Musculoskeletal Pain Disorders and Sedentary Behaviour in Occupational and Non-occupational Settings in Adults: A Systematic Review Protocol

Authors:

Francis Dzakpasu,[1,2] Alison Carver,[1] Christian Brakenridge,[1,2] Neville Owen,[2,3] and David Dunstan[1,2]

Affiliations:

1. Mary MacKillop Institute of Health Research, Australian Catholic University, Melbourne, VIC, Australia.
2. Physical Activity and Behavioural Epidemiology Laboratory, Baker Heart and Diabetes Institute, Melbourne, VIC, Australia.
3. Centre for Urban Transitions, Swinburne University of Technology, Melbourne, VIC, Australia.

Abstract

Purpose: Musculoskeletal pain disorders (MSPDs) are increasingly contributing to the global non-communicable disease (NCD) burden. Sedentary behaviour (long periods of time spent sitting) is common in older adults, especially, in those with NCD. However, the evidence base on associations of sedentary behaviour with MSPDs has not been the subject of a systematic review. We aim to review, summarise and synthesise evidence of associations of sedentary behaviour with MSPDs in adults.

Method: A constructed search terms strategy protocol, guided by the PRISMA format will be followed to search databases for relevant studies. Preliminary search terms were developed according to Population, Intervention, Control/comparison, and Outcome (PICO) framework -derived a priori research questions. The search will be run on the following database search engines: MEDLINE, CINAHL, PsycINFO, Embase, Web of Science, Scopus, Cochrane Library, SPORTDiscus, and AMED, as well as other relevant sources, and the grey literature.

Eligibility Criteria: Studies in adults 18-years and above, which addressed the review's variables of interest, sedentary behaviour as the exposure, and MSPDs as outcomes variables are eligible. All quantitative original epidemiologic studies, including observational and intervention/experimental studies that meet eligibility criteria, will be included. Qualitative designs, as well as non-empirical and review studies, will be excluded.

Evidence Synthesis: Relevant findings extracted using a pre-designed data extraction form will be categorised into observational and intervention studies. The findings will be organised according to the most relevant categories of exposure and/or outcome variables. Findings will be synthesised using quantitative and narrative perspectives, where sufficient homogeneity across study designs and measures allows.

Conclusions: The expectation for this review is that the evidence identified will allow at least preliminary conclusions to be drawn about the associations of sedentary behaviour with MSPDs in adults. It is anticipated that the findings will also provide preliminary insights relevant to understanding the potential biological mechanisms that may underpin MSPDs in adults.

Keywords: Sedentary behaviour; Musculoskeletal pain disorders; MSPD; Adults

Background

Despite improvements in life expectancy worldwide, the burden of non-communicable diseases (NCDs) remains[1]; in 2016 NCDs accounted for approximately 61.4% disability-adjusted life years[2]. According to current evidence, the contribution of musculoskeletal pain disorders (MSPDs) to the burden of NCDs has increased in recent decades[2,3]. Presently, MSPDs are, globally, the second-highest contributor to years lived with disability[4]. As the underlying determinants of MSPDs (ageing populations, obesity, physical inactivity, and sedentary behaviour) continue to increase globally, the burden is expected to will keep rising[1,5].

MSPDs are ubiquitous and involve multiple structures of the locomotive system (bones, muscles, tendons, ligaments, and cartilage)[6,7]. Most are associated with pain and functional disability[7,8]. The debilitating effect of MSPDs substantially impacts on quality of life, limiting activities and dexterity[9,10]. Also, MSPDs negatively impact health and well-being, including fatigue, psychological and sleep problems[7,11,12]. In a broader perspective, MSPD-related limitations may have social impacts, by affecting community engagements and increasing societal economic burdens[13,14].

The prevalence of MSPDs increases with age and is higher among middle-aged and older adults[1,15]. Prevalence is increasing worldwide, both in developed and developing countries[8]. For instance, Australian findings suggest that some 61% of the population with MSPDs are aged between 25 and 64 years, whereas the rate is 72% in older adults aged 75 to 84 years[16]. MSPDs frequently coexist with other morbidities and often present with one or more chronic diseases[17,18]. For example, mental disorders, cardiovascular conditions, chronic respiratory conditions and type 2 diabetes (T2D) can coexist with MSPDs[11,16].

