Introduction

Pressure ulcers (PUs) are localised injuries to the skin and/or underlying tissue and usually present over a bony prominence and result from pressure or pressure together with shear (1). Although pressure is a key factor in the incidence of PU, shearing, fat/ muscle ratio, and the tendons and ligaments involved are also critical factors that determine the formation of PUs. There are six different categories of PUs, categorisation is essential for accurate risk assessment and to enable the identification of appropriate treatment and/or management pathways (2). There are three main PU risk assessment scales (RASs) – Norton, Braden and Waterlow. These RASs are widely used to assess a patient's risk of developing PUs (3-6). These scales were designed to be used mainly by nurses and occupational therapists (OTs) in clinical settings. These locations are likely to be distinctly different from medical imaging (MI) environments in terms of staff training, access to the patient and the procedures being performed. Medical device-related PUs occurs due to sustained pressure from a medical device, including oxygen masks or splints (7). Medical device-related PUs may occur within MI settings since patients are often positioned directly in contact with medical devices, such as X-ray couches, operating theatre tables, and oxygen facemasks (7, 8).

The prevalence of PUs across adult intensive care units, cardiac care units, and long-term care homes in the United Kingdom (UK), Canada, and the United States (US) is 4.7, 36.8, and 12.3% respectively (9-11). PUs have enormous financial implications, costing between £1.8–2.6 billion in the UK (12) and between $11-17 billion in the US (13,14). PUs also have a negative physical and psychological impact on a patient's quality of life; hence, there is a need for radiographers to understand the risk of PUs in MI and work with other healthcare professionals to prevent the occurrence (15,16).

Previous studies have shown that the magnitude and duration of interface pressure (IP) are the two main determinants of PU formation (17,18). IP is defined as the pressure between the human body and a supporting surface (17). There are various benchmarks for capillary closing pressures (CCPs). CCP is defined as the IP necessary to partially or completely occlude blood flow within the capillaries, thereby inducing the formation of PUs (19-21). Some studies have stated that an IP of 60 mmHg, sustained for a period of 60 minutes, may induce soft tissue damage and may lead to the development of PUs (22, 23). Others have suggested CCPs between 32

to 47 mmHg (24-26). Importantly, a lower IP sustained for a longer period is likely to cause as much harm as a high IP sustained for a short period. To mitigate the risk of PU formation, the use of patient repositioning techniques and pressure redistributing overlays are standard practice in most healthcare settings (27,28). However, repositioning techniques might not be appropriate during MI procedures where patients are required to lie still and where overlays may interfere with the MI procedures.

A detailed literature search indicated that only one study investigated the IP experienced by healthy volunteers on MI table surfaces (29). In this study, it was concluded that the potential of high IP risk on MI table surfaces may exist and that this can increase the risk of developing medical device-related PUs among patients accessing MI procedures. However, this study was, conducted using the Talley Oxford Pressure Monitor® Mark 3 (TPM) made up of only 12 pressure recording cells. The cell matrix of the TPM system has poor spatial resolution due to the wide spaces (100 mm) between sensors, the implication being that smaller bony anatomical areas such as the heel and the occiput may partially cover a sensor resulting in a fraction of the IP values being recorded (30). In addition, limitations in the method used to measure the IP exposed this study to further criticism. For example, when measuring the IP for the head, Justham et al. (29) rested the head of the volunteers on a pillow. During pressure mapping, the pressure mat should be placed directly between the anatomical area under investigation and the support surface. The use of a pillow provides some level of cushioning for the head and might have resulted in the reduction of the IP values. Further drawbacks limiting the usefulness of this study (29) were the sample size and lack of a qualitative pain assessment.

The need to ensure accuracy and minimise motion and geometric unsharpness during radiography procedures means that sometimes immobilisation is required. For example, during excretion urography (EUG) procedures, an abdominal compression band is sometimes applied tightly across the lower abdomen to concentrate the contrast and fill the ureters and renal pelvis. The application of the compression band would increase the IP between the patient and the MI table surface. Confounding this, patients would have to remain in the compressed position for several minutes, sometimes up to 45 minutes depending on the clinical history and the specific needs of the patient. Unlike some countries (e.g. UK), mattresses are not used routinely

during radiography procedures (e.g. Ghana and Portugal) (31). Some mattresses may not provide a stable surface and may increase motion and geometric unsharpness. It is perhaps for this reason that mattresses are not routinely used in MI. The implication of not using a mattress is that the patient's body will be in direct contact with the hard MI table surface and this may induce tissue damage and PU formation. Various studies into PU aetiology have reported that PUs most commonly occur at the head, sacrum, and heels (referred to as jeopardy areas in this paper) due to the prominent bony features at these anatomical areas (32,33). The risk of PU formation would be higher if the jeopardy areas are in direct contact with the MI table surface, this is due to the lack of adequate soft tissues necessary to absorb and redistribute applied pressure at these locations (34, 35).

In this study, we investigated the IP of healthy volunteers on MI table surfaces to determine the risks of developing PUs. We also investigated volunteers' perception of pain and comfort while lying on the MI table surfaces. Evidence from this study will enhance the understanding of factors contributing to PU formation and help improve service delivery to patients undergoing MI procedures.

