratory Tract Infections	Agree = 1 Undecided = 2 **Disagree** = 3
When antibiotics are prescribed for you or your child, you are given enough information regarding how to take the antibiotics, how long to take it for, and the possible side effects that could occur while taking it	Agree = 1 Undecided = 2 Disagree = 3
During consultations with a healthcare professional (e.g.: nurse, GP, paediatrician, pharmacist), you are given time to inquire about the antibiotics prescribed to you	Agree = 1 Undecided = 2 Disagree = 3
During consultations with healthcare professionals for self-limiting infections, you are reassured about not needing antibiotics and are given enough information on how to treat the symptoms that you or your child are presenting	Agree = 1 Undecided = 2 Disagree = 3
Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months	Yes = 1 No = 2 Don't know/Do not wish to answer = 3
Have you given any antibiotics to your child in the last 12 months?	Yes = 1 No = 2 Don't know/Do not wish to answer = 3

Did you have a test, for example a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?	Yes = 1 No = 2 Don’t know/Do not wish to answer = 3
Did your child have a test to find out what was causing the illness before or at the same time as they were given antibiotics?	Yes = 1 No = 2 Don’t know/Do not wish to answer = 3
In the last 12 months, do you remember getting any information about not taking antibiotics unnecessarily, for example for a cold?	Yes = 1 No = 2 Don’t know = 3
Did the information that you received change your views on using antibiotics or giving antibiotics to your child?	Yes = 1 No = 2 Don’t know = 3
The doctor prescribes a course of antibiotic for you. After taking 2–3 doses you start feeling better.	
Do you stop taking the further treatment?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you save the remaining antibiotics for the next time you get sick?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you discard the remaining, leftover medication?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you give the leftover antibiotics to your child or children if they get sick?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you complete the full course of treatment?	**Always/Usually** = 1 Sometimes = 2 Seldom/Never = 3
The Doctor prescribes a course of antibiotic for your child. After taking 2–3 doses your child starts feeling better.	
Do you stop giving them further treatment?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you save the remaining antibiotics for the next time they get sick?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you discard the remaining, leftover medication?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you give the leftover antibiotics to your other children or family members if they get sick?	Always/Usually = 1 Sometimes = 2 **Seldom/Never** = 3
Do you follow the full course of treatment for your child?	**Always/Usually** = 1 Sometimes = 2 Seldom/Never = 3
What gender are you?	Male = 1 Female = 2
What is your age?	16-29 = 1 30-39 = 2 40-49 = 3 50+ = 4
What is your ethnicity?	White = 1

	Other ethnicities = 2
Were you born in the UK?	Yes = 1 No = 2
What is the highest qualification you have?	O levels / CSEs / GCSEs = 1 Apprenticeship = 2 A-Levels / Higher School Certificate / Advanced Diploma = 3 Certificate of higher education = 4 Diploma of higher education = 5 Undergraduate degree (e.g. BA, BSc) = 6 Master's degree (e.g. MA, MSc) = 7 Doctorate (e.g. PhD) = 8 Professional qualification (e.g. teaching, nursing, accountancy) = 9 Other vocational / work-related qualifications = 10 Foreign qualifications = 11 No qualifications = 12
How many children do you have that live at home with you or who you have regular responsibility for?	1 = 1 2 = 2 3 = 3 4 or more = 4 None = 5
How many of these children are aged between 3 months and 6 years old?	1 = 1 2 = 2 3 = 3 4 or more = 4 None = 5
We would like to invite you to take part in a focus group/interview. If you are willing to participate in this next phase of our study, please leave your contact information (e.g. email address or phone number) below.	
On which topics, if any, would you like to receive more information? (multiple answers possible)	Resistance to antibiotics How to use antibiotics Medical conditions for which antibiotics are used Prescription of antibiotics Links between the health of humans, animals and the environment Other None I don't want to receive more information on these issues Don't know
Which of the following sources of information would you use in order to get trustworthy information on antibiotics? (multiple answers)	A doctor A nurse A pharmacy A hospital Another health care facility Family or friends An official health-related website (e.g. a website set up by the national government/ public health body/ European Union)

	A health-related personal blog Another health-related website Online social networks TV Newspapers or magazines The radio Other You are not interested in finding information on antibiotics Do not know

Appendix 11: Phase 2 invitation letter for telephone interviews

[Researcher's name]
The University of Salford
Salford, Greater Manchester,
United Kingdom

Tel:
Email:

Date:

Dear Sir/Madam,

Research on parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic resistance, and prescription advice

We are writing to request your participation in our study to evaluate parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic resistance, and prescription advice. We are contacting you, as you have volunteered to participate in a focus group/interview, and you have kindly provided us with your contact details via our online survey on antibiotics use among parents in Greater Manchester. These interviews will be carried out as part of a PhD study on antimicrobial resistance and antibiotic uses among parents.

There is no pressure at all for you to help us in this study, and you are free to say no. However, your valuable insight will help us get a better understanding of parents' knowledge and understanding of antimicrobial resistance, which is an important public health issue these days. The goal for this part of project is to carry out a series of interviews involving parents, to inform the design and development of some type of intervention that could help raise better awareness on antimicrobial resistance among parents' in Greater Manchester and the efficient use of antibiotics.

