1. Introduction

Low back pain (LBP) is the leading cause of disability globally, and years lived with disability caused by low back pain has increased by more than 50% between 1990 and 2015 [1]. For many years, sitting for prolonged periods of time has been reported to be associated with LBP regardless of whether or not an individual is currently experiencing LBP [2,3]. There are a number of theoretical pathways for nociception that could be initiated within spine tissues when seated postures are adopted.. Sitting involves flexed spine postures of 50-97% of the end range of motion [4-12]. When joints, move away from neutral and toward end ranges, the tissues surrounding the joints are subject to increasing levels of stress and strain. The involved mechanical forces (tension, compression, shear) applied to the spine can trigger nociceptive signals through mechanoreceptors imbedded in the tissues. Since many spinal structures (e.g., joint capsule, the peripheral third of intervertebral discs, tendons, muscles and ligaments) have these receptors, there are many mechanical scenarios that have the potential to lead to a pain experience in sitting. Indeed, studies have demonstrated that stretching of the posterior passive tissues (ligaments, tendons and joint capsules) instigates inflammatory and cytokin responses [13], that spine flexion results in stress at the peripheral third of the intervertebral disc, secondary to the posterior migration of the nucleus [14] and that prolonged low-level muscle activation, as occurs in seated postures, results in muscle fatigue and capillary compression [15] A pain response is evident in *in-vivo* basic science research where increased reports of perceived pain have been found in young, healthy populations in response to sitting durations greater than one hour [5,6,16-18]. However, it is currently not known whether or not seated postures cause clinical episodes of low back pain.

It has been suggested that occupational sitting is a risk factor for LBP; however, the data supporting this is unclear [19,20]. One reason for the difficulty in determining the association through epidemiological studies is the high prevalence of both LBP and sitting in the general population [21-23] as well as the multifactorial nature of LBP itself [1]. Further, systematic reviews to date that explore the relation between sitting time and LBP development have relied on self-report sitting time and/or assumed sitting time based on occupation which is known to underestimate the actual durations and may bias the results [25]. The objective measure of sitting time, either by direct observation, timed laboratory trial or wearable sensors should provide a more valid and reliable exposure measurement that can be related to back symptoms. Therefore, the purpose of this study was to take a step back from the association between occupational sitting time and clinical LBP and instead determine whether sitting time is associated with the immediate increase in perceived LBP.

1.1 Research Question

To determine if sitting time measured objectively (by laboratory controlled time trial, direct observation or wearable sensor) is associated with the immediate increase in LBP (determined by pain scale rating) in people >18 years of age.

2. Methods

The review protocol was registered with PROSPERO on October 19, 2017 [CRD42017079738]. The methodology and reporting format of this review follows the recommendations and guidelines of the Preferred Reporting Items of Systematic Reviews and Meta-analyses (PRISMA) [26].

2.1 Literature search

Eligible articles were systematically identified through the following electronic databases: PubMed, EMBASE, SPORTdiscus and CINAHL. The original search was performed on October 20, 2017 and updated on September 1, 2018 to include papers through August 31, 2018. All articles from the inception of each database up to the date of the search were included. The search strategy was developed by a health services librarian (MS), using keywords and subject headings that included: back pain, discomfort, upper back, lower back, objective measure, sensor, laboratory, sitting, motion analysis and video in either the title or abstract. The specific search strategies are included in Appendix 1. The reference lists of relevant articles were also screened to locate additional articles. The PRISMA flow diagram outlining the results of the search strategy are shown in Figure 1.

2.2 Eligibility criteria

No language restrictions were used and all articles that met the inclusion criteria for study design and population, exposure and low back pain were included for analysis.

2.2.1. Study design and population

Eligible study design included observational studies (laboratory-controlled, cross-sectional, cohort and case-control). Randomized controlled studies were included when the control and intervention sessions occured on separate days (within subject control) to ensure an adequate wash-out period or, alternatively, separate populations were randomized into the study arms. Data from control sessions only were considered for this review, comparisons to

interventions were not considered. Studies that investigated self-ambulatory adults older than 18 years were included.

2.2.2. Exposure

Objectively measured sitting time as determined by wearable sensors (accelerometers or inclinometers) and/or laboratory controlled trial time were included. No restrictions were placed on the length of exposure used in the studies. Sitting in any context (i.e. occupational space, laboratory, leisure time etc.) and in any country was included so long as the exposure was objectively measured.

2.2.3. Low back pain

Nonspecific LBP was defined as pain or discomfort between the lower margin of the 12th rib and the gluteal folds, with or without leg pain, where pain is not attributed to specific physical cause or pathology [1]. Perceived back pain, measured by self-reported scale (e.g. visual analogue scale, numerical rating scale) immediately following or shortly after the exposure were included in this review.