In health-related research, it is important to make clear distinctions between behaviours of concern[19]. Health benefits of adequate moderate-to-vigorous physical activity (MVPA) are well known[20,21], as is the deleterious effect of low volumes of physical activity and high volumes of sedentary behaviour[22]. Generally, health-enhancing physical activity refers to meeting a recommended amount of MVPA at least 150 minutes per week[23]. Sedentary behaviour, on the other hand, includes waking hours' behaviours involving a sitting or reclining posture with an accumulated energy expenditure ≤1.5METs/hour[24,25]. Sedentary behaviour is distinct from insufficient physical activity, which is not meeting the recommended guidelines[22,24,26]. This distinction is supported by evidence on the adverse impacts of sedentary behaviour in otherwise physically active individuals[27,28].

Increasingly, studies are supporting the association of sedentary behaviour with a range of chronic diseases, including cardiovascular disease, T2D, metabolic syndrome, musculoskeletal conditions, and

some cancers[28-35]. Also, the health benefits of reducing total sedentary time as well as substituting sitting with light-intensity physical activity or MVPA are evident[36-40]. To date, several studies have considered the association between sedentary behaviour and MSPDs, however, mixed findings have been reported[41-45]. Some studies reported sedentary behaviour to be associated with MSPDs and pain intensity[46-48]. Nevertheless, MSPDs also contribute to sedentary behaviour in adults because of the perceived pain inhibitory effect[49-51]. Thus, a possible bidirectional association may exist. Adding to this, some intervention studies have documented the beneficial impact of reducing sedentary behaviour on musculoskeletal conditions[43,47,52,53].

There is other evidence to suggest that there may be limited associations of sedentary behaviour with MSPDs[54]. For instance, Chen et al.[54], reviewed 10 prospective cohorts and 5 case-control studies in a systematic review and concluded sedentary behaviour is not associated with low back pain. The authors may have focused mainly on sedentary behaviour and low back pain in heterogeneous populations[54]. Nevertheless, since that publication other original studies with robust designs and measures have been published[55-57] suggesting that the location of MSPD could also be a determining factor in the association[58,59]. For example, positive associations between sedentary behaviour and MSPD have been observed in some anatomical sites but not others (example upper back, lower back, knee joints, etc.)[43,58].

It is also informative to consider the growing evidence on objectively measured sedentary behaviour and associations with NCDs[29,60-62], including MSPDs in vulnerable adults[48]. There is compelling evidence that adults with multi-morbidities may have a higher susceptibility to the adverse impacts of sedentary time, increasing the risk of metabolic dysfunction and complications[63,64]. There is emerging evidence of MSPD being commonly reported comorbidity in adults with multi-morbidities which impact their quality of life[17,18]. Moreover, the biological mechanisms that underpin this link have not been explicitly described[65,66]. Considering the existing evidence, it is plausible that sedentary exposure could be a mediating factor that exaggerates MSPD in adults with comorbidities[48,64,67,68]. To this end, however, there is a paucity of recent reviews establishing the link between sedentary behaviour and MSPD.

This review aims to synthesize evidence on the associations of adults' sedentary behaviour as the exposure, with musculoskeletal pain disorders as the outcome, specifically:

- to identify potential associations of sedentary behaviour with MSPDs in adults; and,
- to examine pooled relationships using meta-analysis.

Method

Design

This review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for transparency[69,70]. Further, to ensure extensive data extraction, the review question is framed in accordance with the Population, Intervention, Control/comparison, and Outcome (PICO) framework[71]. Also, the PICO framework will be adapted in the search strategy design for enhanced precision to ensure representativeness and unbiased systematic review[72]. The PRISMA-P template guided protocol development[73]. The various process in the review protocol is illustrated in a flow-diagram below.

