BMJ Open Sport & Exercise Medicine

Thigh-worn accelerometry for measuring movement and posture across the 24-hour cycle: a scoping review and expert statement

Matthew L Stevens ,[1] Nidhi Gupta,[1] Elif Inan Eroglu,[2] Patrick Joseph Crowley,[1] Barbaros Eroglu,[3] Adrian Bauman,[3] Malcolm Granat,[4,5] Leon Straker,[6] Peter Palm,[7] Sari Stenholm,[8] Mette Aadahl,[9] Paul Mork,[10] Sebastien Chastin,[11,12] Vegar Rangul,[13] Mark Hamer,[14] Annemarie Koster,[15] Andreas Holtermann,[1] Emmanuel Stamatakis[3]

To cite: Stevens ML, Gupta N, Inan Eroglu E, *et al*. Thigh-worn accelerometry for measuring movement and posture across the 24-hour cycle: a scoping review and expert statement. *BMJ Open Sport & Exercise Medicine* 2020;**6**:e000874. doi:10.1136/bmjsem-2020-000874

► Additional material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjsem-2020-000874).

Accepted 7 December 2020

Check for updates

For numbered affiliations see end of article.

Correspondence to
Dr Matthew L Stevens; Matthew.stevens@sydney.edu.au

ABSTRACT

Introduction The Prospective Physical Activity Sitting and Sleep consortium (ProPASS) is an international collaboration platform committed to harmonise thigh-worn accelerometry data. The aim of this paper is to (1) outline observational thigh-worn accelerometry studies and (2) summarise key strategic directions arising from the inaugural ProPASS meeting.

Methods (1) We performed a systematic scoping review for observational studies of thigh-worn triaxial accelerometers in free-living adults (n≥100, 24 hours monitoring protocols). (2)Attendees of the inaugural ProPASS meeting were sent a survey focused on areas related to developing ProPASS: important terminology (Q1); accelerometry constructs (Q2); advantages and distinct contribution of the consortium (Q3); data pooling and harmonisation (Q4); data access and sharing (Q5 and Q6).

Results (1) Eighty eligible articles were identified (22 primary studies; n~17 685). The accelerometers used most often were the ActivPAL3 and ActiGraph GT3X. The most commonly collected health outcomes were cardiometabolic and musculoskeletal. (2) None of the survey questions elicited the predefined 60% agreement. Survey responses recommended that ProPASS: use the term physical behaviour or movement behaviour rather than 'physical activity' for the data we are collecting (Q1); make only minor changes to ProPASS's accelerometry construct (Q2); prioritise developing standardised protocols/tools (Q4); facilitate flexible methods of data sharing and access (Q5 and Q6).

Conclusions Thigh-worn accelerometry is an emerging method of capturing movement and posture across the 24 hours cycle. In 2020, the literature is limited to 22 primary studies from high-income western countries. This work identified ProPASS's strategic directions—indicating areas where ProPASS can most benefit the field of research: use of clear terminology, refinement of the measured construct, standardised protocols/tools and flexible data sharing.

What is known

- ► The use of thigh-worn accelereometry for measuring movement and posture is growing.
- ► The Prospective Physical Activity Sitting and Sleep consortium (ProPASS) is committed to harmonising thigh-worn accelerometry data to investigate longitudinal associations of physical activity, posture and sleep with long-term health outcomes and longevity.

What are the new findings

- ► This scoping review identified 22 primary studies (roughly 17 685 participants) with the potential to pool thigh-worn triaxial accelerometer data.
- ► This manuscript will guide and set the direction for ProPASS's contribution to the field of physical activity and health.

INTRODUCTION

Different aspects of movement and posture-defined physical behaviour—such as physical activity, sitting and sleep—are vital and modifiable determinants of health.[1 2] Traditionally, much of the research into physical behaviours has operated in subdisciplinary silos (eg, physical activity, exercise, sedentary behaviour, sleep) partially owing to variations in methodological paradigms, in particular differences in measurements.[3–5] Recent advances in wearable technology, such as accelerometers, provide the potential to concurrently quantify multiple aspects of such behaviours in free-living conditions continuously across a number of days or weeks.[6 7] This presents opportunities for a major breakthrough in our ability to understand how all these aspects of physical behaviour synergistically influence health and promote chronic disease prevention.[7]

One area of vigorous debate regarding the use of accelerometers is where they should be placed, with the aim to maximise feasibility and the breadth and depth of collected data. In the first generation of accelerometer studies, most large-scale studies focused on physical activity used devices worn on a belt around the waist/hip.[8–10] This location was initially chosen due to its simplicity (ease of setup and wear) and close proximity to a person's centre of gravity (minimising the effect of extraneous movement). However, due to it's interference with clothing (requiring removal of the device when changing, etc) and sleep, waist/hip-worn devices have often been used only for waking hours, or part thereof.

Waist/hip-worn devices are also limited regarding the aspects/constructs of physical behaviour that they can currently identify. For instance, although they have been extensively validated for measuring energy expenditure,[11] they have difficulty quantifying postures and distinguishing between different physical behaviours (eg, sitting vs standing, walking on a flat surface vs stair climbing).[12] Wrist-worn devices, traditionally favoured in sleep research, have also gained popularity for physical activity assessment. This 'watch-like' wrist attachment carries less burden for research participants, resulting in higher compliance, and thus, may be more feasible for complete monitoring of 24 hours daily cycles than waist/hip-worn methods.[13 14] However, similar to waist/hip-worn devices, wrist-worn accelerometers currently have difficulty distinguishing between basic aspects of physical behaviour, such as posture and activity type.[12 15]

An emerging accelerometer placement location is the thigh. Thigh-worn accelerometers are typically taped to the front of the thigh and can be worn under clothing 24 hours a day for multiple days.[16–18] In addition to energy expenditure outcomes,[19] thigh placement allows detection of the specific physical behaviours (ie, sitting/lying, standing, walking, running, stair climbing, cycling) with excellent accuracy.[20 21] As such, an increasing number of major international cohorts have recently adopted such methods to measure thousands of participants, such as the Maastricht Study (n~8000), HUNT4 (n~38 000) and the 1970 British Birth Cohort (n~6000).[22] The successful incorporation of thigh-worn accelerometry by these studies demonstrates that thigh-worn accelerometry is feasible for comprehensively quantifying physical behaviour across the 24 hours cycle in large-scale health research.

The Prospective Physical Activity Sitting and Sleep consortium (ProPASS) is a recent research collaboration platform[22] of investigators utilising observational studies of thigh-worn accelerometry. ProPASS's ultimate scientific objective is to produce longitudinal evidence on the associations of physical activity, posture and sleep with long-term health outcomes and longevity. To fulfil these aims, ProPASS will harmonise and integrate thigh-worn accelerometry and corresponding health outcomes data—including linkage to administrative health data such as mortality and cause-specific hospital admissions. Besides its function to harmonise previously collected data, a fundamental aspect of ProPASS is its prospective nature. As such, ProPASS will develop standards to support future population-based studies to collect preharmonised thigh-worn accelerometry data. Meeting these objectives and handling sensitive health-related data is complex and demands long-term planning.

In line with publications describing previous accelerometry consortia,[23] this paper had a dual aim:

- To identify studies potentially eligible for inclusion in ProPASS via a systematic scoping review to summarise observational studies that collected 24 hours thigh-worn triaxial accelerometery data in population or community-based adult samples.
- To guide the development of ProPASS by compiling and sumarising key discussions and decisions arising from the initial ProPASS collaborators meeting (held in October 2018 in Copenhagen, Denmark) into an expert collaborator statement.

OBJECTIVE 1: SCOPING REVIEW

Methods

We conducted a scoping review and reported it according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting standards[24] and the PRISMA Extension for Scoping Reviews.[25]

Search strategy and article selection

Systematic searches scanned the literature (initial: July 2018; updated: August 2020) in MEDLINE via Ovid and Embase via Ovid, with no date or language restrictions. The search included terms for accelerometers combined with terms for observational studies. Full details of the search strategy are provided in online supplemental appendix 1.

Articles identified during the search were screened for their eligibility for the study in two stages by two reviewers independently (MLS, TC, NG, EIE). The first stage involved screening articles by title and abstract and clearly ineligible articles were excluded at this stage. If there was doubt about the eligibility of an article or disagreement between the reviewers, the article was included in the full-text review. The second stage involved a full-text review; any disagreements at this stage were resolved by discussion between the two reviewers until consensus was reached. For each excluded full text article, the reason for exclusion was noted.

To be included in this review, articles had to meet the following criteria: full-text publication using an observational study design where community-based, free-living adult participants wore thigh-worn triaxial accelerometers that used 24 hours activity data monitoring protocols. Exclusion criteria were: studies with <100 participants; studies of institutionalised participants or specialised clinical cohorts (eg, undergoing or perioperative major treatments or surgery); validation and calibration studies and non-English language studies. If studies included some participants (<20%) under 18 years of age, we considered to include them on a case-by-case basis so

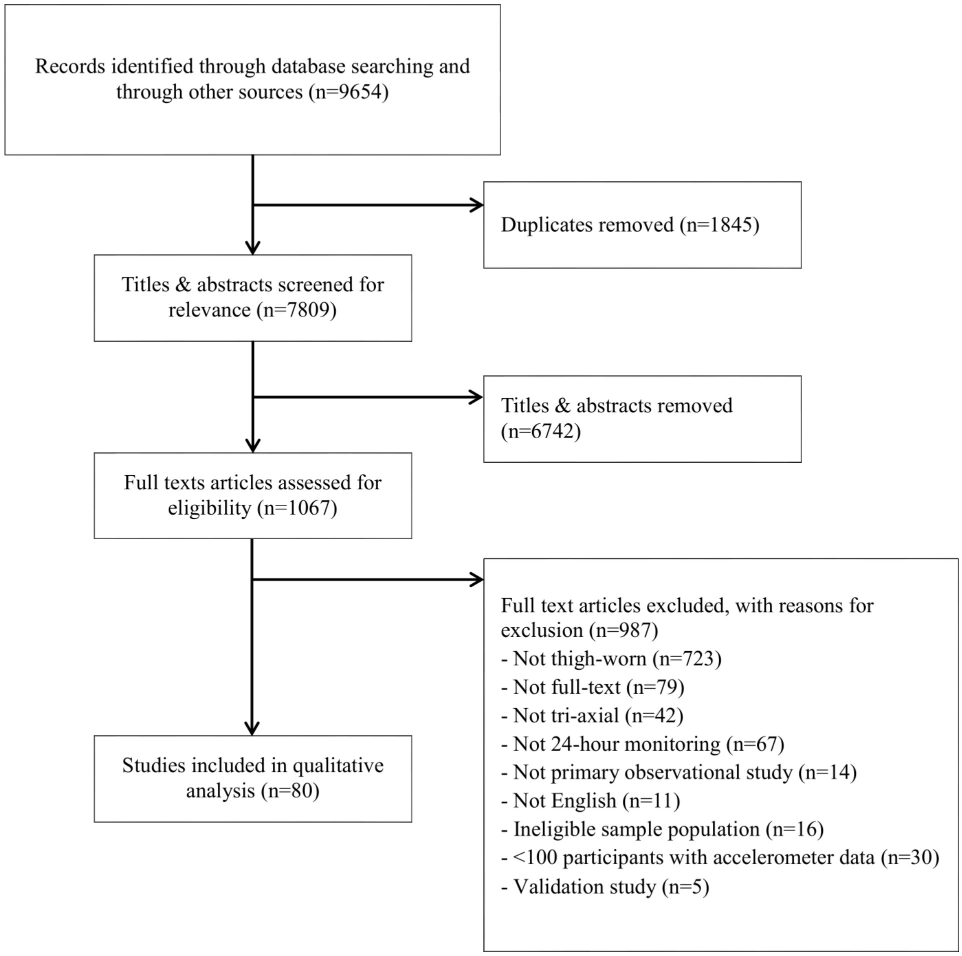

Figure 1 Flow diagram of study selection.

long as the participant range was close to adulthood (ie, older than 15).

Data extraction, outcomes and analysis

Data extraction, undertaken by a single author (EIE and MLS), included details of:

1. Study participants (eg, design, recruitment, sample criteria, size, location, age, sex, employment, whether the study belongs to a 'primary' study/cohort).
2. Accelerometry protocols (eg, device, placement, other sensors, days of wear, software used, variables created).
3. Physical behaviour information collected by other methods (eg, collected by questionnaire).
4. Health outcome variables (eg, cholesterol, fasting glucose, body mass index (BMI), back pain).
5. Data sharing policies.

The data extracted is presented and summarised.

Results

Of the 9654 articles identified through the search, 1845 were duplicates, leaving 7809 articles to be screened for eligibility. Of these 7809 articles, 6742 were excluded by title and abstract and another 987 were excluded after reading through the full text. This left 80 articles eligible for inclusion (figure 1). Full details of the data extracted from each study are provided in online supplemental appendix 2.