Method

This was a prospective quantitative experimental study, which sought to evaluate IP across three MI table surfaces for a range of healthy volunteers. A prospective approach was necessary as IP data are not normally collected as part of routine radiology examinations. Furthermore, a quantitative approach was used since IP is a numerical quantity and can be easily measured by subjects lying directly in contact with a pressure measurement mat. The study was approved by the University of Salford (UoS) research ethics committee. A pilot study was conducted to determine whether the method was fit for the purpose (36). A priori power analysis indicated that 42 volunteers would be needed for the research [(effect size (0.49), power (0.80), alpha (0.05)]. Effect size, power and alpha value were determined from the pilot study (31) and guidance available within the literature (37). A disproportionate stratified random sampling method was used to recruit 49 students and staff from the UoS. This sampling method was chosen to enable recruitment of volunteers with different ethnicities, ages and body mass indices (BMI) (36). Forty-nine volunteers were recruited to allow for potential drop out. Inclusion criteria were healthy people aged 18 years and older. For the purposes of this research, a healthy volunteer was defined as any individual who could lie still for 26 minutes without any difficulty. Exclusion criteria were volunteers who were >250 kg in weight, >190 cm in height. These are based on limitations of the XSENSOR® mat. Volunteers who had back pain, scoliosis or kyphosis who could not lie still for 26 minutes and pregnant women were also excluded.

Data collection instruments

The XSENSOR® pressure mapping system/software

A calibrated XSENSOR® PX100.64.160.02 (XSENSOR® Technology Corporation, Calgary, Canada) pressure mapping system with its X3 software (v6) was used. The XSENSOR® is considered to be the gold standard for pressure mapping and it has previously been used in several studies (38-40). Compared to other pressure mapping systems, such as the Force Sensing Array (FSA®) and the F-Scan® manufactured by Tekscan, the XSENSOR® has superior performance (41). Calibration and quality control data from the manufacturer of the XSENSOR® confirmed a high level of precision and reliability (42). In addition to the manufacturer's quality assurance we

also assessed its reliability. A full body adult PIXY phantom (Radiology Support Devices, Long Beach, CA) was placed on the sensor mat and measurements were taken on consecutive days.   Results indicated excellent reliability of repeat measurements [(Intraclass Correlation Coefficient, ICC=0.93), 95% Confidence Interval, CI (0.81- 0.98)]. The pressure mat is designed as a comfortable, flexible, and durable mat with highly sensitive capacitive sensors (42). XSENSOR® sensing and physical characteristics are given in **Table 1**.

Table 1: Sensing and physical characteristics of the XSENSOR® mat.

Sensing	
Sensing technology	Capacitive pressure imaging
Number of sensors	10,240 sensors
Pressure range	10-256 mmHg
Spatial resolution	1.27 cm
Accuracy	±10%
Sampling frame rate	17 frames per second
Display characteristics	Two-dimensional (2D) Three-dimensional (3D) Numeric interface pressure readings (mmHg)
Physical characteristics	
Total area	104.1 x 243.8 cm
Sensing area	81.3 x 203.2 cm
Thickness of sensing area when compressed	0.081cm
Thickness of sensing area when uncompressed	0.1cm

The XSENSOR® has low hysteresis and low creep enabling it to produce consistent results (38,40). Hysteresis is defined as the phenomenon exhibited by pressure mapping systems in which the systems' reaction to changes is dependent on its immediate history (43). This is mainly due to a delay occurring between the application and removal of a force thereby impeding the system's ability to return to its original state (44). Creep on the other hand is defined as an increase in pressure with constant force and may cause the pressure mapping system to gradually deform with constant

pressure (44). IP readings are transmitted from the mat to a hand-held device via X3 PRO Sensor Pack.

Questionnaire

Although there are a number of validated questionnaires for pain and comfort, none of these were suitable for the purposes of this study. Therefore, to assess volunteers' perception of pain and comfort whilst lying on MI table surfaces, a five-point Likert scale questionnaire was designed. The questionnaire consisted of two sections. Section one of the questionnaire consisted of demographic information: gender, age, height, and weight. Section two of the questionnaire consisted of five questions/statements – three closed-ended and two open-ended questions. Example question one: On a scale of 1-5, "how comfortable were you when lying on the MI table surface?" Responses (1 = very uncomfortable; 2 = uncomfortable; 3 = passable; 4 = comfortable; 5 = very comfortable). Volunteers were asked to tick the box that applies to them. Example question two, "did you experience any pain whilst lying on the MI table surface?" Responses: Yes or No. Volunteers who answered in the affirmative, were then asked to indicate the level of the pain experienced. The response options provided were; 1 = hardly any pain; 2 = slight pain; 3 = moderate pain; 4 = a lot of pain; and 5 = extreme pain. One of the open-ended questions asked the volunteers to indicate on a human diagram the anatomical area where they experienced pain. The other question sought to solicit volunteers' comments or opinions on the overall experience of lying on the MI table surfaces. The questionnaire was piloted on 20 students and staff drawn from five European universities. The questionnaire was deemed appropriate to achieve the aims of the study.