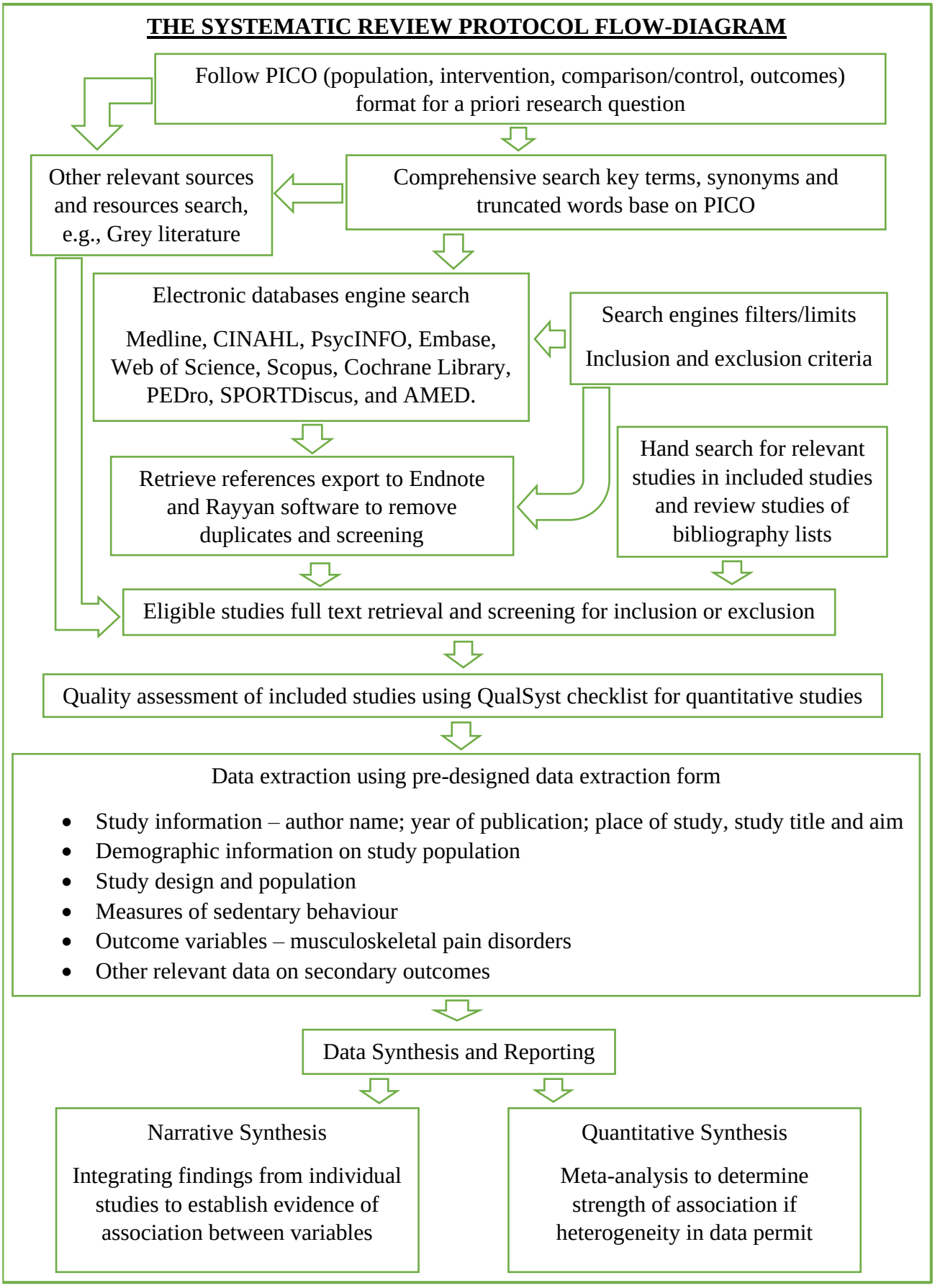
Research Question

- What are the associations of sedentary behaviour (in occupational and non-occupational domains) with musculoskeletal pain disorders in adults?

Eligibility Criteria

Inclusion criteria: Studies in adults 18-years of age and older, and which consider the exposure (sedentary behaviour) and the outcomes (musculoskeletal pain disorders) of interest, will be included. All quantitative epidemiologic studies, including observational and intervention or experimental studies, will be eligible for inclusion[74,75]. This includes cross-sectional studies, case-control studies, case-crossover studies, case series, retrospective and prospective cohort studies. Studies with experimental designs will also be included, for example, randomized controlled trials (RCTs), non-randomized controlled trials, and studies using quasi-experimental study designs[74,75].

THE SYSTEMATIC REVIEW PROTOCOL FLOW-DIAGRAM



Exclusion criteria: Studies conducted in those aged below 18-years nor qualitative studies will not be included as these studies will not address the research questions. Studies that did not use any measuring tool for sedentary behaviour, but rather a proxy estimate, such as "less active", inactive, or "does not engage in physical activities" will be excluded[76]. Further, studies of clinical populations of MSPDs, such as clinical patients with knee osteoarthritis will be excluded. Opinion or perspective articles, conference papers, editorials, and newsletters will be ineligible. Review articles will not be included; however, reviews covering the exposure and outcome of interest in preferred adults will be considered for a hand search of their bibliography lists for relevant studies that align with the focus of our review.

Outcome Variables

The main outcome variable is pain disorders involving any part of the musculoskeletal system and the related soft tissues, including pain disorders in joints, muscles, tendons, ligaments or nerves[7,77,78]. MSPDs are ubiquitous with the associated pain usually chronic in nature, and which could be nociceptive, neuropathic, or functional in origin[78,79]. The MSPDs to be considered will include both inflammatory and non-inflammatory MSPDs, for example, upper and lower back pain, and osteoarthritis, with the exception of autoimmune-related MSPDs (e.g. rheumatoid arthritis and fibromyalgia); and pain that is attributable, acutely or recently, to trauma and. Although there is no universal measure for MSPDs, any acceptable tool described in studies, including objective tests based on diagnostic examination or self-report measures will be the basis for considering MSPDs[80-82].