Studies design and participants

Of the 80 articles identified, 72 were cross-sectional,[6 26–96] leaving 8 articles that presented prospective data.[97–104] The 80 articles contained data from 22 different primary studies.[26 27 35 37 38 40 44 49 63 64 68 72 75 76 79 81 85 94 96 100 104] These 22 primary studies consisted of 18 longitudinal studies[26 27 37 38 40 49 63 68 72 75 76 79 81 85 96 100 104] and 4 cross-sectional studies.[35 44 64 94] The 22 different primary studies (~17 685 participants) were mainly from the Netherlands, UK and Denmark. The mean/median age range for participants was 20–79 years and all collected data in both men and women. Ten of the 22 primary studies recruited participants from their workplace[35 37 44 75 76 79 81 96 100 104]—such as healthcare, construction, manufacturing and cleaning. The remaining 12 studies recruited participants from the general population.[26 27 38 40 49 63 64 68 72 85 94]

Accelerometry protocols

The accelerometer used most often was the ActivPAL (10 primary studies),[26 38 44 49 63 64 68 76 94] followed by the ActiGraph GT3X (eight primary studies)[35 37 72 79 81 96 100 104] and MOX Accelerometry Monitor (two primary studies).[27 40]

Most studies processed accelerometry data using either ActivPAL software (four primary studies)[26 38 44 64] or custom Matlab software (11 primary studies; of which 9 used the custom Matlab Acti4 program).[27 35 37 49 72 75 79 81 96 100 104] All accelerometers were attached to the skin on the front of the thigh (roughly midway between the anterior superior iliac spine and the patella). Participants were asked to wear the accelerometer continuously for between 3 and 10 days with the most commonly requested wear time being 7 days (11 primary studies).[26 27 37 38 40 64 68 72 76 94]

Daily logs/diary data

Fourteen primary studies used diaries to supplement the information collected by accelerometry.[26 27 35 37 38 44 64 68 72 75 76 81 96] Mostly, diary-based information was used to identify participants' time in bed (11 primary studies)[26 27 35 37 38 63 72 76 81 96] non-wear time (8 primary studies)[26 27 35 37 44 72 81 96] and times at work (7 primary studies).[35 37 44 72 75 81 96]

Health outcomes

The most commonly reported health outcomes were cardiometabolic (11 primary studies),[26 35 40 49 63 72 75 79 81 85 96] followed by musculoskeletal (five primary studies).[26 81 96 100 104] Commonly reported cardiometabolic outcomes were insulin and cholesterol levels, fasting/2-hour postload glucose, blood pressure, body composition and BMI. The most commonly reported musculoskeletal outcome was low back pain, followed by neck/shoulder pain. Other identified health outcome fields were mental health (eg, depression, mental fatigue; three primary studies)[38 85] respiratory/cardiorespiratory (eg, forced expiratory volume, forced vital capacity, submaximal cycle ergometer; two primary studies)[40 49] and epigenetics (DNA methylation; one primary study).[38] We identified no prospective studies linked to mortality or incident disease outcomes.

Data sharing

Six primary studies mentioned the potential for data-sharing.[38 68 72 81 85]

OBJECTIVE 2: EXPERT COLLABORATOR STATEMENT

Methods

In October 2018, 19 ProPASS collaborators (including all authors of this paper) met in Copenhagen for 2 days to discuss strategies relevant for the successful establishment, growth and management of the consortium. The meeting was structured around the following areas: (1) The main aims and purpose of ProPASS (including terminology); (2) the constructs that thigh-worn accelerometry can output; (3) the advantages and unique contribution that ProPASS can make to the health literature; (4) the optimal methods for data pooling, harmonisation and linkage with health administration data and (5) the data access and sharing model. To inform this discussion, the results from the above scoping review (initial search) were presented.

Following this meeting there were several key points—vital to the progression and goals of ProPASS—about which no clear decision had been made. Thus, we decided to conduct a formal survey of meeting participants regarding these key points. The purpose of the survey was to systematically consolidate ProPASS collaborators' views on the topics discussed during the 2-day meeting towards an expert collaborator statement as the blueprint for the next stages of the consortium's growth and its contribution to the field.

Participants

The attendees at the ProPASS Copenhagen meeting were associated with the participating ProPASS cohorts, members of the ProPASS advisory group, or scientists with expertise in one or more of the key ProPASS development priority areas. All who attended the 2018 ProPASS meeting were invited to participate in the survey (n=19).

Survey procedures

From the minutes of the ProPASS Consortium meeting in Copenhagen in 2018, we identified key areas that required further input and developed six questions to capture collaborators' views on these areas. Each question corresponded to one of the workshops at the meeting. All survey questions were multiple choice, but permitted 'other' responses and also provided space for unrestricted free comment. This allowed participants to elaborate on their answer and expand beyond the specific questions. These survey questions were:

1. What term best describes the data we aim to collect and analyse in ProPASS?
2. Do you agree with the ProPASS Accelerometry Construct? The ProPASS construct is an ideal set of accelerometer-based movement/posture variables that ProPASS will aim to extract and harmonise (figure 2).
3. What do you think is the main advantage of harmonising and pooling thigh-worn accelerometry data for epidemiological research?
4. What is the best approach for harmonising thigh-worn accelerometry data?
5. What is the best approach for managing access to ProPASS pooled accelerometry data (provided that regulatory and legal conditions are met)?
6. What should be the data sharing model for a thigh-based accelerometry pooled data resource?

In March/April 2019, all attendees of the ProPASS Copenhagen meeting were sent the survey. The survey was communicated by email, and contained the expert collaborator statement protocol and a link (SurveyMonkey (SurveyMonkey, California, USA; www.surveymonkey.com)) to the survey. All participants were asked to complete the survey within 2 weeks. Those not responding to the initial email were sent a single reminder email and given an additional week to respond.

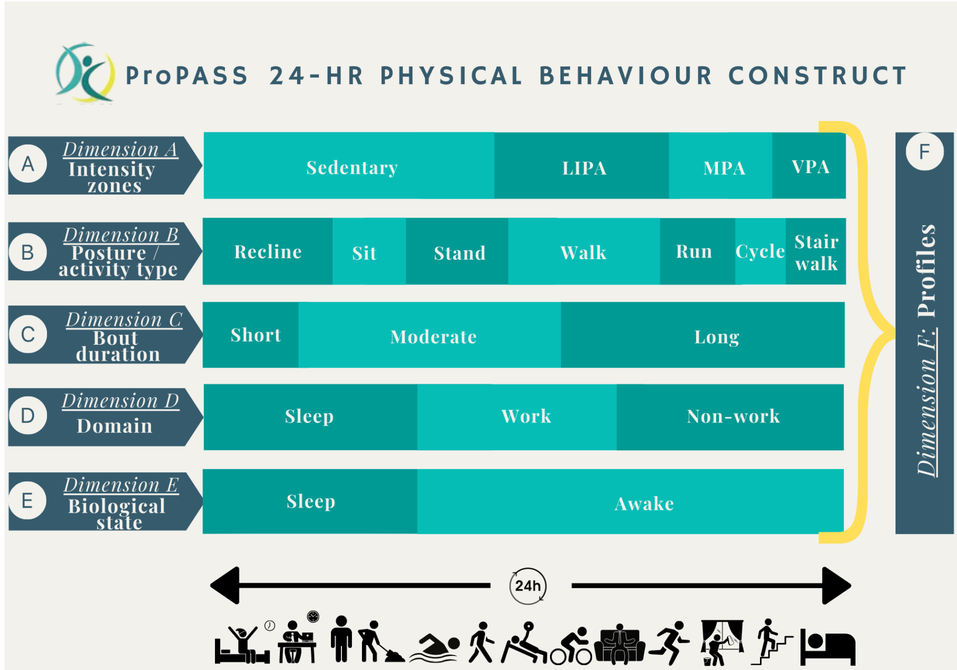

Figure 2 The dimensions of the proposed ProPASS Accelerometry Construct. Dimension A: the basic intensity-based dimension of the 24 hours physical activity (PA) construct stratified on sedentary behaviour, light physical activity (LIPA), moderate physical activity (MPA) and vigorous physical activity (VPA). Dimension B: information about both posture and physical activity types. Dimension C: information of time spent on various length of bouts with uninterrupted periods of physical activity types and posture. For example, short bouts (0–5 mins), moderate (>5–10 min) and long (>10 mins) bouts of standing; meaningful bouts length could be different for sitting and other activity types or postures Dimension D: domains where the physical activity components and posture occurs. Dimension E: Acknowledges that sleep is a different biological state. Dimension F: indicates that the profile is a combination of all other dimensions A–E. ProPASS, Physical Activity Sitting and Sleep consortium.

Data analysis

For each survey question, we calculated frequencies of endorsement for each response and summarised the open-ended responses using thematic analysis. Agreement for a particular response was indicated by an endorsement rating of 60%. Where 60% agreement was not reached, the leading responses (those within 20% of the lead response) were provided. Thematic analysis was performed by identifying the key idea(s) within each free-text field and then collating those ideas into themes that developed from the ideas identified within each question. The thematic analysis was conducted jointly by two authors (MLS/EIE) before being opened up to the whole author group for comment and feedback.

Results

Of the 19 attendees at the ProPASS meeting, 16 responded to the survey. Responders were from 11 different institutions (including government, academia and industry) distributed across seven countries. No question reached the predefined threshold for agreement of 60%. The percentage responses for each question are provided in table 1.

Question 1: what term best describes the data we aim to collect and analyse in ProPASS?

The overall term to describe the data that ProPASS aims to collect and analyse that was voted most highly was 'physical behaviour' with 50% of the votes, followed closely by 'movement behaviour' with 44% of votes. Analysis of the free-text indicated that although many respondents were in favour of the term 'movement behaviour', it missed important concepts such as sedentary time and/or sleep. No respondent voted for the use of 'physical activity'. The free-text suggests that this is because the term 'physical activity' is generally regarded as referring to data collected using accelerometry counts-based methods, a connotation that is not compatible with ProPASS objectives, and also misses sedentary behaviour, postures and sleep behaviours.

Question 2: do you agree with the ProPASS accelerometry construct?

The ProPASS Accelerometry Construct was designed to bring the research theories in physical behaviour research together with the variables to be used in ProPASS. It consists of several dimensions of the construct that are not necessarily hierarchical and can be combined to form new hybrid variables (figure 2). The dimensions are:

Dimension A: 'intensity zones'—containing the information on whether an individual is sedentary or conducting light physical activity, moderate physical activity or vigorous physical activity.

Dimension B: the 'posture/activity type'—consisting of lying, sit, stand, walk, run, cycling and stair climbing.

Table 1 ProPASS collaborator survey: questions and responses (%)

1. what term best describes the data we aim to collect and analyse in ProPASS?					
Physical activity		Physical behaviour	Movement behaviour	Other (please describe)	
0%		50%	44%	6%	
2. Do you agree with the ProPASS Accelerometry Construct? The ProPASS construct is an ideal set of accelerometer-based movement/posture variables that ProPASS will aim to extract and harmonise. (Please note that these dimensions are not mutually exclusive)					
I agree with the construct as it is		I have minor suggestions to improve the construct (describe below)		I have major suggestions (describe below)	
50%		44%		6%	
3. What do you think is the main advantage of harmonising and pooling thigh-worn accelerometry data for epidemiological research?					
Superior statistical power		Better ecological validity/generalisability	Opportunities for network building	Other (please describe)	
31%		25%	19%	25%	
4. What is the best approach for harmonising thigh-worn accelerometry data?					
Central processing—Collaborators send ProPASS the raw data to reprocess from scratch		ProPASS develops software tools, processes, and protocols to allow collaborators to reprocess their own accelerometry data from scratch	Make use of the variables collaborators have already extracted (this will limit the number of harmonised variables available)	Other (please describe)	
0%		56%	19%	25%	
5. What is the best approach for managing access to ProPASS pooled accelerometry data (provided that regulatory and legal conditions are met)?					
All/most data to be pooled/deposited centrally—Data are sent to data analysts when appropriate.		All/most data to be pooled/deposited centrally—analysts access data remotely through appropriate IT infrastructure	Federated data analyses (the data stay in each cohorts' servers)—data are accessed remotely by analysts	Other (please describe)	
13%		30%	44%	13%	
6. What should be the data sharing model for a thigh-based accelerometry pooled data resource?					
Fee to access for all users	Free to all bona fide researchers worldwide	Free to ProPASS collaborators, fee to access for all bona fide researchers	Closed, available to ProPASS collaborators only for a nominal fee	Closed, available to ProPASS collaborators only for free	Other (please describe)
13%	0%	50%	13%	0%	25%

IT, Information Technology; ProPASS, Prospective Physical Activity Sitting and Sleep consortium.

Dimension C: the 'bout duration' of physical behaviours—such as short, moderate and long duration patterns of various dimensions of physical behaviours.

Dimension D: the 'domains' of physical behaviours—such as being at work, commuting to work and non-work time.

Dimension E: the 'biological state'—relating to the condition of being asleep or awake.

Dimension F: the 'physical behaviour profile'—24 hours time spent on various dimensions of physical behaviours.

Nearly all (94%) respondents either agreed with the ProPASS Accelerometry Construct as presented (50%) or had only minor suggestions (44%). In summary, suggestions to improve the construct included: not to limit the construct to 24 hours cycles (eg, allow for diurnal cycles or cycles across weeks/years/life, etc); to avoid arbitrary intensity thresholds (eg, light/moderate/vigorous) and instead focus on other ways of grouping behaviours (eg, aerobic/anaerobic states); the addition of a construct that incorporates the time sequence/patterns of physical behaviour (ie, frequency, duration and order); and the addition of categories into some constructs (eg, slow/fast walking in dimension B (posture/activity types), transportation in dimension D (domain)). Some respondents also felt that it is not completely clear what the purpose of dimension C (bout duration) was, and suggested that it could be included as a vertical dimension that spans across all other dimensions.

Question 3: what do you think is the main advantage of harmonising and pooling thigh-worn accelerometry data for epidemiological research?

Votes for the primary value of harmonising thigh-worn accelerometry data were split between the four choices provided: 'superior statistical power' (31%), 'better ecological validity/generalisability' (25%), 'opportunities for network building' (19%) and 'other' (25%). Within the free-text fields related to 'other' was further mention of both concepts of statistical power and ecological validity. It was also mentioned that while 'opportunities for network building' in itself may not be as important as the other concepts, it is important because it leads to improved approaches to analysis.

Question 4: what is the best approach for harmonising thigh-worn accelerometry data?

Although not meeting the a priori requirements for agreement, there was support for ProPASS developing its own software tools, processes and protocols and allow collaborators to reprocess their own accelerometry data from scratch (56% of respondents). The open ended free-text responses showed support for the need to be flexible and allow for various methods (eg, central or dispersed processing of data) to be used depending on the constraints of collaborators. In line with this, there were also suggestions to focus on the outcomes of harmonisation rather than the process of harmonisation (ie, focus on the definitions and derivations of the outcome variables rather than where or by whom the data are processed).

Question 5: what is the best approach for managing access to ProPASS pooled accelerometry data (provided that regulatory and legal conditions are met)?

With reference to what the best approach to manage access to the ProPASS pooled accelerometry data would be, the most endorsed response was to use federated data analyses where the data remain on local servers hosted by collaborators which are remotely accessed by analysts (44%). This was followed by central pooling of data on ProPASS run servers which could still be accessed remotely for conducting analyses (31%). Free-text responses highlighted the importance of remaining flexible with suggestions for possible hybrid options.

Question 6: what should be the data sharing model for a thigh-based accelerometry pooled data resource?