Medical imaging table surfaces

Three MI table surfaces were used: Arco TN 0055 X-ray table with no mattress, Arco TN 0055 X-ray table with a thin radiolucent mattress, and a Computed Tomography (CT) table with a narrow-curved surface and thin radiolucent mattress **(Figure 1).**

Figure 1: Example of the medical imaging table surfaces used in this study.

a) Arco TN 0055 X-ray table with no mattress

b) Arco TN 0055 X-ray table with a thin radiolucent mattress

c) A narrow-curved CT table surface with a thin radiolucent mattress
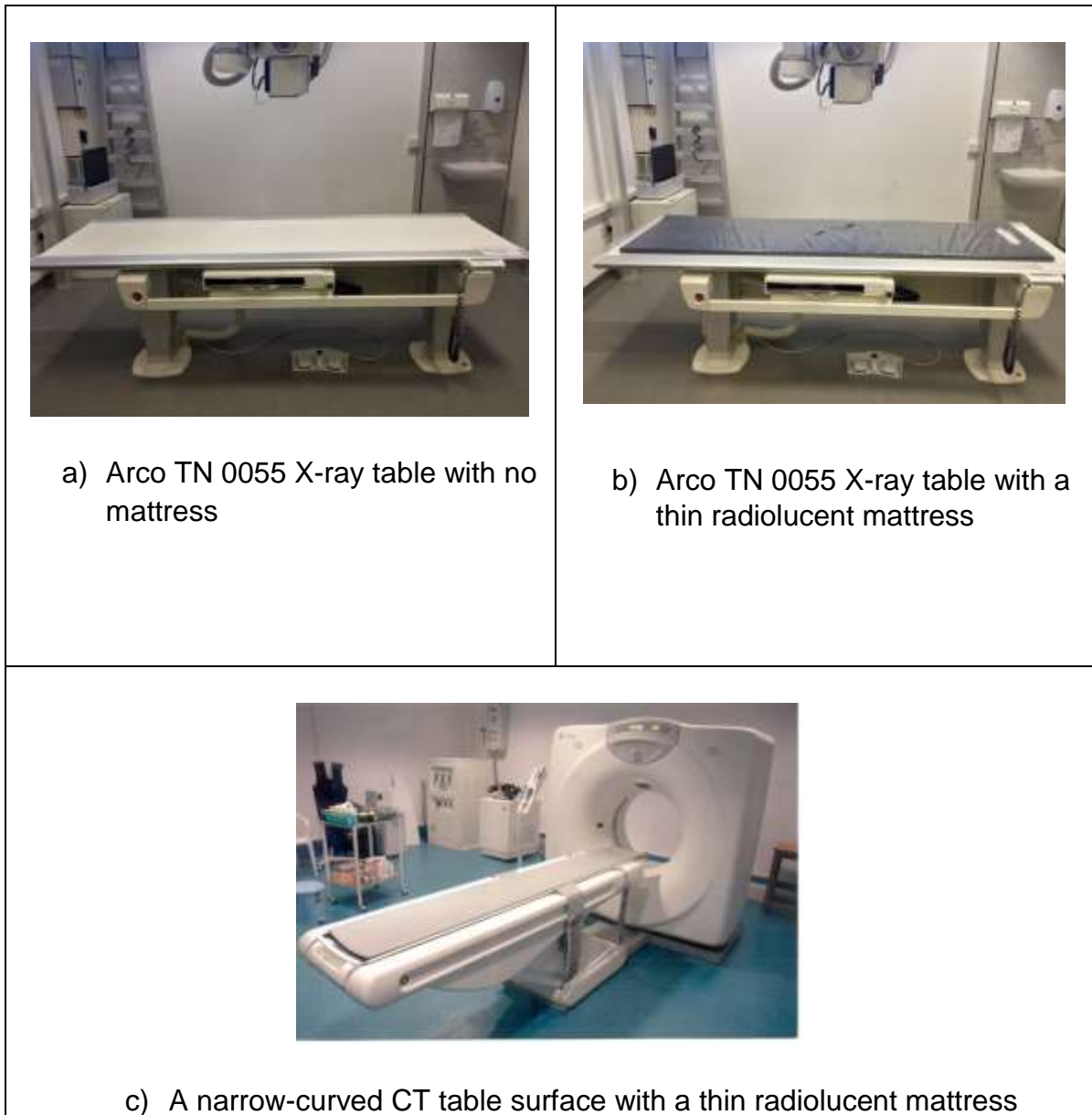
The physical characteristics of the MI table surfaces are described in **Table 2**.

Table 2: Physical characteristics of the three MI table surfaces (45)

Arco TN 0055 X-ray table
• Moveable patient support system
• Industrial grade (IG) Rohacell carbon fibre with 0.9 mm Aluminium (Al)
• Dimensions: 240 cm long, 85.3 cm wide and 2.15 cm thick
• Maximum patient weight limit: 250 kg
• Vertical travel height: 55.5-93.5 cm
Arco TN 0055 X-ray table with a thin radiolucent mattress
• Same characteristics as Arco TN 0055 X-ray table
• Mattress made from combustion polyurethane modified cellular foam
• Dimension of mattress: 213 cm long, 63 cm wide and 2 cm thick
A narrow-curved CT table surface with a thin radiolucent mattress
• Narrow curved surface covered with a thin radiolucent mattress
• 199 cm long
• 46 cm wide
• 1.5 cm thick
• Maximum patient weight limit: 250 kg

Procedure for pressure mapping

Each volunteer was asked to take off their shoes and socks and wear loose fitting leggings and a T-shirt. The weight and height of each volunteer was measured and BMI was calculated. The mat was fixed securely to the three MI table surfaces in turn with adhesive tape. To standardise volunteer positioning, a measurement of 2cm from top (head) of the mat was taken and a tape placed there to ensure that all volunteers had their head placed on the same point of the mat. Volunteers were asked to lie on the mat in a supine position with the hands pronated and the hips adjusted to ensure that they were equidistant from the edges of the mat (**Figure 2**).