Other MSPD-associated variables to be documented in the review as an outcome, will include quality of pain, physical functioning, and disability. Cardiometabolic risk factors associated with MSPDs, overweight/obesity, as well as some systemic inflammatory biomarkers may be considered.

Exposure Variables

Exposures of interest are self-reported and device-measured (for example, accelerometers and/or inclinometers) sedentary behaviours and/or sitting time[83-86]. Parameters of sedentary behaviour that will be explored are total sedentary time; the amount of time in a specified sedentary behaviour, for example, gaming, television watching, commuting in a car, sitting or changes in sitting time at a desk

or screen as in desk-based office workers using accepted sedentary behaviours classification criteria[24]. Also, patterns of sedentary behaviour accumulation as described as the frequency of breaking prolonged sedentary sitting and sedentary time accumulated in bouts of defined durations[86-90].

Search Strategy

Published studies will be searched through electronic databases using specified comprehensive search terms, balanced for high sensitivity to retrieve all potentially relevant documents, and high specificity to help reduce the identification of irrelevant studies[91-93]. The terms and the construction of Boolean operators will be standardized across all electronic databases; however, subject headlines terms will be specific to databases if required. Filters will be standardized across the search engines to retrieve only studies published in the English language and studies of human participants. The search will be run on a specified day and limited to studies published from 2000 to the present, as sedentary behaviour research interest has grown significantly over the past two decades from an initially low base[24]. Additionally, bibliography lists of included studies will be hand searched for further relevant studies. Furthermore, to minimize publication bias the search will not be limited to only peer-reviewed articles[94]. All databases search will be done by one author with guidance from an expert librarian to ensure consistency.

Database Search Engines

The following database search engines will be considered: MEDLINE Complete, CINAHL Complete, PsycINFO, Web of Science, Scopus, Cochrane Library, SPORTDiscus, and AMED. Other databases and resources will be consulted, including grey literature to identify unpublished studies which may be of relevant focus to the current review.

Search Key Terms

An expert librarian (Australian Catholic University) has been consulted for the search strategy development with contribution from all the authors. The strategy will be informed by other search approaches described in review studies[76,88] and a strategy reported in a review protocol[95]. The key terms will be comprehensively developed, guided by PICO format[71]. Keywords, terms, and their synonyms, as well as phrases, will be derived from terms relating to the exposure (sedentary behaviour), outcome (Musculoskeletal pain disorders) and population of interest (adults). To optimize the search, newly identified terms that consistently show up in titles and abstracts of retrieved studies during the search will be added to the search string to ensure completeness of the search strategy[91]. The key terms for initial search string have been used for sample Medline database search which will be replicated on other databases. The sample is provided in appendix A of this document.