Half (50%) of respondents endorsed free data access for ProPASS collaborators but combined with an access fee for external researchers. Open-ended responses also showed support for a differential pricing structure based on contribution (collaborators), need (researchers) and ability to pay (industry). Regardless of the pricing structure, responders mentioned the need for restricting access and having processes for research proposal evaluation and management.

DISCUSSION

The aim of this paper was to highlight the existing observational thigh-worn accelerometry literature and to capture and sumarise key discussions and decisions that arose at the initial ProPASS collaborators meeting. In this section, we discuss the main outcomes of the two paper components and their main implications for the immediate future of ProPASS.

Scoping review: key findings and future directions

The scoping review identified 22 primary studies with the potential to pool thigh-worn triaxial accelerometer data. These studies were primarily conducted in the Netherlands, UK and Denmark and contained participants recruited from both workplaces and the general population. However, the (likely) limited consent for some of these studies means that not all should be expected to be able to contribute to ProPASS. On the other hand, several additional cohorts (which are relatively new and thus were not identified in our scoping review due to a lack of published data) may also be included in the harmonised ProPASS data set.[22]

Although there have been many reviews of accelerometry methods,[11 23 105–108] to date none have focused specifically on thigh-worn accelerometry. Compared with our study, prior reviews have identified a much greater number of individual studies but with a wider variation in accelerometry protocols (including differences in the device used, its placement and processing method). For instance, one review (focused on the use of hip-worn ActiGraph accelerometers in youth studies) found that their included studies used 6 different epoch lengths, different definitions of non-wear time, 13 different definitions of a valid day, 8 different minimum wear day thresholds, 12 different cut points for moderate intensity physical activity and 11 different cut points for sedentary behaviour.[106] In contrast, the data from thigh-worn accelerometry were more homogeneous with 13 of the 22 identified primary studies using one of two primary methods. Moreover, in a recent study, we have shown that processing raw triaxial thigh-worn accelerometry data using a single software package (Acti4,[20]) produces consistent and accurate results across different accelerometer devices.[21] This supports the potential for thigh-worn accelerometer data to be harmonised retrospectively and prospectively across different studies. However, even though there may be less heterogeneity in the collection and processing of thigh-worn accelerometry compared with other wear-locations, there are still several areas for which standardised protocols would be of benefit to the field (eg, number of days of wear, definitions for a valid day, detection of non-wear time).[109]

From the results of our review, there are at least four important implications for ProPASS. The first is the opportunity for ProPASS to be a source of information and infrastructure for collecting and harmonising triaxial thigh-worn accelerometry data. The second can be seen in the relative youth of these studies—which only entered the scientific literature in 2015—and the small number of primary studies containing this data. This indicates the opportunity to collaborate in the development of standardised protocols (and outcome definitions) for collecting triaxial thigh-worn accelerometry data and associated health outcomes—setting the standard for prospective harmonisation. Third, there is currently a lack of studies investigating the prospective associations of physical behaviours with incident health outcomes. For example, despite the longitudinal nature of most of the primary studies identified (82%) only a very small proportion of all identified studies (10%) have used this prospective data. This is likely due to the relative youth of these studies which means that these studies may still be collecting data and/or are waiting to have enough events. Finally, there is also a lack of studies that collect repeated measures of physical behaviour using thigh-worn accelerometry.

ProPASS collaborator statement: responses and implications for moving forward

The responses regarding the terminology for ProPASS highlight its importance for achieving a clear identity and avoiding misunderstanding and confusion. Although there was no clearly favoured response, there was a desire to differentiate from terms that are generally used to describe counts-based measurements of physical activity. As both movement and physical behaviour were highly endorsed it seems that some combination of these ideas may be ideal (eg, movement and posture defined physical behaviour). However, the ability to quickly and simply reference an idea is important and as such a longer, more descriptive term would still require a shortened form (eg, physical behaviour).

The relative agreement around the physical behaviour constructs developed meant that collaborators generally agreed with the ProPASS constructs as defined. However, there is a need for continued refinement of the construct. The purpose of this construct is to provide guidance on the optimal set of accelerometry variables to be extracted and analysed in a framework for understanding the ways in which physical behaviours can be structured. Therefore, it is important to make sure its dimensions are clear and cover all important health-related aspects of physical behaviour.

Although not reaching our predefined agreement of 60%, the relative endorsement of both decentralised processing and federated analyses suggest that there is general agreement towards ProPASS collaborators maintaining control of and being responsible for their own data. This requires that ProPASS develops/adapts tools and processes that enable collaborators to easily manage and process their data in a consistent fashion. Such methods may be easier from a privacy perspective, but require more work on behalf of the collaborators to setup and maintain these systems. In contrast to this trend for ProPASS collaborators to maintain control and responsibility for their own data, the other major accelerometry database—the International Children's Accelerometry database—pooled and processed all data centrally.[110] These differences may be due to tightening privacy laws across Europe[109] and/or the prior lack of the technology required to conduct federated analyses, which were only recently introduced to large scale harmonisation studies with the Biobank Standardisation and Harmonisation for Research Excellence in the European Union project.[111]

With regard to the data sharing model and methods for accessing the data for conducting research, the option most favoured (although not reaching the predefined agreement level of 60%) was to restrict access and put in place an access fee for external researchers. Such a fee would help to offset the costs of developing and maintaining such a database while also rewarding those contributing data. However, it would be important that the fee is not so large as to deter researchers with fewer resources. As the implementation of a fee to access the data does not align with the principles of open access, ProPASS will carefully consider its implementation in the next few years. However, if sustained funding cannot be acquired through other means (grants etc) it may be a necessity.

CONCLUSION

This scoping review and systematically developed expert collaborator statement will guide ProPASS and set the direction for ProPASS's contribution to understanding the associations of physical activity, posture, and sleep with long-term health outcomes and longevity. Directions taken as a result of this work are currently being implemented and have led to positive outcomes in terms of consortium growth, funding and progress with the consirtium's aims. We are: (1) using the term physical behaviour to account for the full spectrum of movement and posture related physical behaviours that includes physical activity, sedentary behaviours and sleep; we encourage others to do the same for the reasons outlined above; (2) developing a comprehensive set of standardised protocols and tools for the collection of accelerometry and important health outcomes data (including fieldwork training materials); (3) developing tools for processing thigh-worn accelerometry data according to the ProPASS construct presented in this manuscript and (4) developing/adopting systems for conducting federated data analysis.

Author affiliations

[1]Musculoskeletal Disorders and Physical Workload, National Research Centre for the Working Environment, Copenhagen, Denmark
[2]Boden Collaboration for Obesity, Nutrition, Exercise & Eating Disorders, Faculty of Medicine and Health, The University of Sydney, Sydney, New South Wales, Australia
[3]School of Public Health, The University of Sydney Faculty of Medicine and Health, Sydney, New South Wales, Australia
[4]School of Health and Society, University of Salford, Salford, UK
[5]PAL Technologies, Glasgow, UK
[6]School of Physiotherapy and Exercise Science, Curtin University, Perth, Western Australia, Australia
[7]Department of Medical Sciences, Uppsala University, Uppsala, Sweden
[8]Department of Public Health, University of Turku and Turku University Hospital, Turku, Finland
[9]Center for Clinical Research and Prevention, Bispebjerg and Frederiksberg Hospital, Copenhagen, Denmark
[10]Department of Public Health and Nursing, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway
[11]School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK
[12]Department of Movement and Sport Sciences, Ghent University, Gent, Belgium
[13]HUNT Research Centre, Department of Public Health and Nursing, Faculty of Medicine, Norwegian University of Science and Technology, Levanger, Norway
[14]Institute Sport Exercise & Health, Faculty of Medical Sciences, University College London, London, UK
[15]Department of Social Medicine, CAPHRI Care and Public Health Research Institute, Maastricht University, Maastricht, The Netherlands

Twitter Matthew L Stevens @_MattStevens_ and Emmanuel Stamatakis @M_Stamatakis

Acknowledgements We would like to thank Tess Cooper for her work in the earlier stages of this project.

Contributors The ProPASS working group (VR, MH, AK, AH and ES) were responsible for the conception of the mansucript. MLS, NG, TC, AH and ES were primarily responsible for the study design. TC conducted the search. MLS and TC were responsible for screeening articles. EIE undertook the data extraction. NG, AH and ES were primarily responsible for the development of the accelerometry constructs. MLS drafted the manuscript. All authors contributed substantially to the interpretation of data, revised it for intellectual content and approved the final version of the manuscript.

Funding ProPASS has received financial support by the British Heart Foundation (SP/F/20/150002), the National Healthand Medical Research Council (Australia) (APP1180812, APP1194510, and an equipmet grant), PAL Technologies (Scotland, UK); the Worldwide Universities Network–Research Development Fund 2018; the Charles Perkins Centre of the University of Sydney; the University of Sydney's SOAR programme, Loughborough University (UK) and in-kind support by the National Research Centre for the Working Environment, Copenhagen.

Competing interests One author (MG) is associated with PAL Technologies. A commercial company that designs and sells research grade tri-axial accelerometers designed to be worn on the thigh.

Patient consent for publication Not required.

Ethics approval Ethical approvals were not required for this study.

Provenance and peer review Not commissioned; externally peer reviewed.

ORCID iD

Matthew L Stevens http://orcid.org/0000-0002-2621-4811

REFERENCES

1 Lee I-M, Shiroma EJ, Lobelo F, *et al*. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* 2012;380:219–29.
2 Jike M, Itani O, Watanabe N, *et al*. Long sleep duration and health outcomes: a systematic review, meta-analysis and meta-regression. *Sleep Med Rev* 2018;39:25–36.
3 Kemp B. Measurement of sleep. *Prog Brain Res* 2010;185:21–5.
4 Van de Water ATM, Holmes A, Hurley DA. Objective measurements of sleep for non-laboratory settings as alternatives to polysomnography--a systematic review. *J Sleep Res* 2011;20:183–200.
5 Ndahimana D, Kim E-K. Measurement methods for physical activity and energy expenditure: a review. *Clin Nutr Res* 2017;6:68–80.
6 Jørgensen MB, Gupta N, Korshøj M, *et al*. The DPhacto cohort: an overview of technically measured physical activity at work and leisure in blue-collar sectors for practitioners and researchers. *Appl Ergon* 2019;77:29–39.
7 Rosenberger ME, Fulton JE, Buman MP, *et al*. The 24-hour activity cycle: a new Paradign for physical activity. *Med Sci Sport Exerc* 2019;51:454–64. doi:10.1249/MSS.0000000000001811
8 Troiano RP, Berrigan D, Dodd KW, *et al*. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc* 2008;40:181–8.
9 Cook NR, Lee I-M, Gaziano JM, *et al*. Low-Dose aspirin in the primary prevention of cancer: the women's health study: a randomized controlled trial. *JAMA* 2005;294:47–55.
10 Howard VJ, Rhodes JD, Mosher A, *et al*. Obtaining Accelerometer data in a national cohort of black and white adults. *Med Sci Sports Exerc* 2015;47:1531–7.
11 Jeran S, Steinbrecher A, Pischon T. Prediction of activity-related energy expenditure using accelerometer-derived physical activity under free-living conditions: a systematic review. *Int J Obes* 2016;40:1187–97.
12 Ellis K, Kerr J, Godbole S, *et al*. Hip and wrist Accelerometer algorithms for free-living behavior classification. *Med Sci Sports Exerc* 2016;48:933–40.
13 Kerr J, Marinac CR, Ellis K, *et al*. Comparison of Accelerometry methods for estimating physical activity. *Med Sci Sport Exerc* 2017;49:617–24.
14 Scott JJ, Rowlands AV, Cliff DP, *et al*. Comparability and feasibility of wrist- and hip-worn accelerometers in free-living adolescents. *J Sci Med Sport* 2017;20:1101–6.
15 Willetts M, Hollowell S, Aslett L, *et al*. Statistical machine learning of sleep and physical activity phenotypes from sensor data in 96,220 UK Biobank participants. *Sci Rep* 2018;8:1–10.
16 Chastin SFM, Granat MH. Methods for objective measure, quantification and analysis of sedentary behaviour and inactivity. *Gait Posture* 2010;31:82–6.
17 Hartley P, Keevil VL, Westgate K, *et al*. Using Accelerometers to measure physical activity in older patients admitted to hospital. *Curr Gerontol Geriatr Res* 2018;2018:1–9.
18 Dall PM, Skelton DA, Dontje ML, *et al*. Characteristics of a protocol to collect objective physical activity/sedentary behaviour data in a large study: seniors USP (understanding sedentary patterns). *J Meas Phys Behav* 2018;1:26–31.
19 White T, Westgate K, Hollidge S, *et al*. Estimating energy expenditure from wrist and thigh accelerometry in free-living adults: a doubly labelled water study. *Int J Obes* 2019;43:2333–42.