I have attached an information sheet to give you more details on the study, as well as more information regarding participant confidentiality and your right to withdraw from the study, if you decide to participate. If you are happy to help us in our endeavour, please e-mail me at [email address] or phone me on [office number]. If you would like any more information, please do not hesitate to get in touch.

Yours sincerely,

[researchers name]

Appendix 12: Phase 2 participant information sheet for telephone interviews

Title of study: The development of a novel health promotion intervention to improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester.

Name of Researcher:
You are invited to take part in a study on antimicrobial resistance and antimicrobial drugs. Participation in this study is entirely voluntary. If you do want to take part now, but change your mind later, you can pull out of the study at any time.

This information sheet will provide some important information regarding the study and will help you make an informed decision regarding your participation in this research project. With this information sheet, we will explain why we are doing the study and what your participation would involve. You may take some time to read this information sheet and decide whether you would like to participate in this study.

If you agree to take part in this study, you will be asked to sign a consent form before the beginning of the interview.

This document is 3 pages long, please make sure you have read and understood all the pages before deciding on whether would you like to participate in our focus group.

What is the purpose of the study?

This part of our study will consist of a series of interviews conducted with the aim to understand more about parents' experiences and perceptions of antibiotic resistance, antibiotic use, and prescription advice, in Greater Manchester. The participants chosen for this study will be parents living in Greater Manchester who have children aged between 3 months and 6 years of age.

Why have I been invited to take part?

You have been invited to take part in this study as you are eligible to participate in this research project as a parent living in Greater Manchester and having a child aged between 3 months and 6 years of age and have volunteered via our survey to participate in a telephone interview.

Do I have to take part?

Participation in this study is completely voluntary. You are under no obligation to participate in this study.

What will my participation in the study involve?

Your participation will involve taking part in a telephone interview, which will be an informal discussion. The topics that will be discussed during this session will involve discussions about antibiotics and their use among children, antibiotic resistance, and antibiotic prescribing. The interview will last no longer than 10-20 minutes. The session will be audio-recorded. However, no participant identifiers will be used.

Expenses and payments?

Participation in the study is entirely voluntary. As this is a student-led research, the researcher will not be providing any payments or remuneration for participation in the study.

What are the possible disadvantages and risks of taking part?

Participation will require you to spend some time reading the information sheet, and to spare 10-20 minutes of your time for the telephone interview. You will be contacted prior to the event to schedule a time that will be convenient for you to take part in interview.

What are the possible benefits of taking part?

Your participation will help the researcher gather data regarding antibiotic resistance and antibiotic use among parents in Greater Manchester. The data you provide by completing the questionnaire will help develop a tool to raise better awareness among parents in Greater Manchester.

What if there is a problem?

If you have concerns or questions about any aspect of this study, please contact the researcher by email (email address of researcher) who will do their best to answer your questions.

If you have any other issues or complaints, you may also contact the research supervisor Dr Margaret Coffey by email (m.coffey@salford.ac.uk).

If the matter is still not resolved, please forward your concerns to Dr Andrew Clark, Chair of the Ethics Panel, Room L521, Allerton Building, Frederick Road Campus, University of Salford, Salford, M6 6PU. Tel: 0161 29 54109. Email: a.clark@salford.ac.uk

This study will aim to collect data from participants in a safe and confidential manner. However, please note that since this is a student-led study involving voluntary participation, there will be no compensation or indemnity schemes available.

Will my taking part in the study be kept confidential?

No personal identifiers will be used during the interview. Participants will be required to give verbal consent at the beginning of the interview, that states that they are comfortable with the interview procedures, they accept being audio recorded, and they understand the information given to them regarding participant confidentiality and their right to withdraw from the study at any time. During analysis participants' anonymity will be ensured by using a numerical code to identify the participants. To ensure confidentiality, all audio recorded interviews will be transcribed by the researcher and all the information that you provide will be stored on encrypted and password-protected equipment and will only be accessible to the researcher and research supervisor.

<u>What will happen if I don't carry on with the study?</u>

Participation in the study is voluntary. You are free to decline to participate, or to withdraw from the research at any time, without any consequences, and the information/data that you provide during the interview will be destroyed. If you want to withdraw from the study, you can request your data to be withdrawn from the study by contacting the researcher within 4 weeks of the interview. After this timeframe it may not be possible to withdraw your data.

<u>What will happen to the results of the research study?</u>

The study will be available to the participants to read after the study has been completed. The study will end in January 2023, after which participants can contact the researcher to enquire about the results. The data collected will be stored for up to 5 years and will be accessible to the researcher only, in the event of further research on the topic. If the data is not needed after 5 years they will be destroyed.

<u>Who is organising or sponsoring the research?</u>

This study is a non-sponsored, student-led research for the completion of a Doctorate degree at the University of Salford.