2.3 Selection of studies

Study selection was divided into 2 stages (Figure 1). Duplicate citations were removed by the health sciences librarian (MS) at the time of the search. In the first stage, two authors (DDC and KD) independently screened the titles and abstracts with the reasons for exclusion compared between the 2 reviewers. In the second stage, the full-text articles of potentially eligible studies were retrieved with each reviewer independently using standardized screening

forms to identify relevant studies. The rationale for inclusion and exclusion were discussed and clarified, with discrepancies resolved through consultation with a third reviewer if necessary (JH).

2.4 Data extraction

For each included article, two reviewers (DDC and KD) independently extracted the following information: study setting, population demographics and baseline characteristics, details of control conditions, methodology, recruitment rates and study dropout numbers, outcome measures (including units and variance). Corresponding authors of included articles were contacted directly in an attempt to acquire missing data where required. To ensure accuracy of data extraction, regular meetings were held between the reviewers to discuss cases.

2.5 Quality of reporing and risk of bias assessment of selected studies

Following data extraction for each paper, two independent assessors (MF and AB) completed an assessment of reporting quality using the Appraisal tool for Cross-Sectional Studies (AXIS) [27]. This checklist ensures all aspects of reporting, from introduction and objectives through to limitations and funding conflicts, are appropriately addressed in the publication of each study. Risk of bias of the included articles was assessed using the Quality In Prognosis Studies (QUIPS) tool [28]. This tool assesses six domains of potential biases: (1) study participation; (2) study attrition; (3) prognostic factor measurement; (4) outcome measurement; (5) study confounding; and (6) statistical analysis and reporting. For the purposes of this study, "prognostic factor measurement" was considered to be the sitting time. Criteria in each domain were evaluated as low, moderate or high risk using the criteria

described by Hayden et al. (2013)[28]. To best summarize our findings we then used a novel approach by generating an overall assessment of risk of bias for each study: low risk of bias (6 low, no high risk on any section), moderate (< 6 low, 1 high), high (2 or more high ratings in any of the 6 sections). The two assessors independently completed the quality assessment for each included study. The assessors subsequently met via video conference to discuss and reach a consensus. If no consensus could be reached a third assessor (JH) was available as a tie-breaker.

3. Results

3.1. Literature search and study selection

Six hundred and six articles were identified through the database searches and three papers were identified through review of the reference lists of relevant papers and a handsearch. Of these articles, we removed 248 duplicates. The titles and abstracts of the 361 remaining articles were screened, and of these 75 full papers were accessed for further review of eligibility. Sixty-five articles were excluded and the remaining 10 articles [25,29-37], including data for 330 participants, were included in this study (Figure 1).

3.2 Characteristics of included studies

Extracted data from the 10 included articles are found in Table 1. All but two (non-randomized cross-over, randomized cross-over) identified articles were cross-sectional in design and the majority were completed in North America with additional representation from Asia (Thailand, Japan, China), and Australia. Two studies were conducted in the field

[25,33] while the rest were conducted in a laboratory-controlled setting. Three studies [18,32,33] examined sitting in automobile seats while the rest of the studies used office-type chairs. Of the seven studies that examined an office-type chair, one study used a chair with the backrest removed [37].

All studies included time-controlled trials of sitting. Durations of sitting ranged from 1 hour to an average of 6.96 hours/day for 5 days (approximately 35 hours total). In all studies, ratings of perceived LBP or discomfort were made with either a C-10 Borg Scale [37], Visual Analog Scale (10 cm [18,30] or 100 mm [32,33,35]), the Nordic Muscukuloskeletal Questionnaire [25,31] or the 5-point Numerical Rating Scale [38]. Attempts were made to contact authors directly where pain rating data were presented with no reference to baseline measures. In all but 1 study, [35] pain ratings increased from baseline following the sitting exposure and, where presented, odds ratios of developing pain during the exposure were greater than 1.0. Kowalsky et al. reported that discomfort ratings were significantly higher in the sitting condition, however, less than half of the participants reported pain following the exposure (45%, OR 0.32).

3.3 Quality of reporting, risk of bias assessment and synthesis of evidence

Reporting in all included studies was appropriately done with some exceptions. Specficially, all included studies except one (Akkarakittichocke and Janwantanakul) failed to justify their sample size. Further, the selection process of all included studies would likely not have selected subjects representative of the target population and several studies did not fully discuss the limitations of their protocol (Table 2). Using the QUIPS tool, five of the 10 included studies were rated as having an overall low risk of bias [29,32,34,35,37] and five were

rated as having moderate risk of bias [25,30,31,33,36]. No study was rated as having an overall high risk of bias or as having a high risk of bias in any one domain. The author of one paper was contacted in order to clarify a question of sample size during the risk of bias assessment. Consensus was reached by the two assessors for all included studies without the need of engaging the third assessor. A summary of the risk of bias assessment is presented in Table 3. A sensitivity analysis was conducted including only the five studies that were rated with having an overall low risk of bias (n=121). Also among these studies, an increased pain rating from baseline following sitting exposure was also observed.