20 Stemland I, Ingebrigtsen J, Christiansen CS, *et al*. Validity of the Acti4 method for detection of physical activity types in free-living settings: comparison with video analysis. *Ergonomics* 2015;58:953–65.
21 Crowley P, Skotte J, Stamatakis E, *et al*. Comparison of physical behavior estimates from three different thigh-worn accelerometers brands: a proof-of-concept for the prospective physical activity, sitting, and sleep Consortium (ProPASS). *Int J Behav Nutr Phys Act* 2019;16.
22 Stamatakis E, Koster A, Hamer M, *et al*. Emerging Collaborative research platforms for the next generation of physical activity, sleep and exercise medicine guidelines: the prospective physical activity, sitting, and sleep Consortium (ProPASS). *Br J Sports Med* 2020;54:bjsports-2019-100786.:435–7.
23 Wijndaele K, Westgate K, Stephens SK, *et al*. Utilization and harmonization of adult Accelerometry data: review and expert consensus. *Med Sci Sports Exerc* 2015;47:2129–39.
24 Moher D, Liberati A, Tetzlaff J, *et al*. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol* 2009;62:1006–12.
25 Tricco AC, Lillie E, Zarin W, *et al*. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169:467–73.
26 Bellettiere J, Winkler EAH, Chastin SFM, *et al*. Associations of sitting accumulation patterns with cardio-metabolic risk biomarkers in Australian adults. *PLoS One* 2017;12:e0180119–17.
27 Breedveld-Peters JJL, Koole JL, Müller-Schulte E, *et al*. Colorectal cancers survivors' adherence to lifestyle recommendations and cross-sectional associations with health-related quality of life. *Br J Nutr* 2018;120:188–97.
28 Gupta N, Heiden M, Aadahl M, *et al*. What is the effect on obesity indicators from replacing prolonged sedentary time with brief sedentary bouts, standing and different types of physical activity during working days? A cross-sectional accelerometer-based study among blue-collar workers. *PLoS One* 2016;11:e0154935–18.
29 Hallman DM, Birk Jørgensen M, Holtermann A. Objectively measured physical activity and 12-month trajectories of neck-shoulder pain in workers: a prospective study in DPHACTO. *Scand J Public Health* 2017;45:288–98.
30 Hallman DM, Birk Jørgensen M, Holtermann A. On the health paradox of occupational and leisure-time physical activity using objective measurements: effects on autonomic imbalance. *PLoS One* 2017;12:e0177042–16.
31 Hallman DM, Mathiassen SE, Gupta N, *et al*. Differences between work and leisure in temporal patterns of objectively measured physical activity among blue-collar workers. *BMC Public Health* 2015;15:1–12.
32 Hallman DM, Mathiassen SE, Heiden M, *et al*. Temporal patterns of sitting at work are associated with neck-shoulder pain in blue-collar workers: a cross-sectional analysis of accelerometer data in the DPHACTO study. *Int Arch Occup Environ Health* 2016;89:823–33.
33 Hallman DM, Sato T, Kristiansen J, *et al*. Prolonged sitting is associated with attenuated heart rate variability during sleep in blue-collar workers. *Int J Environ Res Public Health* 2015;12:14811–27.
34 Hulsegge G, Gupta N, Holtermann A, *et al*. Shift workers have similar leisure-time physical activity levels as day workers but are more sedentary at work. *Scand J Work Environ Health* 2017;43:127–35.
35 Kloster S, Danquah IH, Holtermann A, *et al*. How does definition of minimum break length affect objective measures of sitting outcomes among office workers? *J Phys Act Heal* 2016;14:8–12.
36 Korshøj M, Hallman DM, Mathiassen SE, *et al*. Is objectively measured sitting at work associated with low-back pain? A cross sectional study in the DPhacto cohort. *Scand J Work Environ Health* 2018;44:96–105.
37 Loef B, van der Beek AJ, Holtermann A, *et al*. Objectively measured physical activity of hospital shift workers. *Scand J Work Environ Health* 2018;44:265–73.
38 Čukić I, Shaw R, Der G, *et al*. Cognitive ability does not predict objectively measured sedentary behavior: evidence from three older cohorts. *Psychol Aging* 2018;33:288–96.
39 Martens RJH, van der Berg JD, Stehouwer CDA, *et al*. Amount and pattern of physical activity and sedentary behavior are associated with kidney function and kidney damage: the Maastricht study. *PLoS One* 2018;13:e0195306–18.
40 Mesquita R, Nakken N, Janssen DJA, *et al*. Activity levels and exercise motivation in patients with COPD and their resident Loved ones. *Chest* 2017;151:1028–38.
41 Munch Nielsen C, Gupta N, Knudsen LE, *et al*. Association of objectively measured occupational walking and standing still with low back pain: a cross-sectional study. *Ergonomics* 2017;60:118–26.
42 Pulakka A, Stenholm S, Bosma H, *et al*. Association between employment status and objectively measured physical activity and sedentary Behavior-The Maastricht study. *J Occup Environ Med* 2018;60:309–15.
43 Rasmussen CL, Palarea-Albaladejo J, Bauman A, *et al*. Does physically demanding work hinder a physically active lifestyle in low socioeconomic workers? A compositional data analysis based on accelerometer data. *Int J Environ Res Public Health* 2018;15:1306–23.
44 Sawyer A, Smith L, Ucci M, *et al*. Perceived office environments and occupational physical activity in office-based workers. *Occup Med* 2017;67:260–7.
45 Shaw RJ, Čukić I, Deary IJ, *et al*. The influence of neighbourhoods and the social environment on sedentary behaviour in older adults in three prospective cohorts. *Int J Environ Res Public Health* 2017;14:557–21.
46 Shaw RJ, Čukić I, Deary IJ, *et al*. Relationships between socioeconomic position and objectively measured sedentary behaviour in older adults in three prospective cohorts. *BMJ Open* 2017;7:e016436–10.
47 Skarpsno ES, Mork PJ, Nilsen TIL, *et al*. Objectively measured occupational and leisure-time physical activity: cross-sectional associations with sleep problems. *Scand J Work Environ Health* 2018;44:202–11.
48 Smith L, Hamer M, Ucci M, *et al*. Weekday and weekend patterns of objectively measured sitting, standing, and stepping in a sample of office-based workers: the active buildings study. *BMC Public Health* 2015;15:9.
49 de Rooij BH, van der Berg JD, van der Kallen CJH, *et al*. Physical activity and sedentary behavior in metabolically healthy versus unhealthy obese and non-obese individuals - the Maastricht study. *PLoS One* 2016;11:e0154358–12.
50 Smith L, Sawyer A, Gardner B, *et al*. Occupational physical activity habits of UK office workers: cross-sectional data from the active buildings study. *Int J Environ Res Public Health* 2018;15:1214.
51 van der Berg JD, Stehouwer CDA, Bosma H, *et al*. Associations of total amount and patterns of sedentary behaviour with type 2 diabetes and the metabolic syndrome: the Maastricht study. *Diabetologia* 2016;59:709–18.
52 VAN DER Berg JD, VAN DER Velde JHPM, DE Waard EAC, *et al*. Replacement effects of sedentary time on metabolic outcomes: the Maastricht study. *Med Sci Sports Exerc* 2017;49:1351–8.
53 VAN DER Velde JHPM, Koster A, VAN DER Berg JD, *et al*. Sedentary behavior, physical activity, and Fitness-The Maastricht study. *Med Sci Sports Exerc* 2017;49:1583–91.
54 Villumsen M, Holtermann A, Samani A, *et al*. Social support modifies association between forward bending of the trunk and low-back pain: cross-sectional field study of blue-collar workers. *Scand J Work Environ Health* 2016;42:125–34.
55 Villumsen M, Madeleine P, Jørgensen MB, *et al*. The variability of the trunk forward bending in standing activities during work vs. leisure time. *Appl Ergon* 2017;58:273–80.
56 Villumsen M, Samani A, Jørgensen MB, *et al*. Are forward bending of the trunk and low back pain associated among Danish blue-collar workers? A cross-sectional field study based on objective measures. *Ergonomics* 2015;58:246–58.
57 Clays E, Hallman D, Oakman J, *et al*. Objectively measured occupational physical activity in blue-collar workers: what is the role of job type, gender and psychosocial resources? *Appl Ergon* 2020;82:102948.
58 Coenen P, Korshøj M, Hallman DM, *et al*. Differences in heart rate reserve of similar physical activities during work and in leisure time - A study among Danish blue-collar workers. *Physiol Behav* 2018;186:45–51.
59 Cooper R, Stamatakis E, Hamer M. Associations of sitting and physical activity with grip strength and balance in mid-life: 1970 British cohort study. *Scand J Med Sci Sports* 2020;30:1–11.
60 Gale CR, Čukić I, Chastin SF, *et al*. Attitudes to ageing and objectively-measured sedentary and walking behaviour in older people: the Lothian birth cohort 1936. *PLoS One* 2018;13:e0197357–10.
61 Čukić I, Gale CR, Chastin SFM, *et al*. Cross-Sectional associations between personality traits and device-based measures of step count and sedentary behaviour in older age: the Lothian birth cohort 1936. *BMC Geriatr* 2019;19:1–10.
62 de Oliveira Sato T, Hallman DM, Kristiansen J, *et al*. The association between multisite musculoskeletal pain and cardiac autonomic modulation during work, leisure and sleep – a cross-sectional study. *BMC Musculoskelet Disord* 2018;19:1–10.

63 Edwardson CL, Henson J, Biddle SJH, *et al*. activPAL and ActiGraph assessed sedentary behavior and cardiometabolic health markers. *Med Sci Sports Exerc* 2020;52:391–7.
64 Felez-Nobrega M, Hillman CH, Dowd KP, *et al*. ActivPAL™ determined sedentary behaviour, physical activity and academic achievement in college students. *J Sports Sci* 2018;36:2311–6.
65 Gupta N, Dumuid D, Korshøj M, *et al*. Is daily composition of movement behaviors related to blood pressure in working adults? *Med Sci Sports Exerc* 2018;50:2150–5.
66 Gupta N, Korshøj M, Dumuid D, *et al*. Daily domain-specific time-use composition of physical behaviors and blood pressure. *Int J Behav Nutr Phys Act* 2019;16:1–11.
67 Hallman DM, Krause N, Jensen MT, *et al*. Objectively measured sitting and standing in workers: cross-sectional relationship with autonomic cardiac modulation. *Int J Environ Res Public Health* 2019;16:650.
68 Hamer M, Stamatakis E. The descriptive epidemiology of standing activity during free-living in 5412 middle-aged adults: the 1970 British cohort study. *J Epidemiol Community Health* 2020;74:757–60.
69 Hamer M, Stamatakis E, Chastin S, *et al*. Feasibility of measuring sedentary time using data from a Thigh-Worn Accelerometer. *Am J Epidemiol* 2020;189:963–71.
70 Hulsegge G, Loef B, van Kerkhof LW, *et al*. Shift work, sleep disturbances and social jetlag in healthcare workers. *J Sleep Res* 2019;28:e12802.
71 Gale CR, Marioni RE, Čukić I, *et al*. The epigenetic clock and objectively measured sedentary and walking behavior in older adults: the Lothian birth cohort 1936. *Clin Epigenetics* 2018;10:1–6.
72 Johansson MS, Korshøj M, Schnohr P, *et al*. Time spent cycling, walking, running, standing and sedentary: a cross-sectional analysis of accelerometer-data from 1670 adults in the Copenhagen City heart study. *BMC Public Health* 2019;19:1–13.
73 Johansson MS, Søgaard K, Prescott E, *et al*. Can we walk away from cardiovascular disease risk or do we have to 'huff and puff'? A cross-sectional compositional accelerometer data analysis among adults and older adults in the Copenhagen City Heart Study. *Int J Behav Nutr Phys Act* 2020;17:1–18.
74 Karavirta L, Rantalainen T, Skantz H, *et al*. Individual scaling of Accelerometry to preferred walking speed in the assessment of physical activity in older adults. *J Gerontol A Biol Sci Med Sci* 2020;75:e111–8.
75 Ketels M, De Bacquer D, Geens T, *et al*. Assessing physiological response mechanisms and the role of psychosocial job resources in the physical activity health paradox: study protocol for the Flemish Employees' Physical Activity (FEPA) study. *BMC Public Health* 2019;19:1–10.
76 Larsson K, Ekblom Örjan, Kallings LV, *et al*. Job demand-control-support model as related to objectively measured physical activity and sedentary time in working women and men. *Int J Environ Res Public Health* 2019;16:3370.
77 Locks F, Gupta N, Hallman D, *et al*. Association between objectively measured static standing and low back pain - a cross-sectional study among blue-collar workers. *Ergonomics* 2018;61:1196–207.
78 Locks F, Gupta N, Madeleine P, *et al*. Are accelerometer measures of temporal patterns of static standing associated with lower extremity pain among blue-collar workers? *Gait Posture* 2019;67:166–71.
79 Merkus SL, Lunde L-K, Koch M, *et al*. Physical capacity, occupational physical demands, and relative physical strain of older employees in construction and healthcare. *Int Arch Occup Environ Health* 2019;92:295–307.
80 Oakman J, Clays E, Jørgensen MB, *et al*. Are occupational physical activities tailored to the age of cleaners and manufacturing workers? *Int Arch Occup Environ Health* 2019;92:185–93.
81 Gupta N, Christiansen CS, Hallman DM, *et al*. Is objectively measured sitting time associated with low back pain? A cross-sectional investigation in the NOMAD study. *PLoS One* 2015;10:e0121159–18.
82 Okely JA, Čukić I, Shaw RJ, *et al*. Positive and negative well-being and objectively measured sedentary behaviour in older adults: evidence from three cohorts. *BMC Geriatr* 2019;19:1–10.
83 Palm P, Gupta N, Forsman M, *et al*. Exposure to upper arm elevation during work compared to leisure among 12 different occupations measured with triaxial accelerometers. *Ann Work Expo Health* 2018;62:689–98.
84 Palmberg L, Rantalainen T, Rantakokko M, *et al*. The associations of activity fragmentation with physical and mental fatigability among community-dwelling 75-, 80-, and 85-year-old people. *J Gerontol A Biol Sci Med Sci* 2020;75:e103–10.
85 Portegijs E, Karavirta L, Saajanaho M, *et al*. Assessing physical performance and physical activity in large population-based aging studies: home-based assessments or visits to the research center? *BMC Public Health* 2019;19:1–16.
86 Lund Rasmussen C, Johansson MS, Crowley P, *et al*. Light-Intensity physical activity derived from count or activity types is differently associated with adiposity markers. *Scand J Med Sci Sports* 2020;30:1966–75.
87 Lund Rasmussen C, Palarea-Albaladejo J, Korshøj M, *et al*. Is high aerobic workload at work associated with leisure time physical activity and sedentary behaviour among blue-collar workers? A compositional data analysis based on accelerometer data. *PLoS One* 2019;14:e0217024–16.
88 Sato TO, Hallman DM, Kristiansen J, *et al*. Different autonomic responses to occupational and leisure time physical activities among blue-collar workers. *Int Arch Occup Environ Health* 2018;91:293–304.
89 Skarpsno ES, Mork PJ, Nilsen TIL, *et al*. The joint association of musculoskeletal pain and domains of physical activity with sleep problems: cross-sectional data from the DPhacto study, Denmark. *Int Arch Occup Environ Health* 2019;92:491–9.
90 Sörensen BM, Heide FCT, Houben AJHM, *et al*. Higher levels of daily physical activity are associated with better skin microvascular function in type 2 diabetes—The Maastricht study. *Microcirculation* 2020;27:1–13.
91 Stevens ML, Crowley P, Rasmussen CL, *et al*. Accelerometer-measured physical activity at work and need for recovery: a compositional analysis of cross-sectional data. *Ann Work Expo Health* 2020;64:138–51.
92 Gupta N, Hallman DM, Mathiassen SE, *et al*. Are temporal patterns of sitting associated with obesity among blue-collar workers? A cross sectional study using accelerometers. *BMC Public Health* 2016;16:1–10.
93 van der Velde JHPM, Schaper NC, Stehouwer CDA, *et al*. Which is more important for cardiometabolic health: sedentary time, higher intensity physical activity or cardiorespiratory fitness? the Maastricht study. *Diabetologia* 2018;61:2561–9.
94 Wagnild JM, Hinshaw K, Pollard TM. Associations of sedentary time and self-reported television time during pregnancy with incident gestational diabetes and plasma glucose levels in women at risk of gestational diabetes in the UK. *BMC Public Health* 2019;19:1–8.
95 Gupta N, Heiden M, Mathiassen SE, *et al*. Prediction of objectively measured physical activity and sedentariness among blue-collar workers using survey questionnaires. *Scand J Work Environ Health* 2016;42:237–45.
96 Gupta N, Heiden M, Mathiassen SE, *et al*. Is self-reported time spent sedentary and in physical activity differentially biased by age, gender, body mass index, and low-back pain? *Scand J Work Environ Health* 2018;44:163–70.
97 Hallman DM, Gupta N, Heiden M, *et al*. Is prolonged sitting at work associated with the time course of neck-shoulder pain? A prospective study in Danish blue-collar workers. *BMJ Open* 2016;6:e012689–9.
98 Hallman DM, Gupta N, Mathiassen SE, *et al*. Association between objectively measured sitting time and neck-shoulder pain among blue-collar workers. *Int Arch Occup Environ Health* 2015;88:1031–42.
99 Lagersted-Olsen J, Thomsen BL, Holtermann A, *et al*. Does objectively measured daily duration of forward bending predict development and aggravation of low-back pain? A prospective study. *Scand J Work Environ Health* 2016;42:528–37.
100 Lunde L-K, Koch M, Knardahl S, *et al*. Associations of objectively measured sitting and standing with low-back pain intensity: a 6-month follow-up of construction and healthcare workers. *Scand J Work Environ Health* 2017;43:269–78.
101 Gupta N, Dencker-Larsen S, Lund Rasmussen C, *et al*. The physical activity paradox revisited: a prospective study on compositional accelerometer data and long-term sickness absence. *Int J Behav Nutr Phys Act* 2020;17:1–9.
102 Korshøj M, Jørgensen MB, Hallman DM, *et al*. Prolonged sitting at work is associated with a favorable time course of low-back pain among blue-collar workers: a prospective study in the DPhacto cohort. *Scand J Work Environ Health* 2018;44:530–8.
103 Neupane S, Karstad K, Hallman DM, *et al*. Objectively measured versus self-reported occupational physical activity and multisite musculoskeletal pain: a prospective follow-up study at 20 nursing homes in Denmark. *Int Arch Occup Environ Health* 2020;93:381–9.
104 Karstad K, Jørgensen AFB, Greiner BA, *et al*. Danish observational study of eldercare work and musculoskeletal disorderS (doses):