Figure 2: Volunteer lying still on the XSENSOR® mat.

This position reflects a typical patient position for MI procedures (46). Following a six minute settling time (47), the volunteers were asked to remain still for 20 minutes whilst pressure mapping data were acquired. At the end of pressure mapping, volunteers completed the questionnaire about their perception of pain and comfort whilst lying on the MI table surface. There was a rest period of 24 hours after which the volunteer came back to lie on a different table surface. All the volunteers had their IP measured on each of the three MI table surfaces. The order in which participants lay on the surfaces was selected at random.

Statistical Analysis

The XSENSOR® X3 medical software (v6) was used to calculate the mean IP for the whole body and the three jeopardy areas (head, sacrum and heels) across the three MI table surfaces. Data were analysed using SPSS version 22 (IBM, New York, USA). Data were assessed for normality using histograms and Kolmogorov-Smirnov (K-S) tests. The mean and standard deviation (SD) were used to describe the volunteers' age and BMI distribution, whereas percentages were used to describe the gender of the volunteers. One-way repeated measures analysis of variance (ANOVA) was conducted to test for any statistically significant difference in mean IPs across the three MI table surfaces. Statistical significance was set at $p \leq 0.05$. To quantify the strength of any statistically significant differences the partial eta squared effect size was also calculated. Pairwise comparison using the Bonferroni Confidence Interval (CI) adjustment was also conducted to control for type 1 error. In instances where there was a statistically significant difference, post-hoc Wilcoxon rank tests were conducted to determine exactly where the differences occurred.

Responses from the questionnaire were coded and input into SPSS software for analysis. For example, a yes response was coded "1" and a no response coded "0". Distribution frequencies of the responses were calculated. Since the data collected from the questionnaires were ordinal, non-parametric Friedman tests were conducted to determine the volunteers' perceived level of comfort and pain on the three MI table surfaces. Additionally, using a Bonferroni adjusted alpha value of 0.025 a post-hoc Wilcoxon Signed Rank Test was conducted.

Finally, a parametric Pearson product-moment correlation coefficient (*r*) was used to determine the relationship between mean IP for the whole body and BMI on the three MI table surfaces. Cohen's (48) interpretation of *r* was used to interpret the strength of the correlation: r=0.1-0.29 (small), r=0.30-0.49 (medium), and r=0.50-1.0 (large). Also, the coefficient of determination (R^2) was calculated by multiplying *r* by itself and express it as a percentage.

Results

Demographics

The sample comprised of 26 females (53.1%) and 23 males (46.9%), with an age range of 18-59 years (mean=34.6, SD=10.5) and BMI 19.2-36.7 (mean= 24.7, SD=4.0).

Normality testing

The results of normality testing indicated that the data were normally distributed. Kolmogorov-Smirnov (K-S) tests indicated non-statistically significant p values (p≥0.05).

Inferential statistics

ANOVA results for the whole body on the three MI table surfaces are presented in **Table 3**.

**Table 3**: Mean IP and SD for the whole body across the three MI table surfaces

Medical imaging table surface	Mean IP (whole body), mmHg	SD, mmHg	p-value
X-ray table with no mattress (hard surface)	37.12	4.48	≤0.001
X-ray table with mattress	25.95	1.52	
CT table surface	23.50	1.43	
IP, interface pressure; SD, standard deviation; MI, medical imaging.			

Pairwise comparison using the Bonferroni CI adjustment indicated that there were statistically significant differences between the mean IP of the whole body across the three MI table surfaces, all three comparisons having p≤0.001.

ANOVA showed that there were statistically significant differences in the mean IP for the jeopardy areas across the three MI table surfaces, p≤0.001 (**Figure 3**).