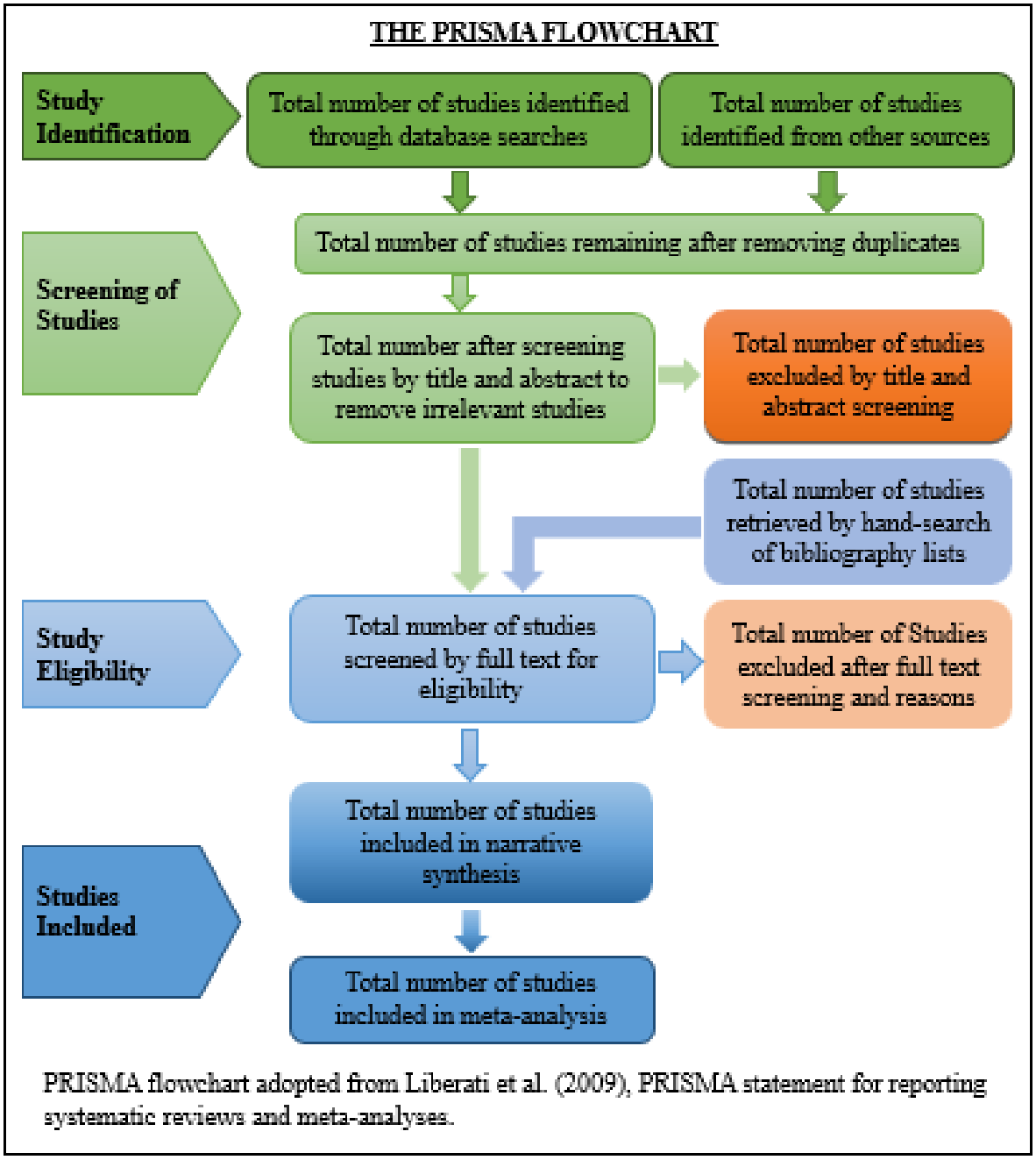
Records Management

Retrieved Studies

All retrieved references will be exported to Endnote software as the relevant reference manager[96]. Duplications will be checked and removed by one of the reviewers and the refined references exported to Rayyan systematic review software[97], which supports a collaborative review, for studies screening.

Study Screening and Selection

This will be in two stages: 1) title and abstract screening; and, 2) full-text screening. Stage one screening will involve the removal of irrelevant studies undertaken by one author according to the inclusion and exclusion criteria. This will then be followed by retrieval of full-text articles of retained studies. The second stage will involve at least two authors reading the full-text articles to independently assess their eligibility and coding them either as "include" or "exclude". Disparities in decisions will be resolved through discussion in consultation with other independent reviewers[69]. Records of all processes in the screening, as well as reasons for excluding studies at stage two, will be documented in a PRISMA flowchart[98]. as shown below.



PRISMA flowchart adopted from Liberati et al. (2009), PRISMA statement for reporting systematic reviews and meta-analyses.

Data Extraction and Storage

A data extraction form based on Cochrane Collaboration data extraction and assessment form template[99] will be developed to ensure data quality and to minimize errors[100]. The first reviewer will perform all data extraction and the data extracts will be verified independently by the second and third reviewers. Verification will involve the second and third reviewers extracting data from at least 20% of the studies which are randomly selected and compared with the data extracts of the first reviewer[95].

Disagreements will be resolved through panel discussions involving all three reviewers. The extracted data will be entered and stored in an excel spreadsheet before evidence synthesis.

The information to be extracted from individual studies will include the following:

- Descriptive details – author name; year of publication; place of study, study title, and aim
- Demographic information on the study population
- Study design and population
- Measures of sedentary behaviour
- Outcome variables– musculoskeletal pain disorders
- Populations' characteristics
- Other relevant data on secondary outcomes

Study Quality Assessment

Quality assessment of all included studies will be conducted by two independent reviewers and disagreements in the assessment will be discussed and resolved between them in consultation with two other reviewers. The quantitative checklist of QualSyst (Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields) quality assessment tool will be used[101].

Briefly, the QualSyst checklist for assessing the quality of quantitative studies is scored on 14-criteria items as either "YES = 2", "PARTIAL = 1", "NO = 0" or "NOT APPLICABLE" (N/A) depending on the extent to which each criterion item is satisfied in the study report[101]. The total QualSyst score excludes the N/A from the computation. Thus, QualSyst score is expressed as the sum of applicable criteria scores divided by the sum of the maximum possible applicable criteria scores[101]. Note, the quality of studies will not be criteria for including studies in the review but may be considered in the determination of robustness of data synthesis. The QualSyst quantitative checklist is provided in appendix B.