a prospective study at 20 nursing homes in Denmark. *BMJ Open* 2018;8:e019670–10.
105 Taraldsen K, Chastin SFM, Riphagen II, *et al*. Physical activity monitoring by use of accelerometer-based body-worn sensors in older adults: a systematic literature review of current knowledge and applications. *Maturitas* 2012;71:13–19.
106 Cain KL, Sallis JF, Conway TL, *et al*. Using Accelerometers in youth physical activity studies: a review of methods. *J Phys Act Heal* 2019;10:437–50.
107 Gorman E, Hanson HM, Yang PH, *et al*. Accelerometry analysis of physical activity and sedentary behavior in older adults: a systematic review and data analysis. *Eur Rev Aging Phys Act* 2014;11:35–49.
108 Skender S, Ose J, Chang-Claude J, *et al*. Accelerometry and physical activity questionnaires - a systematic review. *BMC Public Health* 2016;16:1–10.
109 European Commission. Communication from the commission to the European parliament and the council. Stronger protection, new opportunities - Commission guidance on the direct application of the General Data Protection Regulation as of 25 May 2018, 2018. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:43:FIN
110 Sherar LB, Griew P, Esliger DW, *et al*. International children's accelerometry database (ICAD): design and methods. *BMC Public Health* 2011;11:485.
111 Doiron D, Burton P, Marcon Y, *et al*. Data harmonization and federated analysis of population-based studies: the BioSHaRE project. *Emerg Themes Epidemiol* 2013;10:22–4.

Thigh-worn Accelerometry for measuring Movement and Posture across the 24 hour cycle: A Scoping Review and Expert Statement

Appendix 1 - Search Strategies

Table S1-1: MEDLINE Search Strategy

Database	MEDLINE
Platform	OvidSP 1946 - present
Row #	**Terms**
1	activpal.ti,ab,mp.
2	actigraph.ti,ab,mp.
3	axivity.ti,ab,mp.
4	1 OR 2 OR 3
5	accelerom*.ti,ab,mp.
6	inclinomet*.ti,ab,mp.
7	accelatory.ti,ab,mp.
8	5 OR 6 OR 7
9	observational.ab,mp.
10	Thigh.ab,mp.
11	cohort.ab,mp.
12	cross-sectional.ab,mp.
13	case-control.ab,mp.
14	case series.ab,mp.
15	9 OR 10 OR 11 OR 12 OR 13 OR 14
16	8 AND 15
17	4 OR 16
18	Limit 17 to humans
Filters	Humans: yes
Restrictions	Date restrictions: none Language restrictions: none
#: row number; ***:** truncate; **ab:** abstract; **mp:** keywords; **ti:** title.	

Stevens ML, *et al. BMJ Open Sp Ex Med* 2020; 6:e000874. doi: 10.1136/bmjsem-2020-000874

Table S1-2: Embase Search Strategy

Database	Embase
Platform	OvidSP 1947 - present
Row #	**Terms**
1	activpal (ti,ab,mp)
2	actigraph (ti,ab,mp)
3	axivity (ti,ab,mp)
4	1 OR 2 OR 3
5	accelerometer (ti,ab,mp)
6	inclinomet* (ti,ab,mp)
7	accelatory (ti,ab,mp)
8	5 OR 6 OR 7
9	observational (ab,mp)
10	thigh (ab,mp)
11	cohort (ab,mp)
12	cross-sectional (ab,mp)
13	case-control (ab,mp)
14	case series (ab,mp)
15	9 OR 10 OR 11 OR 12 OR 13 OR 14
16	4 AND 15
17	8 AND 15
18	16 OR 17
19	Limit 18 to humans
Filters	Humans: yes
Restrictions	Date restrictions: none Language restrictions: none
#: row number; ***:** truncate; **ab:** abstract; **mp:** keywords; **ti:** title.	

Stevens ML, *et al. BMJ Open Sp Ex Med* 2020; 6:e000874. doi: 10.1136/bmjsem-2020-000874

Thigh-worn Accelerometry for measuring Movement and Posture across the 24 hour cycle: A Scoping Review and Expert Statement

Appendix 2. Study Details

Table S2-1: Details of studies that use thigh-worn accelerometry to measure 24-hour Physical Behaviour

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
[26]							
1. Cross sectional 2. 2011-2012 3. Purposive sampling 4. Multi centre 5. N = 678 6. Ages: 57.8 7. Gender: F, M 8. Community 9. Health outcomes 10. The Australian Diabetes, Obesity, and Lifestyle study (AusDiab)	1. ActivPAL3 2. Right anterior thigh Water proofed, hypoallergenic patch 3. - 4. 7 consecutive days, 24/7 no removal 5. Minimum 4 days wear 6. ActivPAL Software 6.4.1; custom SAS v9.3 program 7. -	• Total sitting time • Prolonged sitting time • Sit-stand transitions • Usual bout duration	• Insulin • Cholesterol • Fasting plasma glucose • 2-hour post-load glucose • Triglycerides • Diabetes • BMI • Waist circumference • Lower back pain • High-density lipoprotein • Low-density lipoprotein • HbA1c • Systolic and diastolic blood pressure	• Age • Gender • Menopausal status • Contraceptive pill use • Blood pressure tablets • Cholesterol tablets • Diabetes medication • Ethnicity • Employment status • Annual household income • Fiber intake • Fat • Saturated fat • Alcohol intake • Sodium intake • Potassium intake • Fruit and vegetable serve		• Record sleep and any non-wear periods	
[27]							
1. Cross sectional 2. May 2012 and December 2013 3. Purposive sampling 4. -	1. MOX activity monitor 2. Thigh-mounted on anterior thigh 10 cm above the knee	• Total sedentary time • Prolonged sedentary time		• Sex • Age • Education level • Smoking status Presence of stoma	• Stage I to III colorectal cancer survivors diagnosed and treated between 2002 and 2010	• Short Questionnaire to Assess Health-enhancing physical activity	

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
5. N: 145 6. Age: 70 7. Gender: F, M 8. Community 9. Descriptive 10. ColoRectal cancer (EnCoRe) study	waterproofed in a finger cot 3. - 4. 24 h/d during 7 consecutive day 5. ≥4 valid days 6. Customized Matlab program (Version R2012a 7. -	• Total physical activity time • Usual sedentary bout duration		• Diet • Cancer stage age at diagnosis • Treatment		• Record sleep and any non-wear periods	
[28]							
1. Cross sectional Seniors Understanding Sedentary Patterns (USP) study 2. - 3. Purposive sampling 4. Multi-centre 5. N: 700 6. Age: 65, 79, 83 7. Gender: F, M 8. Community 9. Correlates 11. The Lothian Birth Cohort, 1936 (LBC1936), and two cohorts of the West of Scotland Twenty-07 study (Twenty-07)	1. activPAL3c 2. the front of the thigh of their dominant leg using a waterproofing dressing 3. - 4. 7-days continuous recording 5. - 6. activPAL software 7. - 8.	• Average percentage of waking time spent sedentary • The number of sit to stand transitions		• Age at time of cognitive testing • Maximum educational attainment • Employment • Long-standing illness		• Record sleep periods	
[29]							
1. Cross sectional 2. September 2010 - October 2013 3. Convenience sampling 4. Southern part of the Netherlands 5. N:2,449 6. Age: 60	1. ActivPAL 2. The front of the right thigh Waterproofed using a nitrile sleeve. 3. - 4. Protocol: eight consecutive day	• Total time spent sedentary (sitting/lying), standing and stepping • Stepping intensity • Sedentary breaks	• Waist circumference • Triglycerides • High-density lipoprotein (HDL) cholesterol • Diastolic and systolic blood • Pressure	• Age • Sex • Educational level • BMI • Smoking • Alcohol use • T2DM • CVD	• Metabolic syndrome • Type 2 diabetes • History of CVD	• Mobility limitation was obtained from the EuroQol-5D questionnaire	

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
7. Gender: F, M 8. Community 9. Health outcomes 12. The Maastricht Study	5. At least 1 valid day (≥10 h of waking data) 6. MATLAB® R2013b 9. -		• Fasting plasma glucose Medication use				
[30]							
1. Cross sectional 2. - 3. Purposive sampling 4. - 5. N: 271 6. Age: 79.1 7. Gender: F, M 8. Community 9. Correlates 13. Lothian Birth Cohort 1936	1. activPAL3c 2. the anterior thigh of the dominant leg with a waterproof dressing 3. - 4. Continuously for 7 days 5. 7 days 6. – 10. -	• The percentage of time spent sedentary • Number of sit-to-stand transitions • Number of steps		• Sex • Depressive symptoms • Chronic physical disease • BMI • Difficulties with activities of daily living • Education	•	•	
[31]							
1. Cross sectional 2. - 3. Purposive sampling 4. - 5. N: 248 6. Age: 79 7. Gender: F, M 8. Community 9. Health outcomes 14. Lothian Birth Cohort 1936	1. activPAL3c 2. the anterior thigh of the dominant leg with a waterproof dressing **3.** - 4. Continuously for 7seven days 5. 7 days 6. activPAL software (v7.2.32) 11. -	• The percentage of time spent sedentary • Number of sit-to-stand transitions • Number of steps	DNA methylation: epigenetic age acceleration	• Age, • Sex • Depressive symptoms • Chronic physical disease • BMI	•	• Record sleep periods	
[32]							
1. Cross sectional 2. - 3. Convenience sampling 4. Multi-centre 5. N:201 6. Age: 44.7 7. Gender: F, M 8. Occupational	**1.** Actigraph GT3X+ **2.** the medial front of the right thigh, midway between the hip and knee joints processus spinosus at the level of T1–T2 Water resistant **3.** **-**	• Total sitting time • Occupational sitting time • Leisure sitting time •	Low Back Pain intensity	• Age • Job seniority • BMI • Influence at work • Time spent carrying/lifting at work • Gender • Smoking	• A short questionnaire containing a single • item regarding Low Back Pain intensity •	• A diary for noting working hours, leisure time, sleep, non-wear time, and time of reference measurement •	Available upon request

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
9. Health outcomes 15. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark	4. 4 continuous days (4 x 24 hours) 5. A at least two full working days 6. Actilife Software version 5.5; a specially developed MATLAB based program (Acti4) 12. -						
[33]							
1. Cross sectional 2. August 2011 and April 2012 3. Convenience sampling 4. Multi-centre 5. N:205 6. Age: 44.8 7. Gender: F, M 8. Occupational 9. Health outcomes New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark	1. Actigraph GT3X+ 2. thigh and trunk Water resistant 3. - 4. 1-4 working days 5. At least one valid working day 6. Custom-made MATLAB program Acti4 software -	• Sitting time • Moderate vigorous physical activity • Bouts • Exposure Variation Analysis of sedentary time (EVA)	• Weight and fat percentage • Waist circumference BMI	• Age • Gender • Influence at work • Smoking behaviour • Poor dietary habits Alcohol intake		A diary for noting start and end of work, bedtime in the evening, and wake-up in the morning	Available upon request
[34]							
1. Cross sectional 2. - 3. Convenience sampling 4. Multi-centre 5. N:214 6. Age: 44.5 7. Gender: F, M 8. Occupational 9. Descriptive 16. New method for Objective Measurements of physical Activity in Daily living	1. Actigraph GT3X+ 2. - 3. - 4. 1-4 working days 5. At least one valid working day 6. Custom-made Acti4 software 7. - 13.	• Sedentary time (periods of sitting and lying) • Physical activity (collapsed periods with any type of PA) •		• Age • Gender • BMI • Job type Occupational sedentary time • Occupational physical activity	•	• A diary for noting working hours	Available upon request