<u>Further information and contact details</u>:

If you have any queries, concerns or complaints about the study at any stage, you may contact:

Researcher - (Name of researcher, and email address)
Research Supervisor – Dr Margaret Coffey, m.coffey@salford.ac.uk

Appendix 13: Phase 2 consent form for telephone interviews

CONSENT FORM – *can be completed at the interview, or scanned and e-mailed to [researcher's email address]*

Name of Researcher:

Please complete and sign this form **after** you have read and understood the study information sheet. Read the statements below and choose 'yes' or 'no', as applicable in the box on the right hand side. As is mentioned in the information sheet, please take your time to consider your potential participation in this study before signing the Consent Form attached.

1. I confirm that I have read and understand the study information sheet version 4, dated 20/06/2020 for the above study. I have had the opportunity to consider the information and ask questions which have been answered satisfactorily.	Yes/No
2. I understand that my participation is voluntary and that I am free to withdraw any time, without giving any reason, and without my rights being affected.	Yes/No
3. If I do decide to withdraw (up to one month after taking part) I understand this will not impact on any aspects not related to the study and any interview recordings and transcripts will be destroyed.	Yes/No
4. I understand that my personal details will be kept confidential and not revealed to people outside the research team. I understand that this will be breached if anything related to criminal activity/self-harm or other safeguarding issues is revealed.	Yes/No
5. I understand that my anonymised data will be used in the research report other academic publications and conferences presentations.	Yes/No
6. I agree to take part in the study:	Yes/No
7. I would like to take part in an interview and understand that this will be audio-recorded.	Yes/No

______________________	______________________	______________________
Name of participant	**Date**	**Signature**
______________________	______________________	______________________
Name of person taking consent	**Date**	**Signature**

Appendix 14: Phase 2 interview guide

Conducting the interview (to be read out at the beginning)

Firstly, I'd like to thank you for agreeing to take part; I really value your input into our study to better understand parents' knowledge, understanding, and attitude toward antimicrobial resistance, antibiotic use, and prescription advice. My name is xxxxxxx and I will be asking the questions today. I am a PhD student from the University of Salford, and I would like us to cover a number of important topics that would give us important insights into your experiences and beliefs as a parent regarding antibiotics and antimicrobial resistance.

Just to remind you that the interview is strictly voluntary, and that I will be recording the interviews to allow them to be transcribed for analysis.

The session will last no longer than 10-20 minutes, and before we start, I'd just like to assure you that:

- There are no right or wrong answers to the questions I will ask – we just want to hear what you think.
- I'd like to stress that we will not use names or anything directly identifying when you talk about your personal experiences.

To start with I need to read out a short consent form so that I can record that you're happy to take part - you just need to respond by saying yes or no to each question. [READ CONSENT FORM]

Do you have any questions so far? If you are still happy to participate in this interview today, we will start the session now.

Draft questions:

1. Could you tell me about your experience of using antibiotics for your child? [prompt: have you used them with your child; what kinds of symptoms would trigger you to seek antibiotics/medical advice]?
2. Have you ever been refused antibiotics when you've felt they were needed? [prompt: can you tell me about it? Why was this? How did you feel?]
3. If you or your child is prescribed antibiotics how do you administer them? [prompt: how long do you take them for? Do you stop taking them when you feel better? Do you save some to use later if the symptoms get worse?]
4. When you leave a medical consultation with a healthcare professional, how do you feel about the information you have been given? [prompt: do they explain things clearly? Do you feel like you were given the opportunity to ask the questions you wanted to ask? Do you understand your prescription advice?]
5. What have you heard, if anything, about antibiotic resistance? [prompt: can you explain to me what you think it means? Is it something you are concerned about? Do you feel it can affect you or your child? What do you think about the language used/medical jargon when information on antibiotic resistance is offered to you?]
6. Do you think there needs to be more awareness on antibiotic resistance? [prompt: what sources would you want to get more information from? Where did you hear

about antibiotic resistance last? Which specific topic about antibiotic resistance would you be interested in hearing more about]

7. Do you think there needs to be more awareness/information on antibiotic use? [prompt: what sources would you want to get more information from? Which specific topic about antibiotic use would you be interested in hearing more about]
8. What kind of resources do you think parents would benefit from more when it comes to antibiotic resistance awareness? [prompt: what would be more impactful for you or what would catch your attention? What sort of media would you want to look at: pamphlet, brochure, advert in newspaper/magazines, radio/TV public service announcements, posters, articles, blog, podcast, social media posts]
9. Which sources of information would you consider to be trustworthy about antibiotic resistance? [prompt: medical experts, family members, government officials, international organisation like the WHO. What do you think about misinformation on antibiotic resistance and how resistance occurs?]
10. Have your views/perceptions about public health information, health promotion (e.g. hygiene/sanitation practices), or healthcare services changed since COVID-19? [prompt: in what way?]

At the end of the questions:

I think we've come to the end of our questions. Thank you for your honest opinions – you were very helpful and gave us great insights into your experiences with antibiotic use, prescription advice, and antimicrobial resistance. Is there anything else you would like to add before we finish?

Again, thank you very much for your participation today. I really appreciate your help.

Appendix 15: Phase 3 Twitter message for online workshops

Parents in Greater Manchester if you have children aged between 3 months and 6 years we would love you to take part in our research about antibiotic use. This will involve being part of an online creative workshop to develop a way of improving parents' knowledge, understanding and attitudes towards antibiotics.