Figure 3: Bar chart comparing the mean IP of the jeopardy areas across the three MI surfaces. Error bars indicate SD values.
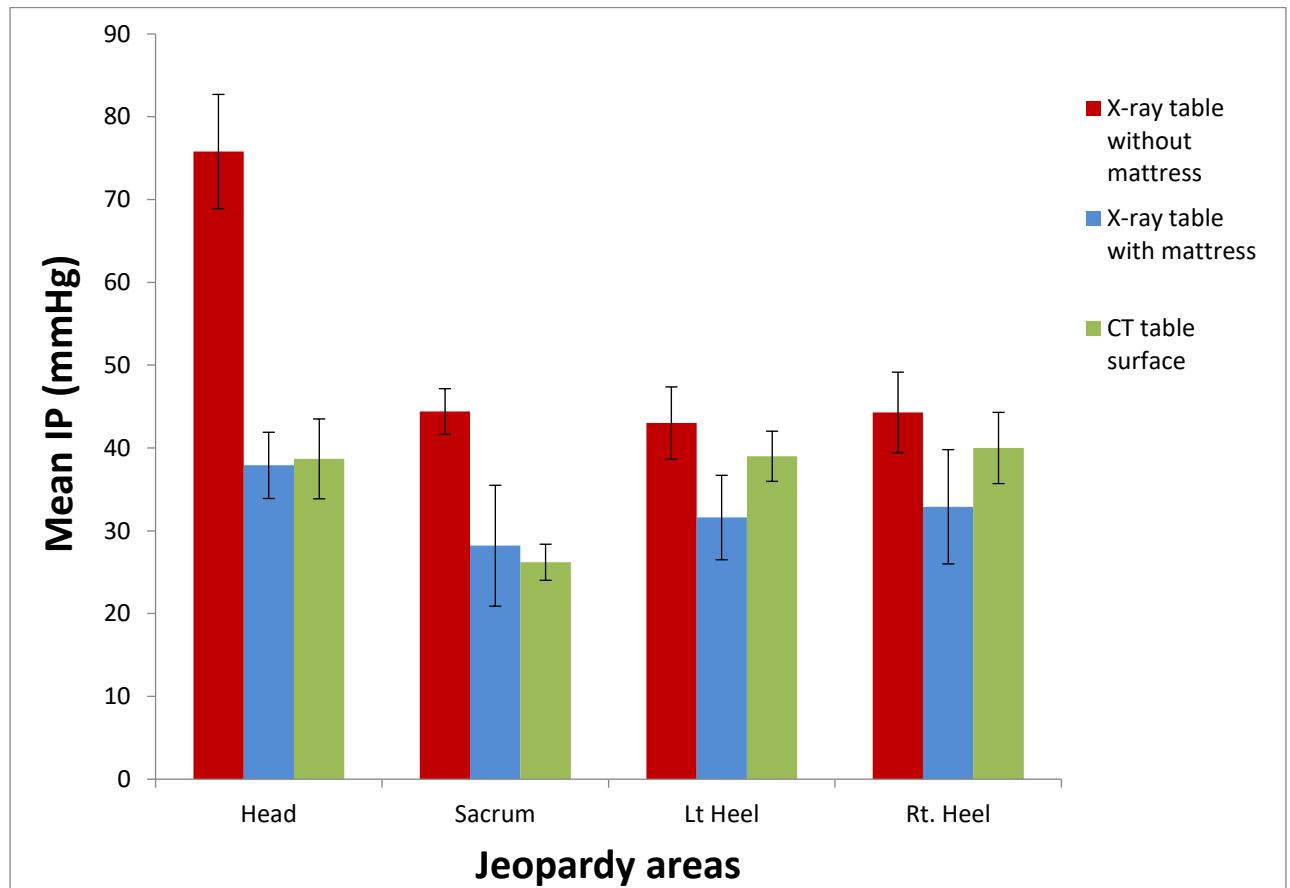
The results of a pairwise comparison using the Bonferroni CI adjustment indicated there were statistically significant differences between the mean IP for the jeopardy areas across the three MI table surfaces (p≤0.001). However, the results of pairwise comparison indicated that two comparisons were not statistically significant (head, X-ray table with ~~no~~ mattress vs CT table p=0.45; ~~left heel~~<u>sacrum</u>, X-ray table with ~~no~~ mattress vs CT table p=0.61).

The Friedman test indicated a statistically significant difference between volunteers' perception of comfort on the three MI table surfaces (p≤0.001). Approximately 70% of the volunteers found lying on the X-ray table with no mattress very uncomfortable or uncomfortable (**Figure 4**).