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
(NOMAD) Denmark							
[35]							
1. Cross sectional 2. October 2011 to April 2012 3. Convenience sampling 4. Multi-centre 5. N:147 6. Age: 44.4 7. Gender: F, M 8. Occupational 9. Health outcomes 17. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark	1. Actigraph GT3X+ 2. the right thigh; water resistant 3. - 4. 4 consecutive days 5. At least one valid day 6. MATLAB software Acti4 7. - 14.	• Light physical activity: the average time spent standing still, moving and slow walking • The average time spent fast walking, running, stair climbing and cycling •	Low back pain	• Age • BMI • LBP intensity	•	• A diary for noting working hours, non-work time, sleep periods, and time • of reference measurement • A retrospective questionnaire • regarding the average time spent lying, sitting, standing, • slow and fast walking, running, and cycling per day during the measurement period	Available upon request
[36]							
1. Cross sectional 2. Spring 2012- Spring 2014 3. Convenience sampling 4. Multi-centre 5. N:692 6. Age: 45.1 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	1. Actigraph GT3X+ 2. Right thigh 3. - 4. 4 consecutive days including at least 2 working days 5. At least one valid day 6. Custom-made MATLAB program (Acti4 software) 7. -	• Total sedentary time (total time spent sitting or lying) • Total time spent standing still, moving • Total time spent stair-climbing, running, cycling • MVPA time • Total walk time • Exposure Variation Analysis of sedentary time	• Weight • Body fat percentage • Waist circumference	• Sex • Age • Smoking behaviour • Alcohol intake • Poor dietary habits • Influence at work		• A diary for noting working • hours, non-work time, time in bed, non-wear • time, and time of reference measurement	• Danish Data Protection Agency • accepted the handling and storage of data
[37]							
1. Prospective	1. Actigraph GT3X+	• The total time spent walking, climbing	• Neck shoulder pain	• Age • Sex		• A diary for noting working hours,	• Danish Data Protection Agency

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
2. Spring 2012- Spring 2013 3. Convenience sampling 4. Multi-centre 5. N:625 6. Age: 44.8 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	2. Thigh, dominant upper arm, hip, and trunk 3. - 4. Four to five days, including at least two working days 5. At least 1 day 6. Actilife software version 5.5 a custom-made MATLAB-based software, Acti4 7. -	stairs, running and cycling		• Seniority in the • current job • Lifting and carrying time at work • Influence and social support at work • The number of days • with NSP during the previous 12 months • BMI		leisure time, sleep periods, and time of reference measurement	• accepted the handling and storage of data
[38]							
1. Cross sectional 2. April 2012- May 2014 3. Convenience sampling 4. Multi-centre 5. N:514 6. Age: 45.3 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	1. Actigraph GT3X+ 2. Thigh, dominant upper arm, hip, and trunk Water resistant 3. The Actiheart monitor – water resistant 4. Four to five days, including at least two working days 5. At least 1 day 6. Actilife software version 5.5 7. -	• Total time spent walking, climbing stairs, running, cycling	• Resting systolic and diastolic blood pressure • Heart rate variability	• Age • Gender • Smoking • Social support at work • Seniority in the current job • Current use of cardiovascular drugs • BMI • Resting systolic and diastolic blood pressure		• Written diary to note working hours, leisure • time and sleep, as well as the time of the reference • measurements	• Danish Data Protection Agency • accepted the handling and storage of data
[39]							
1. Cross sectional 2. October 2011 to April 2012 3. Convenience sampling 4. Multi-centre 5. N:191	1. Actigraph GT3X+ 2. Thigh and trunk water-resistant 3. - 4. Four consecutive days for at least two working days	• Total time spent sitting, standing, walking • Exposure Variation Analysis of physical activity		• Age • Gender		• A diary for noting working hours, non-wear time, and sleep periods	• Available upon request

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
6. Age: 45 7. Gender: F, M 8. Occupational 9. Descriptive 10. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark	5. Days only included if they contained objective measurements for at least 4 h of work 6. Actilife software version 5.5; a custom-made MATLAB-based software, Acti4 7. -						
[40]							
1. Cross sectional 2. Spring 2012- Spring 2013 3. Convenience sampling 4. Multi-centre 5. N:659 6. Age: 45 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	1. Actigraph GT3X+ 2. Thigh, dominant upper arm, hip, and trunk 3. - 4. Four consecutive days, including at least two working days 5. At least 1 day 6. Actilife software version 5.5; a custom-made MATLAB-based software, Acti4 7. -	• Sitting periods • EVA • The total time spent walking, climbing stairs, running and cycling	• Neck shoulder pain	• Age • Smoking • BMI • Seniority in the current • Job • Lifting and carrying at work • Influence at work • Social support	• Self-reported neck– • shoulder pain	• A diary for noting working hours, leisure time, sleep periods, and time of reference measurement	• Danish Data Protection Agency • accepted the handling and storage of data
[41]							
1. Cross sectional 2. October 2011 to April 2012 3. Convenience sampling 4. Multi-centre 5. N:138 6. Age: 45.5 7. Gender: F, M 8. Occupational 9. Health outcomes 10. New method for Objective	1. Actigraph GT3X+ 2. Thigh and trunk water-resistant 3. Actiheart monitor 4. Four consecutive days 5. At least 1 day 6. Actilife software version 5.5; a custom-made MATLAB-based software, Acti4 7. -	• Sitting time • Total time spent walking fast-pace, running, cycling, and walking stairs	• Heart Rate Variability during night-time sleep	• Age • Gender • Smoking • BMI • Seniority in the current job • Influence at work • Lifting and carrying time at work • Working night shifts • Regular use of prescribed heart	• Self-reported data on medical diagnoses • The life-time occurrence of diagnosed • diabetes, cardiovascular disease, hypertension, and depression	• A diary for noting working hours, non-wear time, sleep periods	• Available upon request

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
Measurements of physical Activity in Daily living (NOMAD) Denmark				and/or lung medicine			
[42]							
1. Cross sectional 2. 2011 to 2013 3. Convenience sampling 4. Multi-centre 5. N:812 6. Age: 45 7. Gender: F, M 8. Occupational 9. Descriptive 10. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark and the Danish Physical ACTivity cohort with Objective measurements (DPhacto)	1. Actigraph GT3X+ 2. Halfway between crista iliac and patella at the medial front of the right thigh 3. - 4. Four successive days 5. - 6. Actilife software version 5.5 a custom-made MATLAB-based software, Acti4 7. -	• Sedentary behaviour (lying/sitting) • Light (stand/slow walking) • Moderate-to-vigorous (fast walking/running/cycling).		• Occupational sector • Job seniority • Smoking • Frequency of fruit and vegetable intake • BMI		• A diary for noting working hours, non-wear time, sleep periods, and time of reference measurement	
[43]							
1. Cross sectional 2. - 3. Convenience sampling 4. Multi centre 5. N:317 6. Age: 45 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Take a Stand!	1. ActiGraph GT3x+ 2. Right thigh Waterproofed 3. - 4. 5 continuous working days 5. Only working hours 6. MatLab software (Acti4) 7. -	• Number of sit-to-stand transitions • Total sitting time • Number of prolonged sitting • Total time accumulated in prolonged sitting periods	• Waist circumference • Weight • BMI	• Age • Sex • Smoking • Self-rated health		• A log for noting sleep periods and any irregularities such as problems with the ActiGraph, days off work or working at home	
[44]							

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
1. Cross sectional 2. December 2012-March 2013 3. Convenience sampling 4. Multi-centre 5. N:704 6. Age: 45 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	1. ActiGraph GT3x+ 2. The skin at the front of the right thigh (medial between the iliac crest and the upper border of the patella) and at the trunk (at processus spinosus at the level of T1-T2) 3. - 4. For 4–6 days, 24 hours a day 5. Working hours were included if they were ≥4 hours/day (continuous periods) or a duration of ≥75% of average wear time during work across days 6. Actilife software version 5.5; the customized software Acti4 7. -	• Sitting periods • Sitting during the whole day • Sitting during work • Plus EVA variables	• Low back pain	• Age • Sex • Smoking • BMI • Level of occupational lifting • Occupational • Sector • Previously diagnosed with a herniated • Disc • Leisure-time physical activity • Intensity of physical activity during working hours • Social support Influence at work • Age • Sex • BMI • Occupational • Sector • Level of physical activity during leisure • time • Intensity of physical activity during working hours.		• A diary for noting working hours, time off work, non-wear time and sleep periods	• Danish Data Protection Agency • accepted the handling and storage of data
[45]							
1. Cross sectional 2. - 3. Convenience sampling 4. Multi-centre 5. N:479 6. Age: (median: 47 for no LBP, 46 for LBP)	1. ActiGraph GT3x+ 2. medial front of the right thigh, halfway between knee and hip 3. - 4. 7 consecutive days 5. Only participants with ≥40 hours of	• Time spent sedentary, standing, walking, running, stairclimbing, and cycling during leisure time and at work		• Age • Gender • Marital status • Educational level Smoking • Chronotype • Occupation		• A diary for noting working hours, non-wear time, and sleep periods	

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
7. Gender: F, M 8. Occupational 9. Descriptive 10. Klokwerk+	wear-time including ≥4 working hours and ≥10 hours of leisure time were included 6. Actilife software version 5.5; a custom-made MatLab-based software Acti4 7. -						
[46]							
1. Cross sectional 2. November 2010 - September 2013 3. Convenience sampling 4. Southern part of the Netherlands 5. N:2,258 6. Age: 60.1 7. Gender: F, M 8. Community 9. Health outcomes 10. The Maastricht Study	1. ActivPAL3 2. The front of the right thigh Waterproofed 3. - 4. 8 consecutive days 5. At least 1 valid day (≥10 h of waking data) 6. - 7. -	• Stepping time • Waking time • The total amount of sedentary time • Number of sedentary breaks • Number of prolonged sedentary bouts • Average sedentary bout duration	• Kidney function • Waist circumference Total cholesterol, HDL-cholesterol • Triglycerides • Blood pressure, • 24h average ambulatory blood pressure • Glucose metabolism status	• Sex • Age • Smoking behavior Alcohol consumption Daily energy intake, Mobility limitation • Noncardiovascular comorbidity • History of CVD • Level of education • Use of • antihypertensive and lipid-modifying medication			
[47]							
1. Cross sectional 2. - 3. Purposive sampling 4. Multi centre 5. N:458 patient/loved one dyads 6. Age: patient -67, loved ones-66 7. Gender: F, M 8. Community 9. Health outcomes	1. MOX Activity Monitor 2. The right thigh 3. - 4. At least 7 days 5. At least 5 days of assessment (three weekdays, Saturday, Sunday), each with at least 10 h of measurement. 6. –	• Time in sedentary behavior • Time in light activities • Time in moderate to vigorous physical activity	• Clinical data • Body composition • Postbronchodilator lung function • Functional mobility • Generic and • COPD-specific health status	• Age Sex • Relationship between patient and • loved one • Working situation • Smoking status • Time living together • Receiving informal care from • relatives • Rollator use	• Global Initiative for • Chronic Obstructive Lung Disease (GOLD) COPD diagnosis with a • moderate to very severe degree of airflow limitation (GOLD grades 2-4)	• Exercise motivation (Behavioral Regulation and Exercise Questionnaire 2 (BREQ-2)	

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
10. Home Sweet Home study	7. -			• Cane use • Long-term oxygen therapy • Exacerbations past 12 mo • Medications in use • BMI			
[48]							
1. Cross sectional 2. October 2011 – April 2012 3. Convenience sampling 4. Multi-centre 5. N:187 6. Age: 45 7. Gender: F, M 8. Occupational 9. Health outcomes 10. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark	1. Actigraph GT3X+ 2. Thigh and hip Water resistant 3. - 4. 4 consecutive days for at least two working days 5. Days with at least 4 h of work 6. Actilife software version 5.5; a custom-made MATLAB-based software, Acti4 7. -	• Duration of standing still and walking at work • Forward bending	• Low back pain intensity	• Gender • Age, • Seniority • BMI • Smoking • Time on feet during leisure hours • Forward bending • Carrying/lifting • Influence at work	• Self-reported • LBP intensity	• A diary for noting working hours, leisure time, non-wear time, sleep periods and time of reference measurement	• Available upon request
[49]							
1. Cross sectional 2. November 2010 - September 2013 3. Convenience sampling 4. Southern part of the Netherlands 5. N:2,045 6. Age: 60.2 7. Gender: F, M 8. Community 9. Descriptive 10. The Maastricht Study	1. ActivPAL3 2. The front of the right thigh Waterproofed 3. - 4. 8 consecutive days 5. At least 1 valid weekday and 1 valid weekend day (≥10 h of waking data) 6. activPAL software MATLAB R2013b 7. -	• The total sedentary time • The total amount of stepping • The total standing time		• Employment status • Age • Sex • Diabetes Status • Mobility limitations • Level of education • Smoking • Alcohol consumption • BMI • Frequency of shift work			

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
[50]							
1. Cross sectional 2. 2011 to 2013 3. Convenience sampling 4. Multi-centre 5. N:895 6. Age: 46.6 men, 46.5 women 7. Gender: F, M 8. Occupational 9. Health outcomes 10. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark and the Danish Physical ACTivity cohort with Objective measurements (DPhacto)	1. Actigraph GT3X+ 2. upper back and right thigh 3. - 4. Four consecutive days 5. At least one day of valid accelerometer measurements 6. Actilife software version 5.5 a custom-made MATLAB-based software, Acti4 7. -	• Time spent walking, standing, sitting • High intensity activities (HiPA: stair climbing, running and cycling). • Sedentary behavior (sitting and lying), • Time in bed	• Pain in lower back, knees and feet/ankles	• Sex • Age • BMI • Shift work • Information about pain in lower back, knees and feet/ankles • Information on whether the worker was skilled		• A diary for noting working hours, non-wear time and sleep periods	
[51]							
1. Cross sectional 2. March 2013 to March 2014 3. Convenience sampling 4. Multi-centre 5. N:433 6. Age: 39.6 7. Gender: F, M 8. Occupational 9. Correlates 10. Active Buildings study	1. ActivPAL3 2. Middle front of the right thigh waterproof 3. - 4. Five consecutive days (encompassing ≥3 workdays) 5. Days when the ActivPALTM3 was not worn continuously were Removed 6. ActivPALTM3 software Microsoft Excel 2010 7. -	• Sitting time • Standing time • Sit-to-stand transitions • Step counts		• Age • Sex • Smoking • Occupation and organization • BMI • Participants' environmental perceptions		• A diary for noting working hours and non-wear time	