If you are interested in taking part in this exciting study, please get in touch.

Please RT

Appendix 16: Phase 3 invitation email for online workshops

[Researcher's name]
The University of Salford
Salford, Greater Manchester,
United Kingdom

Tel:
Email:

Date:

Dear Sir/Madam,

Research on parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic resistance, and prescription advice

We are writing to ask you to take part in our study to develop a novel health promotion tool to improve parents' knowledge, understanding, and attitudes towards antibiotic use, prescription advice, and resistance in Greater Manchester. We are contacting you, as you have either already participated in Phase 1 and/or 2 of our study or have expressed interest in participating via our social media posts. We would like to invite you to participate in an online creative workshop, which will be carried out as part of a PhD study on antimicrobial resistance and antibiotic use among parents in Greater Manchester.

There is no pressure at all for you to help us in this study, and you are free to say no. However, your valuable insight will help us get a better assessment of what parents want to know and see in AMR awareness campaigns and interventions. We would like parents to be central to this creative process, as they would be the target audience for the intervention/tool developed in our study. The goal for this part of our project is to carry out online creative workshops with parents, to inform the design and development of some type of intervention that could help raise awareness about antimicrobial resistance among parents in Greater Manchester and the efficient use of antibiotics.

I have attached an information sheet to give you more details about the study, as well as more information regarding participant confidentiality and your right to withdraw from the study (if you decide to take part). If you are happy to help us, please e-mail me at [email address]. If you would like any more information, please do not hesitate to get in touch.

Yours sincerely,

[researchers name]

Appendix 17: Phase 3 invitation email for University of Salford students

Hello,

Research on parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic resistance, and prescription advice

We are recruiting parents to take part in a study to evaluate parents' knowledge, understanding, and attitudes towards antibiotic use, antibiotic resistance, and prescription advice. If you are a parent of a child aged 3 months to 6 years old, and you live in Greater Manchester, we would like to invite you to participate in an online creative workshop, which will be carried out as part of a PhD study on antimicrobial resistance and antibiotic use among parents in Greater Manchester.

There is no pressure at all for you to help us in this study, and you are free to say no. However, your valuable insight will help us get a better assessment of what parents want to know and see in AMR awareness campaigns and interventions. We would like parents to be central to this creative process, as they would be the target audience for the intervention/tool developed in our study. The goal for this part of our project is to carry out online creative workshops with parents, to inform the design and development of some type of intervention that could help raise awareness about antimicrobial resistance among parents in Greater Manchester and the efficient use of antibiotics.

I have attached an information sheet to give you more details about the study, as well as more information regarding participant confidentiality and your right to withdraw from the study (if you decide to take part). If you are happy to help us, please e-mail me at [email address]. If you would like any more information, please do not hesitate to get in touch.

Yours sincerely,

[researchers name]

Appendix 18: Phase 3 participant information sheet for online workshops

Title of study: The development of a novel health promotion intervention to improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester.

Name of Researcher:

You are invited to take part in a study on antimicrobial resistance and antimicrobial drugs. Participation in this study is entirely voluntary. If you want to take part now, but change your mind later, you can pull out of the study at any time.

This information sheet provides important information regarding the study to help you make an informed decision regarding your participation in this research project. With this information sheet, we will explain why we are doing the study and what your participation would involve. You may take some time to read this information sheet and decide whether you would like to participate in this study.

If you agree to take part in this study, you will be asked to sign a consent form before participating in the online creative workshop.

This document is 3 pages long, please make sure you have read and understood all the pages before deciding on whether you would like to participate in our workshop.

<u>What is the purpose of the study?</u>

This part of our study will consist of an online workshop conducted with the aim of developing a health promotion intervention that will help improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester. The participants chosen for this study will be parents living in Greater Manchester who have children aged between 3 months and 6 years of age.

<u>Why have I been invited to take part?</u>

You have been invited to take part in this study as you are eligible to participate in this research project as a parent living in Greater Manchester and having a child aged between 3 months and 6 years of age. You have also been invited as you have expressed interest in this research either by previously participating in the other phases of the study, or by volunteering to participate via our social media posts recruiting participants.

<u>Do I have to take part?</u>

Participation in this study is completely voluntary. You are under no obligation to participate in this study.

<u>What will my participation in the study involve?</u>

Your participation will involve taking part in one online creative workshop alongside other volunteer parents. The workshop will be hosted on Microsoft Teams (we can help you in understanding how this works and in setting this up), and will involve an informal discussion followed by a brain storming session on antibiotic awareness, information of interest regarding antibiotics and their use among children, antibiotic resistance, and antibiotic prescribing, and how this information can be efficiently provided to parents in Greater Manchester. The creative workshop will last no longer than an hour and 30 minutes. The session will be recorded via Microsoft Teams. However, no participant identifiers will be used during the analysis of the data or shown to anyone outside of the research team without your permission.

Expenses and payments?

Participation in the study is entirely voluntary. As this is a student-led research, the researcher will not be providing any payments or remuneration for participation in the study.