Data Synthesis

Studies will be first sorted into broad categories of observational studies, or experimental/intervention studies. Second, measures and comparisons reported within these groups will be separately organized, as well as the study design. Also, the primary outcomes (types of musculoskeletal pain disorders) will be categorised within relevant categories.

Narrative review: Individual study findings will be systematically described and integrated into a narrative synthesis, exploring the within and between relationships of studies to synthesise the evidence on the association between sedentary behaviour and musculoskeletal pain disorders based on the best-evidence synthesis approach[102].

Quantitative Synthesis: Pooled meta-analysis of data to estimate the effect size of associations will be considered if variations in study designs and measures are permissible. Should there be comparable similarities in measures and outcome variables within groups, meta-analysis will be presented separately for observational and intervention/experimental studies. The analysis will be performed on homogenous data, including sedentary behaviour, MSPDs, and other relevant data like systemic inflammatory biomarkers related to pain. The pooled relationship will be estimated based on either "fixed-effect" model or "random-effect" model for statistically homogenous or heterogenous data respectively[103]. Further, for statistically heterogeneous data, a meta-regression analysis will be performed. Likewise, heterogeneity in effect size will be estimated by computing pseudo-R^2. Forest plots to illustrate the contributions of individual studies to the pooled relationship will be considered. Data heterogeneity will be estimated with I^2 and Cochranes Q analysis[104,105].

Comparison groups to be considered for the analysis will include adults with MSPDs and adults without MSPDs; and probably sedentary behaviour domains (in occupational and non-occupational settings). All statistical analyses will be performed using STATA software.

However, when considerable variations in the nature of the findings in the individual studies render meta-analysis inappropriate, data will be presented in descriptive tables and as a narrative in the text. The narrative text will reflect the variations in study designs and the quality of the studies. Additionally, if there is enough data, the impact of confounding factors will be explored in subgroup data analysis. The following subgroups will be considered: gender differences and other relevant subgroup analyses for presenting the findings. Finally, when appropriate, the robustness of the analyses will be tested by sensitivity analysis. The meta-analysis will exclude studies of low quality or with a high risk of bias

from the pooled relationship analysis [106]. The confidence in the evidence synthesis will be considered based on the robustness of the design of the individual studies included in the evidence synthesis.

Dissemination

The review findings will be well disseminated, for example, in academic/research journals and presented at seminars, conferences, or workshops.

Discussion

This systematic review aims to identify, evaluate and synthesise the evidence for associations between sedentary behaviour and MSPDs in adults. Evidence available supports the health benefit of adequate physical activity on health outcomes[36,39]. Likewise, the deleterious effect of high-volume sedentary behaviour on NCDs risk which could be independent of physical activity is evident[31,32]. There is emerging evidence of a high prevalence of sedentary behaviour in older adults with multiple chronic diseases[107]. Understanding this behaviour shift in adults has been complicated by the increasing prevalence of MSPDs in multi-morbidities[108]. There is a possibility of bidirectional associations of sedentary behaviour with MSPDs in adults, however, there is limited evidence to draw definite conclusions.

There are some highlights in this review design to consider. Foremost, the approach proposed is robust with a comprehensive protocol that is transparent and reproducible. The protocol was developed on the guides of PRISMA-P template[73] and clearly outlines the eligibility criteria for the study population and designs. Also, outcome and exposure variables are well described. Likewise, strategies for study search; database search engines; study management and screening; quality assessment; as well as data extraction and evidence synthesis strategy is well outlined. By adhering strictly to this protocol and possibly making the protocol publicly available will ensure the transparency of the review and minimise bias[109]. Also, the review will include both observational and intervention/experimental studies which are either cross-sectional or longitudinal in design and is considered another strength of this review.

Additionally, the outcome variable comprised of a comprehensive list of different types of MSPDs, broadening the scope to address the review questions, hence, adding strength to our approach. The ubiquity of MSPDs in older adult populations may influence their association with sedentary behaviour. For instance, an intervention study found sedentary behaviour reduction to improve MSPDs at some anatomical sites, while no effect was observed in other anatomical sites[58].