Figure 4: Bar chart showing volunteers' perception of comfort across the three MI table surfaces.
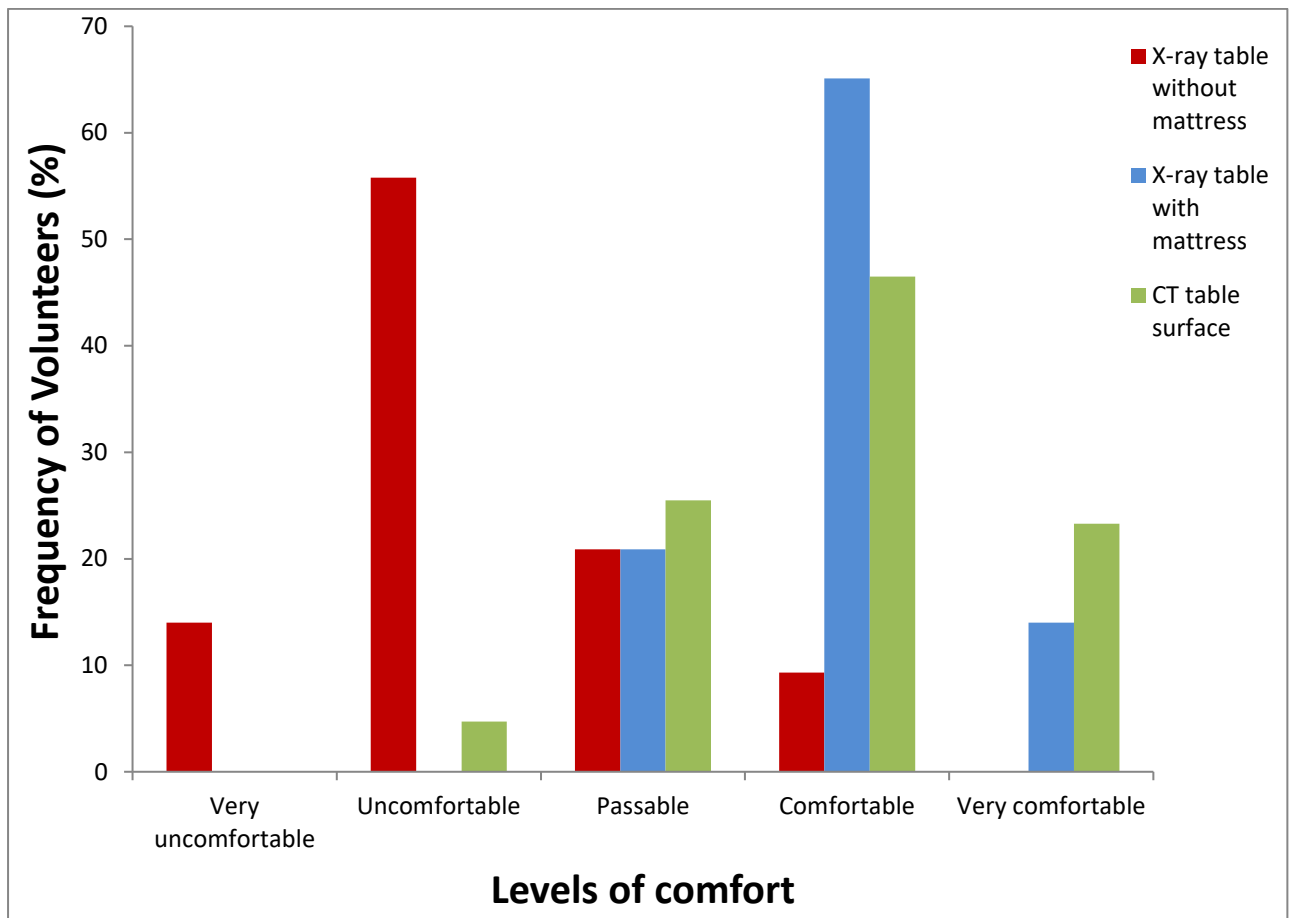
The Friedman test also indicated a statistically significant difference in volunteers' perception of pain on the three MI table surfaces ($p \leq 0.001$). Approximately 67.4% of the volunteers experienced pain whilst lying on the X-ray table with no mattress *(Figure 5)*. Over 81.3% of the pain occurred at the head.

Figure 5: Bar chart showing the frequency of volunteers who experienced pain across the three MI surfaces.
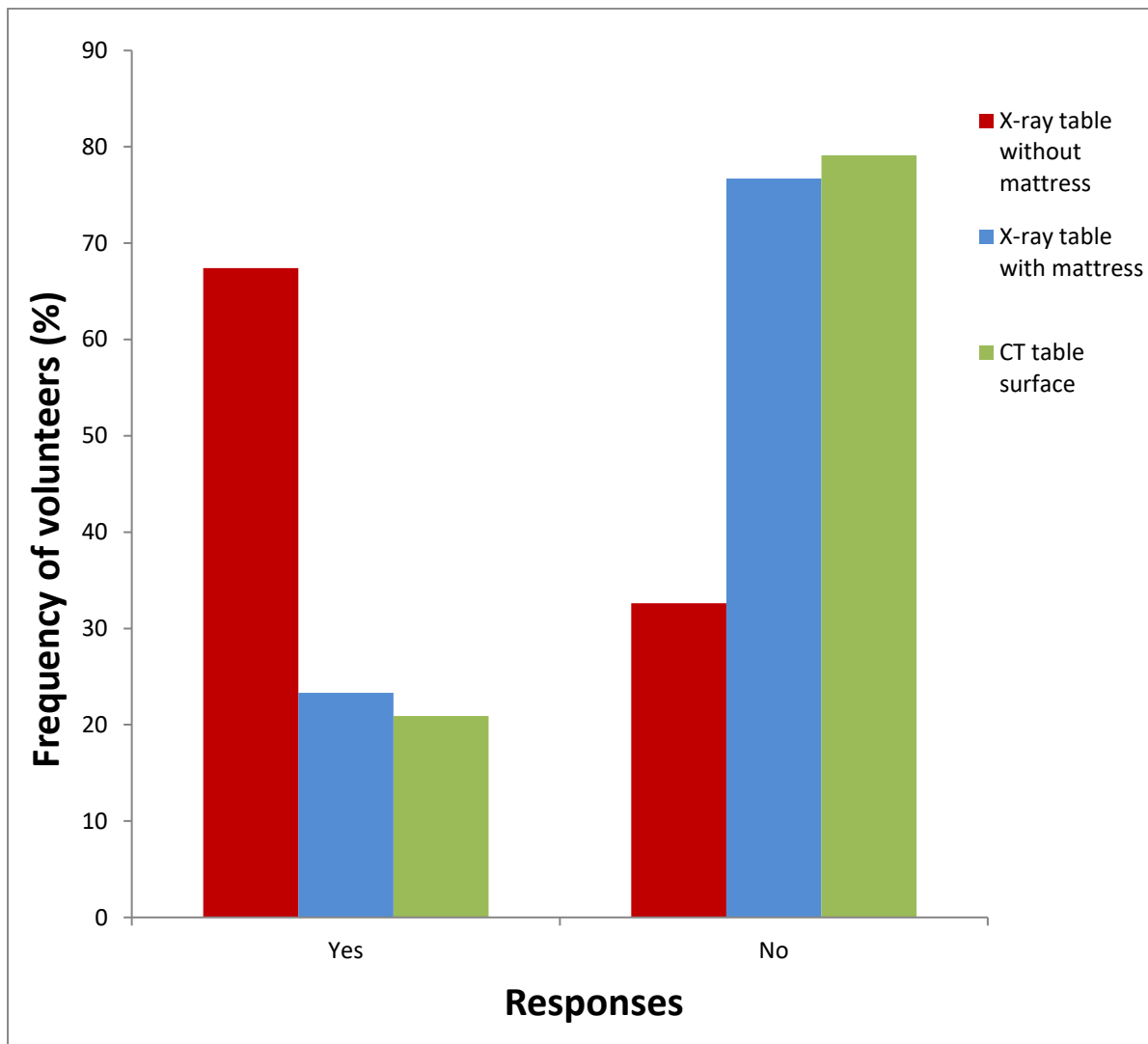
The results of Pearson correlations indicated a small positive correlation between BMI and mean IP for the whole body on the mattress, X-ray table without mattress and the CT table surface (1, 10, and 16% shared variance, respectively).