What are the possible disadvantages and risks of taking part?

Participation will require you to spend some time reading the information sheet, and to spare an hour and thirty minutes of your time for the online workshop. You will be contacted prior to the event to schedule a time that will be convenient for you to take part in the workshop.

What are the possible benefits of taking part?

Your participation will help the researcher gather data regarding awareness on antibiotic resistance and antibiotic use among parents in Greater Manchester. The results obtained from the discussion and activities conducted during the online workshop will help develop a tool to raise better awareness among parents in Greater Manchester.

What if there is a problem?

If you have concerns or questions about any aspect of this study, please contact the researcher by email (email address of researcher) who will do their best to answer your questions.

If you have any other issues or complaints, you may also contact the research supervisor Dr Margaret Coffey by email (m.coffey@salford.ac.uk).
If the matter is still not resolved, please forward your concerns to Dr Andrew Clark, Chair of the Ethics Panel, Room L521, Allerton Building, Frederick Road Campus, University of Salford, Salford, M6 6PU. Tel: 0161 29 54109. Email: a.clark@salford.ac.uk

This study will aim to collect data from participants in a safe and confidential manner. However, please note that since this is a student-led study involving voluntary participation, there will be no compensation or indemnity schemes available.
Will my taking part in the study be kept confidential?

No personal identifiers will be used during the online workshop, other than the participants' name. Participants will be required to sign a consent form before they participate in the workshop, that states that they are comfortable with the workshop procedures, they accept being recorded, and they understand the information given to them regarding participant confidentiality and their right to withdraw from the study at any time. During analysis participants' anonymity will be ensured by using a numerical code to identify the participants. To ensure confidentiality, the recorded online workshop, conducted on Microsoft Teams, will only be accessible to the researcher and her research supervisor, and all the information that you provide will be stored on encrypted and password-protected equipment only accessible to the researcher and research supervisor.

<u>What will happen if I don't carry on with the study?</u>

Participation in the study is voluntary. You are free to decline to participate, or to withdraw from the research at any time, without any consequences. Due to the workshop being a discussion with other participants, the information that you provide during the online session will not be destroyed if you choose to withdraw from the study. However, all of your personal information and possible identifiers will be destroyed, and your input in the online discussion will remain anonymous. It will not be possible to withdraw your data from the online workshop, but you are free to leave the workshop at any point and without giving a reason.

<u>What will happen to the results of the research study?</u>

Findings from the study will be available to the participants to read after the research has been completed. The study will end in January 2023, after which participants can contact the researcher to enquire about the results. The data collected will be stored for up to 5 years and will be accessible to the researcher only, in the event of further research on the topic. If the data is not needed after 5 years, they will be destroyed.

<u>Who is organising or sponsoring the research?</u>

This study is a non-sponsored student-led research for the completion of a Doctorate degree at the University of Salford.

<u>Further information and contact details</u>:

If you have any queries, concerns or complaints about the study at any stage, you may contact:

Researcher - (Name of researcher, and email address)
Research Supervisor – Dr Margaret Coffey, m.coffey@salford.ac.uk

Appendix 19: Phase 3 consent form for online workshops

CONSENT FORM – *can be scanned and e-mailed to [researcher's email address]*

Name of Researcher:

Please complete and sign this form **after** you have read and understood the study information sheet. Read the statements below and choose 'yes' or 'no', as applicable in the box on the right hand side. As is mentioned in the information sheet, please take your time to consider your potential participation in this study before signing the Consent Form attached.

1.	I confirm that I have read and understand the study information sheet version 5 dated 23/02/2021 for the above study. I have had the opportunity to consider the information and ask questions which have been answered satisfactorily.	Yes/No
2.	I understand that my participation is voluntary and that I am free to withdraw any time, without giving any reason, and without my rights being affected.	Yes/No
3.	If I do decide to withdraw (up to one month after taking part) I understand this will not impact on any aspects not related to the study and that the data I provided during the online discussions will not be destroyed.	Yes/No
4.	I understand that my personal details will be kept confidential and not revealed to people outside the research team. I understand that this will be breached if anything related to criminal activity/self-harm or other safeguarding issues is revealed.	Yes/No
5.	I agree to respect the anonymity of the other participants taking part in the online workshop, and to keep what is discussed during the session confidential.	Yes/No
6.	I understand that my anonymised data will be used in the research report other academic publications and conference presentations.	Yes/No
7.	I agree to take part in the study:	Yes/No
8.	I would like to take part in an online creative workshop and understand that this will be recorded.	Yes/No

______________________	________________	________________
Name of participant	**Date**	**Signature**
______________________	________________	________________
Name of person taking consent	**Date**	**Signature**

Appendix 20: Phase 3 brainstorming brief for online workshops

This brief will provide you with further information regarding the brainstorming activity during your scheduled online workshop.

Aim of brainstorming activity: To obtain ideas, views, and opinions from participating parents to inform the development of a tool to help improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester.

The brainstorming activity will begin with the researcher introducing some initial concepts and ideas about antibiotic awareness to help guide parents through the brainstorming activity. There are no right or wrong answers, all your ideas are welcome, and you will be encouraged to express your views and opinions freely.