Despite the aforementioned strengths, there are some limitations anticipated for this systematic review. First, study design variations and heterogeneity in measures are weaknesses to consider in this review. Different study designs will be included in this review, ranging from low-level evidence designs, for example, cross-sectional designs, to high-level evidence design like RCTs. Nevertheless, is proposed that studies will be sorted according to designs and measures organised within study categories before evidence synthesis. Also, results will be presented separately for observational and experimental/intervention studies. Further, self-reported and objective measures data will be extracted,

but self-report measures have more limitations with an increased likelihood of reporting bias. Nevertheless, meta-analysis will be considered in the context of permissible measurement heterogeneity. To account for differences in pooled data, fixed effect model and random-effect model have been proposed for statistically homogenous and heterogeneous data analysis respectively[103].

Second, sedentary behaviour research has only gained increased focus in recent decades and there might not be enough studies on desired variables, particularly studies using objective device-measured sedentary behaviour. Therefore, the odds of limited studies with robust methodological design for evidence synthesis, which could reduce the confidence of evidence to make an inference from data synthesis.

In summary, the expectation is that this review will identify, synthesise and interpret the likely implications of existing evidence in the association between sedentary behaviour and outcome of MSPDs in adults. There are heterogeneous potential pathways but no explicit biological mechanisms that explain MSPDs. Hopefully, the findings of this review could provide some clues, and also identify literature gaps for further exploration to delineate possible mechanisms. A better understanding of the mediating role of sedentary behaviour in the pathophysiology MSPDs will provide stronger evidence for public health, occupational health, and clinical professionals to develop guidelines for their prevention and management.

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Appendix A

Musculoskeletal Pain Disorders and Sedentary Behaviour in Occupational and Non-occupational Settings in Adults: A Systematic Review

Search Key Terms and Strings Strategy

Sample Medline database search syntax for the review's study search. The search strings and Boolean operators' construction will be replicated across the chosen databases.

MH = Medline Subject Headlines TI = Title AB= Abstract

Search	Search Term	Search Options	Result
EXPOSURE			
S1	(MH "Sedentary Behavior") OR (MH "Sitting Position") OR (MH "Screen Time")	Expanders - Apply equivalent subjects Search modes - Find all my search terms	8,711
S2	TI ("Sedentary behavio*" OR "Sedentary lifestyle" OR Sedenta* OR sitting OR "prolong* sitting" OR "uninterrupted sitting" OR "Sitting time" OR "Screen time" OR "Sitting position" OR "sitting disease*" OR "television viewing time" OR "television-viewing time" OR "TV viewing time" OR "TV-viewing time") OR AB ("Sedentary behavio*" OR "Sedentary lifestyle" OR Sedenta* OR sitting OR "prolong* sitting" OR "uninterrupted sitting" OR "Sitting time" OR "Screen time" OR "Sitting position" OR "sitting disease*" OR "television viewing time" OR "television-viewing time" OR "TV viewing time" OR "TV-viewing time")	Expanders - Apply equivalent subjects Search modes - Find all my search terms	51,342
S3	S1 OR S2	Expanders - Apply equivalent subjects Search modes - Find all my search terms	53,786
OUTCOME			
S4	(MH "Musculoskeletal Pain+") OR (MH "Musculoskeletal Diseases+") OR (MH "Neck Pain") OR (MH "Arthritis+") OR (MH "Arthritis, Rheumatoid+") OR (MH "Arthritis, Psoriatic+") OR (MH "Arthritis, Gouty+") OR (MH "Crystal Arthropathies+") OR (MH "Osteoarthritis+") OR (MH "Osteoarthritis, Hip+") OR (MH "Osteoarthritis, Knee+") OR (MH "Osteoarthritis, Spine+") OR (MH "Back Pain+") OR (MH "Low Back Pain+") OR (MH "Carpal Tunnel Syndrome+") OR (MH "Tarsal Tunnel	Expanders - Apply equivalent subjects Search modes - Find all my search terms	1,110,925