Discussion

Comparing results of the study to previous studies

The primary aim of this study was to investigate the IPs of healthy volunteers on three different MI table surfaces to determine whether there were IP risks that could increase the risk of PU formation. The secondary aim was to investigate volunteers' perception of pain and comfort whilst lying on the MI table surfaces. The results of this study indicated that there are statistically significant differences in volunteers' mean IPs for the whole body ($p \leq 0.001$), with volunteers experiencing the highest IP on the X-ray table without mattress (37.12 ± 4.48, in mmHg) and the lowest IP on the X-ray table with mattress (23.50 ± 1.43 mmHg). Although Justham et al. (29) investigated IP on MI surfaces, their study did not assess IP for the whole body. Similarly, the mean IP for head on the X-ray table without mattress recorded in this study was the highest (75.85±6.89, mmHg) compared to that on the mattress surface (37.95±4.03) and the CT table surface (38.68±4.82 mmHg). The recorded IP values around the head were the highest on the X-ray table without mattress. This is consistent with the findings by Justham et al. (29) in which the recorded mean IP for head on an X-ray table without mattress was 59.2±25.1 mmHg. The lower mean IP recorded for the head in Justham's study could be attributed to the limitations in their pressure mapping system and the method used. In Justham et al's. (29) study, the head of each volunteer was rested on a pillow during the pressure mapping process. The use of the pillow might have provided some level of cushioning and envelopment to the head resulting in a larger contact area and consequently lower IPs for the head.

When the volunteers lay on the hard surface, the mean IP for the sacrum (44.45±7.30, mmHg) and the heels (44.25±6.91 mmHg), in our study, varies from those reported by Justham et al. (29) (sacrum, 97.7±55.9 mmHg and heels, 126.9±79.6 mmHg). These differences could be attributed to the differences in the methods used to collect data between the two studies. For example, the use of a pillow in the previous study might have elevated the head, neck and upper chest of the volunteers which might have contributed to the higher IP recorded for the sacrum. A linear relationship between the 'head of bed' elevation and an increase in sacral IP is well-documented (45).

In the study by Justham et al. (29), there were large SDs in the recorded IP values. In our study the SD IP for the heels on the X-ray table with mattress surface, X-ray table

with no mattress and the CT table surfaces were 4.86, 6.91 and 4.31 mmHg, respectively. For the same anatomical areas, Justham et al. (29) reported SDs of 79.6 mmHg for the X-ray table with no mattress, 50.0 mmHg for a 25 mm thick mattress and 79.1 mmHg for a 55 mm thick mattress surface. The large SDs might be due to the poor spatial resolution of the pressure mapping system used in Justham et al.'s study. The poor spatial resolution of the pressure mapping system means that the heels might have been partially placed on active (recording) pressure mapping cells due to the small anatomical surface area of the contact point (30). As a result, the recorded data in this study may not truly reflect the IP values for the jeopardy areas.

The results of our study indicated a small positive correlation between mean IP and BMI across all three MI table surfaces (1, 10, and 16% shared variance between BMI and mean IP for the whole body on the mattress surface, hard surface and CT couch, respectively). These results are comparable to those of Stinson et al. (47) but contrast that of Kernozek et al. (49). The discrepancy between the results of our study and that of Kernozek et al (49) was expected because the volunteers for our study were healthy, mobile and able-bodied, whereas those of Kernozek et al. (49) were elderly patients aged between 65-95 years suffering from spinal cord injuries. Differences may have resulted from the range of BMIs included in Kernozek study (49) when compared to our work. Our study drew a sample from a University Campus, whereas Kernozek and colleagues (49) used elderly patients with spinal cord injuries. There would undoubtedly be differences in the quantities of adipose and muscular tissues between these two cohorts which would have affected the correlation data.