Some themes and topics to think about before the online creative workshop:

- Antibiotic resistance awareness that could benefit you as a parent.
- Antibiotic use awareness that could benefit you as a parent.
- Types of media that would interest you when it comes to antibiotic awareness.
- Topics on antibiotic resistance and antibiotic use that you have wanted to know more about or would like more information on.
- What you might find attractive in posters or other media used for antibiotic resistance awareness?
- Where you would like to see more awareness/information on antibiotic awareness made available?

Please feel free to discuss these topics with your family, relatives, and friends, as we would welcome all ideas, views, and opinions you would be willing to share with us.

Appendix 21: Phase 3 online workshop guide

Conducting the online workshop (to be read out at the beginning)

Firstly, I'd like to thank you for agreeing to take part in this online workshop; I really value your input into our study to develop a health promotion intervention that will help improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance among parents in Greater Manchester. My name is xxxxxxx and I will be facilitating this workshop today. I am a PhD student from the University of Salford, you could benefit from as parents.

Just to remind you that the workshop is strictly voluntary, and that I will be recording the session to allow it to be analysed later on.

The session will last no longer than 1 hour and 30 minutes, and before we start, I'd just like to assure you that:

- There are no right or wrong answers to the questions I will ask – I just want to hear what you think.
- All participants are welcome to express their opinions and views

The session will start with a very short and informal presentation to give you some context for the study, a summary of the main findings so far, and the aim of this creative workshop.

I will then ask each participant to introduce themselves (name, number of children, and age of children), and we will start with an ice-breaker (*chat storm*).

We will then begin with a brainstorming session, which will involve a discussion and mind-mapping.

Do you have any questions so far? If you are still happy to participate in this workshop today, we will start the session now.

<u>Start with short presentation (3 minutes)</u>

Do you have any questions?

Participant introductions

<u>Start chat-storm activity:</u>

Participants are given a word, theme, or topic. And they have to type, in the chat section of Microsoft Teams, 3 words that come to their mind.

Word/Themes/Topic:

- Antibiotic prescription
- Antibiotic resistance knowledge
- Antibiotic awareness for parents
- Parents and antibiotics use

Start brainstorming session:

Questions that will guide the brainstorming session:

1. Who would be the target audience for? (new parents, parents with children in schools etc.)?
2. Type of media that interest a working/busy parent (Facebook, printed material, online tool etc.)?
3. What topics/themes should be included in the intervention/tool?
4. What kind of messaging would a parent want to see/read?
5. What would be attractive to look at, what would catch their attention?
6. What about language used?
7. How would the intervention/tool be disseminated? Via which channels (schools, home visitors, GP surgeries, community centres etc.)
8. How to make the intervention/tool inclusive (parents in both deprived and less deprived areas)?

The whiteboard feature on Microsoft Teams will be used to create mind-maps. The researcher/facilitator will create the mind-maps as the participants share their views and opinions on each question/topic chosen to guide the session. All participants will be able to see the whiteboard via screen share.

At the end of the session:

I think we've come to the end of our session. Thank you all for your honest opinions and contributions to our study – you have all been very helpful. Would any of you like to add anything before we end this session?

Again, thank you very much for your participation today. I really appreciate your help. Have a nice day.

Appendix 22: Ethics amendment for Phase 4

University of Salford MANCHESTER

Amendment Notification Form

Title of Project:		
The development of a novel health promotion intervention to improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester		
Name of Lead Applicant:	**School:**	
Cynthia Poolay Mootien	Health & Society	
Are you the original Principal Investigator (PI) for this study?		Yes
If you have selected 'NO', please explain why you are applying for the amendment:		
Date original approval obtained:	**Reference No:**	**Externally funded project?**
23/12/2019	HSR1920-018	No
Please outline the proposed changes to the project. *NB. If the changes require any amendments to the PIS, Consent Form(s) or recruitment material, then please submit these with this form highlighting where the changes have been made:*		
Ethics approval has already been obtained for all 3 phases of this study, and data has been collected for all phases. However, due to the small homogenous sample size obtained for phase 2 and 3 (due to the unforeseen circumstances brought about by the COVID-19 pandemic), and as per the examiner's requirements for the resubmission of my PhD thesis more data is needed to obtain a more representative view of the parent population in GM. Therefore, this ethics amendment relates to changes in recruitment strategy, to obtain more data for phases 2 and 3. As the sample already obtained does not have enough parents from deprived areas in GM, this new data collection phase will be focused only on Manchester, a GM borough with the highest proportion of deprived areas. Managers of Sure Start centres in the most deprived areas of Manchester, will be contacted to enquire about when parents of children aged between 3 and 6 months were more likely to attend the centre. The researcher will then go to the Sure Start centre, on the days indicated by the manager, to chat with parents who may be interested in participating in face-to-face or telephone interviews. Interested parents will be given a participant information sheet and consent form, detailing the nature of the study, how the interviews will be conducted, their role in the study, and their right to withdraw. This is to ensure they are properly informed about the study and can review the information provided to them before giving written consent to participate in these interviews. Participants will also be informed via these documents that the interviews will be audio recorded with an audio recorder, and that no identifiers will be used when processing/analysing the audio recording from the interviews. This will be reiterated at the beginning of each interview. The researcher's contact information (e-mail and telephone number) will be provided to potential participants, who may contact the researcher to express their interest in being interviewed. Interviews will then be organised based on parents' availability. Parents will first be invited to take part in telephone or face-to-face interviews, after which they will be invited to participate in a face-to-face creative workshop with other participating parents, at a later date. A consent form, participant information sheet, and brainstorming brief will be given to parents who are interested in participating in the face-to-face creative workshops. Participants will be able to contact the researcher (via email or telephone) to express their interest in participating in these workshops. Participants will also be informed that the face-to-face creative workshops will be		