	Syndrome+") OR (MH "Bursitis+") OR (MH "Dupuytren Contracture+") OR OR (MH "Tenosynovitis+") OR (MH "Spondylitis+") OR (MH "Spondylitis, Ankylosing+") OR (MH "Spondylarthropathies+") OR (MH "Spondylarthritis+") OR (MH "Joint Diseases+") OR (MH "Arthropathy, Neurogenic+") OR (MH "Diabetic Neuropathies+") OR (MH "Hyperostosis, Diffuse Idiopathic Skeletal+") OR (MH "Enthesopathy+") OR (MH "Fibromyalgia+")		
S5	TI (“Musculoskeletal pain disorder*” OR “Musculoskeletal pain*” OR “Musculoskeletal disorder*” OR “Musculoskeletal system disorder*” OR “osteomuscular disease*” OR “osteomuscular disorder*” OR “osteomuscular pain*” OR osteoarthritis OR osteochondritis OR arthritis OR polyarthritis OR capsulitis OR spondylitis OR arthropath* OR “shoulder pain*” OR “knee pain*” OR “back pain*” OR “lumbar pain*” OR “neck pain*” OR “cervical pain*” OR “joint pain*” OR "ankle pain*" OR “rheumatoid arthritis” OR gout* OR “limited joint mobility syndrome” OR “diabetic cheiroarthropathy” OR cheiroarthropathy OR “carpal tunnel syndrome” OR “Dupuytren* contracture” OR “Dupuytren* disease*” OR “stiff hand syndrome” OR “flexor tenosynovitis” OR “Charcot osteoarthropathy” OR “neuropathic arthropathy” OR “diabetic muscular infarction” OR “proximal motor neuropathy” OR “acute proximal neuropathy” OR “diffuse idiopathic skeletal hyperostosis syndrome” OR “DISH syndrome” OR enthesopathy OR fibromyalgia OR “fibromyalgia Syndrome” OR FMS OR “Tarsal Tunnel Syndrome”) OR AB (“Musculoskeletal pain disorder*” OR “Musculoskeletal pain*” OR “Musculoskeletal disorder*” OR “Musculoskeletal system disorder*” OR “osteomuscular disease*” OR “osteomuscular disorder*” OR “osteomuscular pain*” OR osteoarthritis OR arthritis OR polyarthritis OR capsulitis OR spondylitis OR arthropath* OR “shoulder pain*” OR “knee pain*” OR “back pain*” OR “lumbar pain*” OR “neck pain*” OR “cervical pain*” OR “joint pain*” OR "ankle pain*" OR "leg pain*" OR “rheumatoid arthritis” OR gout* OR “limited joint mobility syndrome” OR “diabetic cheiroarthropathy” OR cheiroarthropathy OR “carpal tunnel syndrome” OR “Dupuytren* contracture” OR “Dupuytren* disease*” OR “stiff hand syndrome” OR “flexor tenosynovitis” OR “Charcot osteoarthropathy” OR “neuropathic arthropathy” OR “diabetic muscular infarction” OR “proximal motor neuropathy” OR “acute proximal neuropathy” OR “diffuse idiopathic skeletal hyperostosis syndrome” OR “DISH syndrome” OR	Expanders - Apply equivalent subjects Search modes - Find all my search terms	351,010

	enthesopathy OR fibromyalgia OR “fibromyalgia Syndrome” OR FMS OR “Tarsal Tunnel Syndrome”)		
S6	S4 OR S5	Expanders - Apply equivalent subjects Search modes - Find all my search terms	1,217,422
POPULATION			
S7	(MH "Adult+") OR (MH "Young Adult") OR (MH "Frail Elderly") OR (MH "Aged+")	Expanders - Apply equivalent subjects Search modes - Find all my search terms	6,972,234
S8	TI (Adult* OR “young adult*” OR “middle-aged adult*” OR “middle aged adult*” OR “older adult*” OR Flail adult* OR “flail older adult*” OR Elderly OR aged) OR AB (Adult* OR “young adult*” OR “middle-aged adult*” OR “middle aged adult*” OR “older adult*” OR Flail adult* OR “flail older adult*” OR Elderly OR aged) NOT (child* OR adolescen* OR "adolescen* age*" OR Teenag* OR "Teenag* age*")	Expanders - Apply equivalent subjects; Apply related words Search modes - Find all my search terms	1,353,720
S9	S7 OR S8	Expanders - Apply equivalent subjects Search modes - Find all my search terms	7,598,772
Studies Identified			
S13	**S3 AND S6 AND S9** Note: Sedentary behaviour AND musculoskeletal pain disorders AND adults.	Limiters - Date of Publication: 20000101-20191231 Expanders - Apply equivalent subjects Search modes - Find all my search terms	**2,132**

Appendix B

QualSyst quality assessment tool for quantitative studies

Item	Criteria	Yes (2)	Partial (1)	No (0)	N/A
1	Question / objective sufficiently described?				
2	Study design evident and appropriate?				
3	Method of subject/comparison group selection or source of information/input variables described and appropriate?				
4	Subject (and comparison group, if applicable) characteristics sufficiently described?				
5	If interventional and random allocation was possible, was it described?				
6	If interventional and blinding of investigators was possible, was it reported?				
7	If interventional and blinding of subjects was possible, was it reported?				
8	Outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias? Means of assessment reported?				
9	Sample size appropriate?				
10	Analytic methods described/justified and appropriate?				
11	Some estimate of variance is reported for the main results?				
12	Controlled for confounding?				
13	Results reported in sufficient detail?				
14	Conclusions supported by the results?				