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
[52]							
1. Cross sectional 2. November 2014-April 2016 3. Purposive sampling 4. Multi-centre 5. N: 700 6. Age: 64, 79, 83 7. Gender: F, M 8. Community 9. Correlates 10. The Lothian Birth Cohort, 1936 (LBC1936), and the West of Scotland Twenty-07 study (Twenty-07)	1. activPAL3c 2. the front of the thigh of their dominant leg using a waterproofing dressing 3. Other sensors 4. 7-days continuous recording 5. - 6. - 7. -	• Percentage of waking time • Sedentary behaviour		• Objective neighbourhood • Subjective neighbourhood • Social support • Social participation, Home environment measures		• Record sleep periods	
[53]							
1. Cross sectional 2. November 2014-April 2016 3. Purposive sampling 4. Multi-centre 5. N: 700 6. Age: 64, 79, 83 7. Gender: F, M 8. Community 9. Correlates 10. The Lothian Birth Cohort, 1936 (LBC1936), and the West of Scotland Twenty-07 study (Twenty-07)	1. activPAL3c 2. the front of the thigh of their dominant leg using a waterproofing dressing 3. Other sensors 4. 7-days continuous recording 5. - 6. - 7. -	• Sedentary behaviour • Time spent walking		• Education • Occupation • Income • Car ownership Subjective social position • Parental social • class • Lifetime social class		• Record sleep periods	
[54]							
1. Cross sectional 2. Spring 2012- Spring 2014 3. Convenience sampling 4. Multi-centre	1. ActiGraph GT3x+ 2. on the thigh and the upper back; waterproof 3. upper back	• Total time spent walking, running, cycling and walking stairs	• Insomnia symptoms	• Age • BMI • Smoking • Alcohol consumption • Medication		• A diary for noting working days, working hours, days off work and non-wear time	• Danish Data Protection Agency • accepted the handling and storage of data

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
5. N:650 6. Age: 49 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	4. Protocol n Days / hour/day: six consecutive days, including at least two working and two leisure days 5. Valid n of days for inclusion: non-wear periods excluded 6. Actilife software version 5.5; Acti4 7. -			• for depression • participant's workplace • Intensity and extent of musculoskeletal • Pain • Shift work • Number of working hours per week			
[55]							
1. Cross sectional 2. 2013 to 2014 3. Convenience sampling 4. Multi-centre 5. N:164 6. Age: 39 7. Gender: F, M 8. Occupational 9. Descriptive 10. Active Buildings study	1. ActivPAL3 2. middle front of the right thigh; waterproof 3. - 4. 24 hours a day for five consecutive days (encompassing ≥3 workdays) 5. Days when three or more weekdays and at least one weekend day 6. ActivPALTM3 software Microsoft Excel 2010 7. -	• Time spent sitting, standing, stepping • Step counts • Frequency of sit/stand transitions		• Age • Sex • Ethnicity • Job role		• A diary for noting sleep periods and any irregularities such as problems with the ActiGraph, days off work or working at home	
[56]							
1. Cross sectional 2. March 2013 to March 2014 3. Convenience sampling 4. Multi-centre 5. N:116 6. Age: 40 7. Gender: F, M 8. Occupational 9. Descriptive	1. ActivPAL3 2. middle front of the right thigh; waterproof 3. - 4. 24 hours a day for five consecutive days (encompassing ≥3 workdays) 5. Minimum of 3 workdays	• Occupational step counts, stepping time, sitting time, standing time and sit-to-stand transitions		• Age • Sex • Ethnicity • Job role • Habit strength • Organisation • BMI • Scio-cultural workplace environment		• The Movement at Work survey • A diary for noting • working days, time of arrival and departure from the office and non-wear time	

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
10. Active Buildings study	6. - 7. -						
[57]							
1. Cross sectional 2. November 2010 - September 2013 3. Convenience sampling 4. Southern part of the Netherlands 5. N:2,497 6. Age: 60 7. Gender: F, M 8. Community 9. Health outcomes 10. The Maastricht Study	1. ActivPAL3 2. The front of the right thigh; waterproofed 3. Other sensors 4. 24 h/day for 8 consecutive days 5. At least 1 valid day (>14 h of waking data). 6. activPAL software MATLAB R2013b 7. -	• Sedentary time • Number of sedentary breaks • Prolonged sedentary bouts • Average duration of the sedentary bouts	• Oral glucose tolerance test • Metabolic syndrome • Waist circumference, Triacylglycerol levels • HDL-cholesterol levels • Fasting glucose levels • Blood pressure • Medication use	• Sex • Age • Level of education • Smoking status • Alcohol consumption Mobility limitation Health status • Diabetes duration • Medication use • BMI • HbA1c • Higher intensity • physical activity		• Record sleep periods	
[58]							
1. Cross sectional 2. November 2010 - September 2013 3. Convenience sampling 4. Southern part of the Netherlands 5. N:2,213 6. Age: 60 7. Gender: F, M 8. Community 9. Health outcomes 10. The Maastricht Study	1. ActivPAL3 2. The front of the right thigh Waterproofed 3. - 4. 8 consecutive days 5. At least 1 valid day (≥10 h of waking data) 6. - 7. -	• Sedentary time (sitting or lying) • The total amount of standing time • The total amount of stepping time	• Waist circumference • BMI • Blood pressure • HDL cholesterol • Total-to-HDL cholesterol ratio • Triacylglycerol • Fasting glucose • 2 h postload glucose, • HbA1c • Fasting insulin • Metabolic syndrome • Type 2 diabetes	• Sex • Age • Level of education Smoking • status • Alcohol consumption Energy intake Mobility limitation • Prevalent cardiovascular disease • Use of lipid-modifying, antihypertensive • Glucose-lowering medication • Depression • Glucose metabolism • status			
[59]							

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
1. Cross sectional 2. November 2010 - September 2013 3. Convenience sampling 4. Southern part of the Netherlands 5. N:2,024 6. Age: 59.7 7. Gender: F, M 8. Community 9. Health outcomes 10. The Maastricht Study	1. ActivPAL3 2. The front of the right thigh; waterproofed 3. - 4. 8 consecutive days 5. At least 1 valid day (≥10 h of waking data) 6. activPAL software customized MATLAB R2013b 7. -	• Sedentary time (sitting or lying) • The number of sedentary breaks • Prolonged sedentary bouts • Average bout duration • The total amount of standing • The total amount of stepping • Stepping time	• Submaximal cycle ergometer test: CRF	• BMI • Age • Education level Alcohol use • Smoking status • CVD • Energy intake • Mobility limitations • Beta-blocker use T2DM			
[60]							
1. Cross sectional 2. May and August 2014 3. Convenience sampling 4. One centre 5. N:159 6. Age: 50 7. Gender: M 8. Occupational 9. Health outcomes 10. -	1. ActivPAL3 2. The front of the right thigh; waterproofed 3. - 4. 24 h/day over 7 days 5. At least four full days 6. activPAL software; custom Microsoft Excel macro 7. -	• Sitting, standing and stepping time • Average number of transitions from sitting to standing • Number of steps • Average cadence of steps	• Blood pressure • Heart rate • Waist circumference • Hip circumference • Body composition • Fasted capillary blood glucose • Triglycerides • High density lipoprotein cholesterol, • Low-density lipoprotein • cholesterol • Total cholesterol	• Age • Ethnicity • Average weekly working hours • Medical problems Medication • Intake of fruit and vegetables, • Alcohol intake • Smoking status • Anxiety and depression • BMI		• A diary for noting sleep periods and non-wear time	
[61]							
1. Cross sectional 2. December 2011 - March 2013 3. Convenience sampling 4. Multi-centre 5. N:457 6. Age: 46	1. ActiGraph GT3x+ 2. processus spinosus at the level of T1-T2 and at the halfway mark on the vertical line between spina illiaca anterior	• The duration of forward bending	• Trunk and low back • pain intensity	• Age • Gender • Smoking habits • BMI • Social • Seniority • Lift burden at work		• A diary for noting working hours, leisure hours, sleep, non-wear time and specific time for the reference • measurements	• The Danish Data Protection Agency has • accepted the handling and storage of data

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	superior and the patella 3. - 4. For several consecutive days during work 5. ≥4 hours of recordings of working time or ≥75% of average self-reported working time, and ≥4 hours measured during leisure time or ≥75% of average self-reported leisure time per day if the worker had ≥2 days of recordings. 6. MATLAB based Acti4 7. -			• Forward bending of the trunk during work • Social support at work			
[62]							
1. Cross sectional 2. December 2011 - March 2013 3. Convenience sampling 4. Multi-centre 5. N:657 6. Age: 45 7. Gender: F, M 8. Occupational 9. Descriptive 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	1. ActiGraph GT3x+ 2. At processus spinosus at the level of T1-T2 and at the halfway mark on the vertical line between spina illiaca anterior superior and the patella 3. - 4. - 5. ≥4 hours of recordings of working time or ≥75% of average self-reported working time, and ≥4 hours measured during leisure time	• The duration of forward bending of the trunk • EVA		• Age • Gender • BMI • Smoking habits • Low back pain intensity		• A diary for noting information • about specific time episodes during the measurement • period	• Danish Data Protection Agency • accepted the handling and storage of data

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
	or ≥75% of average selfreported leisure time per day if the worker had ≥2 days of recordings. 6. Acti4 7. -						
[63]							
1. Cross sectional 2. October 2011 to April 2012 3. Convenience sampling 4. Multi-centre 5. N:198 6. Age: 44.7 7. Gender: F, M 8. Occupational 9. Health outcomes 10. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark	1. Actigraph GT3X+ 2. At processus spinosus at the level of T1–T2 and at the halfway mark on the vertical line between spina illiaca anterior superior and the patella 3. - 4. - 5. ≥4 working hours and ≥10 of total recordings per day 6. Actilife software version 5.5; a custom-made MATLAB-based software (Acti4) 7. -	• The duration of forward bending of the trunk	• LBP intensity	• Age • Gender • Smoking habits • BMI • Work-related psychosocial risk factors • the duration categories of forward • bending of the trunk during work		• A diary for noting working hours, leisure hours, sleep, non-wear time and specific time for the reference • measurements	• Available upon request
11.	8.	•	•	•		•	•
12.	9.	•	•	•		•	•
13.	10.	•	•	•		•	•
14.	11.	•	•	•		•	•
15.	12.	•	•	•		•	•
16.	13.	•	•	•		•	•
17.	14.	•	•	•		•	•
18.	15.	•	•	•		•	•
19.	16.	•	•	•		•	•
20.	17.	•	•	•		•	•
21.	18.	•	•	•		•	•

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
22.	19.	•	•	•		•	•
23.	20.	•	•	•		•	•
24.	21.	•	•	•		•	•
25.	22.	•	•	•		•	•
26.	23.	•	•	•		•	•
27.	24.	•	•	•		•	•
28.	25.	•	•	•		•	•
29.	26.	•	•	•		•	•
30.	27.	•	•	•		•	•
31.	28.	•	•	•		•	•
32.	29.	•	•	•		•	•
33.	30.	•	•	•		•	•
34.	31.	•	•	•		•	•
35.	32.	•	•	•		•	•
36.	33.	•	•	•		•	•
37.	34.	•	•	•		•	•
38.	35.	•	•	•		•	•
39.	36.	•	•	•		•	•
40.	37.	•	•	•		•	•
41.	38.	•	•	•		•	•
42.	39.	•	•	•		•	•
43.	40.	•	•	•		•	•
44.	41.	•	•	•		•	•
45.	42.	•	•	•		•	•
46.	43.	•	•	•		•	•
47.	44.	•	•	•		•	•
48.	45.	•	•	•		•	•
49.	46.	•	•	•		•	•
50.	47.	•	•	•		•	•
51.	48.	•	•	•		•	•
52.	49.	•	•	•		•	•
53.	50.	•	•	•		•	•
54.	51.	•	•	•		•	•
55.	52.	•	•	•		•	•
56.	53.	•	•	•		•	•
57.	54.	•	•	•		•	•
58.	55.	•	•	•		•	•
59.	56.	•	•	•		•	•

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
[64]							
1. Prospective 2. Spring 2012- Spring 2013 3. Convenience sampling 4. Multi-centre 5. N:625 6. Age: 44.8 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	1. Actigraph GT3X+ 2. Thigh, dominant upper arm, hip, and trunk 3. - 4. Four to five days, including at least two working days 5. At least 1 day 6. Actilife software version 5.5; a custom-made MATLAB-based software (Acti4) 7. -	• Total time spent walking, climbing stairs, running, cycling, sitting	• Neck shoulder pain	• Age • BMI • Seniority in the current job • Lifting and carrying time at work • Change in physical work tasks over the • 12-month period • Influence and social support at work • The number of days • with NSP during the previous 12 months • The number of days with pain • Intake of pain medication		• A diary for noting working hours, leisure time, sleep periods, and time of reference measurement	• Danish Data Protection Agency • accepted the handling and storage of data
[65]							
1. Cross sectional 2. October 2011 to April 2012 3. Convenience sampling 4. Multi-centre 5. N:202 6. Age: 44.8 7. Gender: F, M 8. Occupational 9. Health outcomes 10. New method for Objective Measurements of physical Activity in Daily living (NOMAD) Denmark	1. Actigraph GT3X+ 2. the medial front of the right thigh, midway between the hip and knee joints the trunk (spinous process at the level of T1–T2) water-resistant 3. - 4. Four consecutive days for at least two working days 5. At days were only included if they contained objective measurements for at least 4 h of work 6. Actilife software version 5.5; a custom-made	• Total sitting time	• Neck shoulder pain	• Age • Smoking behaviour • BMI • Seniority in the job • Perceived influence at work • Time spent carrying/ • lifting at work Working with arms raised • Working with • repetitive arm movements • Influence at work			• Available upon request