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audio recorded with an audio recorder, and that no identifiers will be used when processing/analysing the audio recording and data obtained from the workshops. This will be reiterated at the beginning of each workshop.

All participants will be asked to bring their signed consent forms to the face-to-face interview and face-to-face creative workshops. For those who cannot do so or have opted for a telephone interview, verbal consent will be recorded prior to the start of the session.

Participants taking part in the interviews will be informed in the information sheet of their right to withdraw from the study at any time, and that any data pertaining to them would be destroyed when if they withdraw from the study. Those participating in the workshops will be informed that in case of withdrawal from the study, the researcher will not be able to delete any information provided during the workshops as this would compromise the data obtained from the discussions involving other participants as well. However, the participants will be reassured that no identifiers will be used during the analysis and presentation of the data obtained from the online workshops, and that participant anonymity will be respected.

Participants will be given at least 24 hours to consider whether they still want to participate in the interviews and workshops and will be asked to contact the researcher (via email or telephone) to express their interest in participating. The interviews and workshops will be organised based on the availability of each participant. For the face-to-face workshops, recruited parents will be put into groups of 3 participants for each workshop.

We are hoping to recruit 6 participants for the interviews, and to conduct 2 workshops with these parents.

Please say whether the proposed changes present any new ethical issues or changes to ethical issues that were identified in the original ethics review, and provide details of how these will be addressed:

As the face-to-face sessions (interviews and workshops) will be conducted in a public place (Sure Start centres), the researcher does not foresee any issue that may arise during data collection. However, in line with the University of Salford lone worker policy, the researcher's supervisor will be informed of the time and place of each session and will be contacted if any issues arise.

Amendment Approved:	YES	***Date of Approval:***	05/07/2023

Chair's Signature:

C. Sherriff

Once completed you should submit this form and any additional documentation to the ethics@salford.ac.uk

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Appendix 23: Participant information sheet – Sure Start Centre Interviews

Title of study: The development of a novel health promotion intervention to improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester.

Name of Researcher:
You are invited to take part in a study on antibiotic resistance and antibiotics. Participation in this study is entirely voluntary. If you do want to take part now, but change your mind later, you can pull out of the study at any time.

This information sheet will provide some important information regarding the study and will help you make an informed decision regarding your participation in this research project. With this information sheet, we will explain why we are doing the study and what your participation would involve. You may take some time to read this information sheet and decide whether you would like to participate in this study.

If you agree to take part in this study, you will be asked to sign a consent form before the beginning of the interview.

This document is 3 pages long, please make sure you have read and understood all the pages before deciding on whether would you like to participate in our focus group.

<u>What is the purpose of the study?</u>

This part of our study will consist of a series of interviews conducted with the aim to understand more about parents' experiences and perceptions of antibiotic resistance, antibiotic use, and prescription advice, in Greater Manchester. The participants chosen for this study are parents living in Greater Manchester who have children aged between 3 months and 6 years of age.

<u>Why have I been invited to take part?</u>

You have been invited to take part in this study as you are eligible to participate in this research project as a parent living in Greater Manchester and having a child aged between 3 months and 6 years of age.

<u>Do I have to take part?</u>

Participation in this study is completely voluntary. You are under no obligation to participate in this study.

<u>What will my participation in the study involve?</u>

Your participation will involve taking part in a telephone or face-to-face interview, which will be an informal discussion. The topics that will be discussed during this session will involve discussions about antibiotics and their use among children, antibiotic resistance, and antibiotic prescribing. The interview will last no longer than 10-20 minutes. The session will be audio-recorded. However, no participant identifiers will be used.

Expenses and payments?

Participation in the study is entirely voluntary. As this is a student-led research, the researcher will not be providing any payments or remuneration for participation in the study.

What are the possible disadvantages and risks of taking part?

Participation will require you to spend some time reading the information sheet, and to spare 10-20 minutes of your time for the telephone or face-to-face interview. You will be contacted prior to the event to schedule a time that will be convenient for you to take part in interview.

What are the possible benefits of taking part?

Your participation will help the researcher gather data regarding antibiotic resistance and antibiotic use among parents in Greater Manchester. The data you provide by completing the questionnaire will help develop a tool to raise better awareness among parents in Greater Manchester.

What if there is a problem?

If you have concerns or questions about any aspect of this study, please contact the researcher (email address and telephone number of researcher) who will do their best to answer your questions.