Clinical implications of the results

Our research has demonstrated that the mean IP of the whole body on the X-ray table without mattress exceeds the threshold (32 mmHg) above which IP may induce PUs formation (27). However, using mean IP for the whole body as a parameter to predict a patient's risk of developing PUs would be of little, if any clinical significance because it fails to give a clear indication of the magnitude of IP brought to bear on specific anatomical areas. To illustrate this point, consider the IP data of volunteers *A* and *B*, both males, aged 26 and 27 years respectively with BMIs of 25.4 and 24.9 respectively. Both volunteers recorded approximately the same mean IP for the whole body on the X-ray table without a mattress (42.7 and 42.3 mmHg, respectively) but

there were different IP distributions across the jeopardy areas. For example, volunteer A, mean IP for the head, sacrum, right and left heels were 138.0±2.5, 50.8±1.8, 43.2±2.1 and 24.9±1.2 mmHg, respectively. For volunteer B, mean IP's for the head, sacrum, right and left heels were 53.6±1.3, 56.8±2.6, 30.1±4.2 and 21.0±2.1 mmHg, respectively.

The clinical implications of the differences in IP distribution in volunteers *A* and *B* is that, all other factors being equal, the risk of volunteer *A* developing a PU at the head is significantly higher than that of *B*. Using the mean IP for the whole body to predict the risk of developing PU will be misleading because it does not provide a clear indication of the amount of pressure on specific anatomical areas (15). Using mean IP for the whole body to predict PU risks could lead to waste of hospital resources, with patients who may not be at risk of developing PUs being placed on PUs preventive programmes (17). Similarly, patients at risk of developing PUs may not correctly be identified; thus denying them the opportunity to access vital PUs preventive measures.

The results of this study have shown that there are IP risks on the X-ray table without a mattress (hard surface). Although high IP risks have been identified on the X-ray table with no mattress among healthy volunteers, it is unlikely to induce PUs in patients undergoing short duration MI procedures. It may, however, induce tissue ischaemia, which in turn may lead to PUs formation in patients undergoing lengthy interventional radiography/radiology procedures such as cervical vertebroplasty (50). Procedures like this could take between 45 minutes to several hours and consequently caution should be exercised in such patients (50). Most of the volunteers (70%) found the X-ray table with no mattress to be very uncomfortable or uncomfortable. Similarly, 67% of the volunteers indicated that they experienced pain whilst lying on the X-ray table with no mattress, with over 81% of the pain occurring at the head. These findings are consistent with the high IP values recorded for the head on the X-ray table with no mattress. The clinical implication of this is that, radiographers must be educated to understand that patients reporting pain and/or discomfort could indicate that the IP on a specific anatomical area may be too high, and that the patient should be repositioned (51).

Our research has demonstrated small positive correlations between BMI and mean IP for the whole body on the three MI surfaces. The clinical implication of this finding is

that patients with higher BMI are more likely to have higher IP and higher risk of developing medical device-related PUs. In some studies it is suggested that high BMI leads to an increased PU risk (52-56) and suggests that this could be attributed to a lack of physical activities among obese people. Obesity is associated with the presence of other diseases such cardiovascular disease and type 2 diabetes, which further increase PU risk (57). However, a high BMI with its associated high body fat and adipose tissues may provide an enhanced subcutaneous protection to ease the pressure. Very low BMIs may be an indicator for poor health and may also increase the risk of developing PUs (57,58). There seems to be an agreement in the literature that patients at either end of the spectrum (low and high BMI) may have a higher risk of developing PUs compared to patients with a healthy BMI. This research supports the idea that any PU prevention plan developed within MI settings should be specifically targeted to meet the individual needs of patients. It should be acknowledged that the effects of low BMI were not specifically investigated within our study.

Manual handling and positioning of patients by radiographers and other healthcare professionals could create potential shearing and frictional forces, which could increase the risk of PU formation. Also, the specific health characteristics of patients who are likely to access prolonged radiography procedures makes the IP risks more likely to predispose them to the formation of PUs. Often, patients accessing prolonged interventional radiology procedures are older patients of poorer health, low levels of physical activity, and there may be the presence of comorbidities i.e. type 2 diabetes. Research has shown that advancing age comes with an associated reduction in the skin's collagen and elastin contents, key factors that protect the skin from damage (59). Such information further adds to the need for MI practitioners to continual assess the PU risk on all patients attending for imaging examinations.

The results of this study have shown that mattress surface overlays help to redistribute IP, thereby helping to reduce volunteers' risk of PUs. This could have a significant clinical implication for radiography practice in countries that do not routinely use mattresses on imaging tables. If the findings of this study are implemented into practice in these centres then patients would be provided with mattresses thereby minimising the potential for PU formation. This will enhance patient care and improve patient management.

Limitations

The research involved only healthy volunteers under the age of 60 years therefore the findings of this study must be applied with caution into clinical practice. Also, the questionnaire used to assess the volunteers' perception of comfort and pain is not a validated scale, hence may not be reliable when used to assess pain and comfort outside of the MI settings.

Conclusion

The results of this study have shown that IP risk exists for the head, sacrum and heels on the X-ray table with no mattress. Whole body mean IP measurements are not suitably accurate for making inferences about the IP on jeopardy areas.

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Conflicts of interest

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