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
	MATLAB-based software (Acti4) 7. -						
[66]							
1. Prospective 2. April 2012- May 2014 3. Convenience sampling 4. Multi-centre 5. N:644 6. Age: (median: 47 for no LBP, 46 for LBP) 7. Gender: F, M 8. Occupational 9. Health outcomes 10. Danish PHysical ACTivity cohort with Objective measurements (DPhacto) Denmark	1. ActiGraph GT3x+ 2. the right thigh (medially between the iliac crest and the upper border of the patella), the hip (near the upper point of the iliac crest), the upper back (at processus spinosus below T1) waterproof 3. - 4. For 4–6 days, 24 hours a day 5. Working hours were included if they were ≥4 hours/day (continuous periods) or a duration of ≥75% of average wear time during work across days 6. Actilife software version 5.5; a custom-made MatLab-based software (Acti4) 7. -	• Forward bending • Domain-specific forward bending (work or leisure)	• Low back pain	• Age • Gender • Working conditions (eg, seniority and lift • factor at work) • BMI	• 1-year monthly follow-up on LBP intensity: every four weeks over a 1-year period	• A diary for noting working hours, non-wear time, and sleep periods	• Danish Data Protection Agency • accepted the handling and storage of data
[67]							
1. Prospective 2. - 3. Convenience sampling 4. Multi centre 5. N:1,165 6. Age: 39.9 for construction, 44.5	1. ActiGraph GT3x+ 2. right thigh (medially between the iliac crest and the upper crest of the patella) and right side of the hip (just below iliac crest)	• Minutes spent in sitting and standing positions • Forward bending during work	• Low back pain	• Age • Gender • Seniority in • Profession • BMI • Smoking status	• Self-reported • LBP intensity for the • preceding four weeks		

Study Details 1. Design 2. Years 3. Sampling method 4. Multi-centre? 5. N 6. Age* 7. Gender 8. Setting (community, occupational, clinical, other 9. Study Type (descriptive; health outcomes; correlates) 10. Mother study name	**Accelerometry Protocol** 1. Device 2. Placement/attachment 3. Other sensors 4. Protocol n Days / hour/day 5. Valid n of days for inclusion 6. Software 7. Processing Method	**Accelerometry Variables**	**Health Outcome Variables**	**Covariates (confounders) / Mediators / Moderators**	**Sample Health Status (Descriptors variables)**	**PA/SB/Sleep Variables collected via Questionnaires**	**Data sharing**
for healthcare workers 7. Gender: F, M 8. Occupational 9. Health outcomes 10. a part of a larger prospective cohort study among construction and healthcare workers	3. - 4. 3-4 consecutive days 5. - 6. a custom-made MatLab-based software Acti4 7. -			• Self-reported mechanical exposures Time spent sitting and standing during work • Heavy lifting, • Decision control • Fair and empowering leadership • Social climate in the • organization			

N: sample size; **PA:** physical activity; **SB:** sedentary behaviour; **LBP:** low back pain; **COPD:** Chronic Obstructive Pulmonary Disease; **BMI:** Body Mass Index; **MVPA**: moderate to vigorous physical activity; **EVA:** Exposure Variation Analysis; **T2DM:** Type 2 Diabetes Mellitus; **CVD:** cardiovascular diseases; **NSP:** neck shoulder pain

*Age is given as mean unless otherwise stated.

References

Note: Reference numbers match those used in the primary manuscript

26 Bellettiere J, Winkler EAH, Chastin SFM, *et al.* Associations of sitting accumulation patterns with cardio-metabolic risk biomarkers in Australian adults. *PLoS One* 2017;**12**:1–17. doi:10.1371/journal.pone.0180119

27 Breedveld-Peters JJL, Koole JL, Müller-Schulte E, *et al.* Colorectal cancers survivors' adherence to lifestyle recommendations and cross-sectional associations with health-related quality of life. *Br J Nutr* 2018;**120**:188–97. doi:10.1017/s0007114518000661

28 Çukić I, Shaw R, Der G, *et al.* Cognitive ability does not predict objectively measured sedentary behavior: Evidence from three older cohorts. *Psychol Aging* 2018;**33**:288–96. doi:10.1037/pag0000221

29 De Rooij BH, Van Der Berg JD, Van Der Kallen CJH, *et al.* Physical activity and sedentary behavior in metabolically healthy versus unhealthy obese and non-obese individuals - The Maastricht study. *PLoS One* 2016;**11**:1–12. doi:10.1371/journal.pone.0154358

30 Gale CR, Čukić I, Chastin SF, *et al.* Attitudes to ageing and objectively-measured sedentary and walking behaviour in older people: The lothian birth cohort 1936. *PLoS One* 2018;**13**:1–10. doi:10.1371/journal.pone.0197357

31 Gale CR, Marioni RE, Čukić I, *et al.* The epigenetic clock and objectively measured sedentary and walking behavior in older adults: The Lothian Birth Cohort 1936. *Clin Epigenetics* 2018;**10**:1–6. doi:10.1186/s13148-017-0438-z

32 Gupta N, Christiansen CS, Hallman DM, *et al.* Is objectively measured sitting time associated with low back pain? A cross-sectional investigation in the NOMAD study. *PLoS One* 2015;**10**:1–18. doi:10.1371/journal.pone.0121159

33 Gupta N, Hallman DM, Mathiassen SE, *et al.* Are temporal patterns of sitting associated with obesity among blue-collar workers? A cross sectional study using accelerometers. *BMC Public Health* 2016;**16**:1–10. doi:10.1186/s12889-016-2803-9

34 Gupta N, Heiden M, Mathiassen SE, *et al.* Prediction of objectively measured physical activity and sedentariness among blue-collar workers using survey questionnaires. *Scand J Work Environ Heal* 2016;**42**:237–45. doi:10.5271/sjweh.3561

35 Gupta N, Heiden M, Mathiassen SE, *et al.* Is self-reported time spent sedentary and in physical activity differentially biased by age, gender, body mass index, and low-back pain? *Scand J Work Environ Heal* 2018;**44**:163–70. doi:10.5271/sjweh.3693

36 Gupta N, Heiden M, Aadahl M, *et al.* What is the effect on obesity indicators from replacing prolonged sedentary time with brief sedentary bouts, standing and different types of physical activity during working days? a cross-sectional accelerometer-based study among blue-collar workers. *PLoS One* 2016;**11**:1–18. doi:10.1371/journal.pone.0154935

37 Hallman DM, Birk Jørgensen M, Holtermann A. Objectively measured physical activity and 12-month trajectories of neck-shoulder pain in workers: A prospective study in DPHACTO. *Scand J Public Health* 2017;**45**:288–98. doi:10.1177/1403494816688376

38 Hallman DM, Jørgensen MB, Holtermann A. On the health paradox of occupational and leisure-Time physical activity using objective measurements: Effects on autonomic imbalance. *PLoS One* 2017;**12**:1–16. doi:10.1371/journal.pone.0177042

39 Hallman DM, Mathiassen SE, Gupta N, *et al.* Differences between work and leisure in temporal patterns of objectively measured physical activity among blue-collar workers. *BMC Public Health* 2015;**15**:1–12. doi:10.1186/s12889-015-2339-4

40 Hallman DM, Mathiassen SE, Heiden M, *et al.* Temporal patterns of sitting at work are associated with neck–shoulder pain in blue-collar workers: a cross-sectional analysis of accelerometer data in the DPHACTO study. *Int Arch Occup Environ Health* 2016;**89**:823–33. doi:10.1007/s00420-016-1123-9

41 Hallman DM, Sato T, Kristiansen J, *et al.* Prolonged sitting is associated with attenuated heart rate variability during sleep in blue-collar workers. *Int J Environ Res Public Health* 2015;**12**:14811–27. doi:10.3390/ijerph121114811

42 Hulsegge G, Gupta N, Holtermann A, *et al.* Shift workers have similar leisure-time physical activity levels as day workers but are more sedentary at work. *Scand J Work Environ Heal* 2017;**43**:127–35. doi:10.5271/sjweh.3614

43 Kloster S, Danquah IH, Holtermann A, *et al.* How Does Definition of Minimum Break Length Affect Objective Measures of Sitting Outcomes Among Office Workers? *J Phys Act Heal* 2016;**14**:8–12. doi:10.1123/jpah.2015-0658

44 Korshøj M, Hallman DM, Mathiassen SE, *et al.* Is objectively measured sitting at work associated with low-back pain? A cross sectional study in the DPhacto cohort. *Scand J Work Environ Heal* 2018;**44**:96–105. doi:10.5271/sjweh.3680

45 Loef B, Van Der Beek AJ, Holtermann A, *et al.* Objectively measured physical activity of hospital shift workers. *Scand J Work Environ Heal*

2018;**44**:265–73. doi:10.5271/sjweh.3709

46 Martens RJH, Van Der Berg JD, Stehouwer CDA, *et al.* Amount and pattern of physical activity and sedentary behavior are associated with kidney function and kidney damage: The Maastricht Study. *PLoS One* 2018;**13**:1–18. doi:10.1371/journal.pone.0195306

47 Mesquita R, Nakken N, Janssen DJA, *et al.* Activity Levels and Exercise Motivation in Patients With COPD and Their Resident Loved Ones. *Chest* 2017;**151**:1028–38. doi:10.1016/j.chest.2016.12.021

48 Munch Nielsen C, Gupta N, Knudsen LE, *et al.* Association of objectively measured occupational walking and standing still with low back pain: a cross-sectional study. *Ergonomics* 2017;**60**:118–26. doi:10.1080/00140139.2016.1164901

49 Pulakka A, Stenholm S, Bosma H, *et al.* Association between Employment Status and Objectively Measured Physical Activity and Sedentary Behavior-The Maastricht Study. *J Occup Environ Med* 2018;**60**:309–15. doi:10.1097/JOM.0000000000001254

50 Rasmussen CL, Palarea-Albaladejo J, Bauman A, *et al.* Does physically demanding work hinder a physically active lifestyle in low socioeconomic workers? A compositional data analysis based on accelerometer data. *Int J Environ Res Public Health* 2018;**15**:1–23. doi:10.3390/ijerph15071306

51 Sawyer A, Smith L, Ucci M, *et al.* Perceived office environments and occupational physical activity in office-based workers. *Occup Med (Chic Ill)* 2017;**67**:260–7. doi:10.1093/occmed/kqx022

52 Shaw RJ, Čukić I, Deary IJ, *et al.* The influence of neighbourhoods and the social environment on sedentary behaviour in older adults in three prospective cohorts. *Int J Environ Res Public Health* 2017;**14**:1–21. doi:10.3390/ijerph14060557

53 Shaw RJ, Cukic I, Deary IJ, *et al.* Relationships between socioeconomic position and objectively measured sedentary behaviour in older adults in three prospective cohorts. *BMJ Open* 2017;**7**:1–10. doi:10.1136/bmjopen-2017-016436

54 Skarpsno ES, Mork PJ, Nilsen TIL, *et al.* Objectively measured occupational and leisure-time physical activity: Cross-sectional associations with sleep problems. *Scand J Work Environ Heal* 2018;**44**:202–11. doi:10.5271/sjweh.3688

55 Smith L, Hamer M, Ucci M, *et al.* Weekday and weekend patterns of objectively measured sitting, standing, and stepping in a sample of office-based workers: the active buildings study. *BMC Public Health* 2015;**15**:9. doi:10.1186/s12889-014-1338-1

56 Smith L, Sawyer A, Gardner B, *et al.* Occupational physical activity habits of UK office workers: Cross-sectional data from the active buildings study. *Int J Environ Res Public Health* 2018;**15**. doi:10.3390/ijerph15061214

57 van der Berg JD, Stehouwer CDA, Bosma H, *et al.* Associations of total amount and patterns of sedentary behaviour with type 2 diabetes and the metabolic syndrome: The Maastricht Study. *Diabetologia* 2016;**59**:709–18. doi:10.1007/s00125-015-3861-8

58 Van Der Berg JD, Van Der Velde JHPM, De Waard EAC, *et al.* Replacement Effects of Sedentary Time on Metabolic Outcomes: The Maastricht Study. *Med Sci Sports Exerc* 2017;**49**:1351–8. doi:10.1249/MSS.0000000000001248

59 Van Der Velde JHPM, Koster A, Van Der Berg JD, *et al.* Sedentary behavior, physical activity, and fitness - The Maastricht study. *Med Sci Sports Exerc* 2017;**49**:1583–91. doi:10.1249/MSS.0000000000001262

60 Varela-Mato V, O'Shea O, King JA, *et al.* Cross-sectional surveillance study to phenotype lorry drivers' sedentary behaviours, physical activity and cardio-metabolic health. *BMJ Open* 2017;**7**:1–9. doi:10.1136/bmjopen-2016-013162

61 Villumsen M, Holtermann A, Samani A, *et al.* Social support modifies association between forward bending of the trunk and low-back pain: Cross-sectional field study of blue-collar workers. *Scand J Work Environ Heal* 2016;**42**:125–34. doi:10.5271/sjweh.3549

62 Villumsen M, Madeleine P, Jørgensen MB, *et al.* The variability of the trunk forward bending in standing activities during work vs. leisure time. *Appl Ergon* 2017;**58**:273–80. doi:10.1016/j.apergo.2016.06.017

63 Villumsen M, Samani A, Jørgensen MB, *et al.* Are forward bending of the trunk and low back pain associated among Danish blue-collar workers? A cross-sectional field study based on objective measures. *Ergonomics* 2015;**58**:246–58. doi:10.1080/00140139.2014.969783

64 Hallman DM, Gupta N, Heiden M, *et al.* Is prolonged sitting at work associated with the time course of neck-shoulder pain? A prospective study in Danish blue-collar workers. *BMJ Open* 2016;**6**:1–9. doi:10.1136/bmjopen-2016-012689

65 Hallman DM, Gupta N, Mathiassen SE, *et al.* Association between objectively measured sitting time and neck–shoulder pain among blue-collar workers. *Int Arch Occup Environ Health* 2015;**88**:1031–42. doi:10.1007/s00420-015-1031-4

66 Lagersted-Olsen J, Thomsen BL, Holtermann A, *et al.* Does objectively measured daily duration of forward bending predict development and aggravation of low-back pain? A prospective study. *Scand J Work Environ Heal* 2016;**42**:528–37. doi:10.5271/sjweh.3591

67 Lunde LK, Koch M, Knardahl S, *et al.* Associations of objectively measured sitting and standing with low-back pain intensity: A 6-month follow-up of construction and healthcare workers. *Scand J Work Environ Heal* 2017;**43**:269–78. doi:10.5271/sjweh.3628