If you have any other issues or complaints, you may also contact the research supervisor Dr Margaret Coffey by email (m.coffey@salford.ac.uk).

If the matter is still not resolved, please forward your concerns to Dr Graeme Sherriff, Chair of the Ethics Panel, Room L521, Allerton Building, Frederick Road Campus, University of Salford, Salford, M6 6PU. Tel: 0161 29 54109. Email: a.clark@salford.ac.uk

This study will aim to collect data from participants in a safe and confidential manner. However, please note that since this is a student-led study involving voluntary participation, there will be no compensation or indemnity schemes available.

Will my taking part in the study be kept confidential?

No personal identifiers will be used during the interview. Participants will be required to bring their signed consent form to the face-to-face interview. If they are unable to do so or have opted for a telephone interview, verbal consent will be taken at the beginning of the interview, that states that they are comfortable with the interview procedures, they accept being audio recorded, and they understand the information given to them regarding participant confidentiality and their right to withdraw from the study at any time. During analysis participants' anonymity will be ensured by using a numerical code to identify the participants. To ensure confidentiality, all audio recorded interviews will be transcribed by the researcher and all the information that you provide will be stored on encrypted and password-protected equipment and will only be accessible to the researcher and research supervisor.

What will happen if I don't carry on with the study?

Participation in the study is voluntary. You are free to decline to participate, or to withdraw from the research at any time, without any consequences, and the information/data that you provide during the interview will be destroyed. If you want to withdraw from the study, you can request your data to be withdrawn from the study by contacting the researcher within 4 weeks of the interview. After this timeframe it may not be possible to withdraw your data.

What will happen to the results of the research study?

The study will be available to the participants to read after the study has been completed. The study will end in January 2023, after which participants can contact the researcher to enquire about the results. The data collected will be stored for up to 5 years and will be accessible to the researcher only, in the event of further research on the topic. If the data is not needed after 5 years they will be destroyed.

Who is organising or sponsoring the research?

This study is a non-sponsored student-led research for the completion of a Doctorate degree at the University of Salford.

Further information and contact details:

If you have any queries, concerns or complaints about the study at any stage, you may contact:

Researcher - (Name of researcher, email address, and telephone number)
Research Supervisor – Dr Margaret Coffey, m.coffey@salford.ac.uk

Appendix 24: Consent form – Sure Start Centre Interviews

CONSENT FORM – *can be completed at the interview, or scanned and e-mailed to [researcher's email address]*

Name of Researcher:

Please complete and sign this form **after** you have read and understood the study information sheet. Read the statements below and choose 'yes' or 'no', as applicable in the box on the right hand side. As is mentioned in the information sheet, please take your time to consider your potential participation in this study before signing the Consent Form attached.

1. I confirm that I have read and understand the study information sheet version 5, dated 23/05/2023 for the above study. I have had the opportunity to consider the information and ask questions which have been answered satisfactorily.	Yes/No
2. I understand that my participation is voluntary and that I am free to withdraw any time, without giving any reason, and without my rights being affected.	Yes/No
3. If I do decide to withdraw (up to one month after taking part) I understand this will not impact on any aspects not related to the study and any interview recordings and transcripts will be destroyed.	Yes/No
4. I understand that my personal details will be kept confidential and not revealed to people outside the research team. I understand that this will be breached if anything related to criminal activity/self-harm or other safeguarding issues is revealed.	Yes/No
5. I understand that my anonymised data will be used in the research report other academic publications and conferences presentations.	Yes/No
6. I agree to take part in the study: "The development of a novel health promotion intervention to improve parents' knowledge, understanding and attitudes towards antibiotic use, prescription advice and resistance in Greater Manchester."	Yes/No
7. I would like to take part in an interview and understand that this will be audio-recorded.	Yes/No

____________________	____________________	____________________
Name of participant	**Date**	**Signature**
____________________	____________________	____________________
Name of person taking consent	**Date**	**Signature**

Appendix 25: Letter to managers of Sure Start Centres

Hello,

I am writing to ask for your help to recruit parents for a study I am doing. This study is being carried out as part of my PhD to better understand parents' views and attitudes towards antibiotic use, antibiotic resistance, and prescription advice. I would like chat to parents of children aged between 3 months and 6 years of age, who are attending your Sure Start centre to see if they would like to take part in an interview on this topic.

There is no pressure for you to help us recruit participants for this study, and you are free to say no. However, recruiting participants from your centre will help us get a better understanding of parents' views on antibiotic resistance within Greater Manchester, which is an important public health issue these days.

Your role in participant recruitment would be straightforward. If you could let me know which days parents of children aged between 3 months and 6 years of age are more likely to come to the centre, then with your permission I would like to come to the centre at those times and chat to these parents to explain what my study is about and see if they would be interested in taking part in a face-to-face or telephone interview.

I have attached an information sheet to give you more details on the study, as well as more information regarding participant confidentiality and their right to withdraw from the study. If you are happy to help us in our endeavour, please contact me [email address and telephone number]. If you would like any more information, please do not hesitate to get in touch as I would be very happy to have a chat with you about this.

Yours sincerely,

[researchers name]