4. Discussion

4.1 Summary of findings

We found that sitting, for total durations ranging from 1 hour to 6.96 hours/day for 5 days is associated with immediate increases in LBP in people with and without a clinical history of LBP in both laboratory and field settings. Similar results were found when including only the studies with low risk of bias.

4.2 Interpretation of findings

The consistency of the above finding was high, with only the Kowalsky et al. [35] study reporting an odds ratio below 1. The study population included in Kowalsky et al. [35] can be classified as obese, with an average body mass index (BMI) of 31.9 +/- 5.0 kg/m^2, thus setting it apart from the populations studied in the rest of the included studies.

Where studies involved both asymptomatic and symptomatic groups [37,39], participants with a history of LBP reported higher levels of pain intensity than asymptomatic controls after an identical exposure to sitting in a laboratory setting [34,37]. However, it is noteworthy that the pain response, while lower, was evident in both people with and without LBP. Typically it is assumed that sitting aggravates existing cases of LBP [40], but we found that sitting also provoked pain in individuals without a history of LBP. At this point it is not known whether transient pain experienced by individuals in response to sitting is clinically relevant, predictive of future significant LBP or merely a nuisance. Future work is warranted in this area.

In six of the 10 studies, in both healthy and symptomatic participants, the increase in pain over the sitting exposure could be considered to surpase the threshold of minimal clinically important difference: having an increase of more than 2 points on a 10 point scale/20 mm on a 100 mm scale [41] (Table 1). It is interesting to note that this pain response is evident in both the laboratory and field settings. Laboratory studies provide extremently controlled environments which means that they are often not generalizable to the real world. However, evidence of this pain response is apparent after 90 minutes of driving in the field (n=40) [33] and across five working days in a real office setting (n= 75) [25], suggesting that this phenomenon is not restricted to the laboratory environment alone.

4.3 Comparison to existing literature

This systematic review of literature, having objective measures of sitting exposure, has found a positive relation between sitting and immediate increase in LBP. This result contradicts many studies that have not included an objective measure of exposure. Publication bias is

always a threat (i.e. where only studies finding a significant increase in reported LBP are published), and one must consider that this is the reason for the lack of studies showing no increase in LBP. However, LBP was not the main outcome measure in most of the studies included in this review; therefore, the likelihood of this problem should be low.

The literature is replete with inconsistent reports regarding the association between sitting and LBP with some studies showing a positive association [42-45], particularly in those who drive [46-54], whereas others do not [20,55-61]. The fact that both sitting and LBP are so prevalent in society, paired with the complex multi-factorial nature of LBP likely contribute to the confusion. Further, the relationship may be different for sub-sets of the general population (e.g. for individuals of different body mass, occupation and/or clinical history). In addition, this work shows a number of methodological factors play a role. Specifically, many studies rely on self-reported sitting time. Several studies have demonstrated that self-reported sitting time has low [62-65] to moderate [66] validity, and a direct comparison of self-reported sitting time and objectively measured sitting time has shown that self-reports can underestimate total sitting time [67]. This is not to say that the subjective experience of individuals regarding exposure is not important in the overall understanding of this problem; only that an accurate quantification of exposure is necessary to determine if a response (such as pain) is related to it. Either over- or under-reporting the exposure would not be helpful for answering this question. Similarly, re-call bias could be involved when a measure of LBP is not temporally related to the exposure (i.e. taken during or immediately after). To address this, our review searched specifically for evidence regarding this relationship based on objective measurements of sitting exposure, and included only those studies that reported ratings of pain immediately following or shortly after the exposure. From our findings, it is apparent that, at least for short-term durations, sitting does result in immediate increases in LBP

reporting. There are a number of ways a large scale study could objectively measure sitting exposure over more realistic durations of time. With the rapid improvements in wearable sensor technology, accelerometer-based measures of activity can easily be incorporated to track postures and confirm sitting durations [68]. Other options may include video monitoring, seat/desk based sensors or a combination of objective measures with self-report to increase accuracy. Regardless of how this is done, there is no doubt that improving estimates of exposure will vastly improve our ability to confidently determine the relationship between sitting and LBP.

4.5 Risk of bias assessments of the included studies (e.g., recruitment method, the inclusion of representative samples, small sample size, statistical analysis, etc.)

Half of the included studies in this review were rated as having a low risk of bias and half were rated as moderate risk of bias. To be conservative, the overall risk of bias of the data included in this review could be considered to be low-moderate. Most studies provided partial or no information about the method used to identify the population of interest, recruitment period and place of recruitment. Similarly, most studies did not provide details regarding potential confounding factors, such as the validity and reliability of the method used to measure confounders and appropriate accounting for confounding factors. A few studies failed to report the inclusion/exclusion criteria for participants and/or define LBP in the context of their studies. These details would be very straightforward to address in order to improve the quality of studies in the future, especially in laboratory-controlled cross-sectional designs.

4.6 Strengths and weaknesses of the current review

A strength of this current review is that a comprehensive and systematic search strategy was used to identify potential articles related to the research question. In particular, we specifically searched for articles that involved sitting over sedentary behaviour. This choice was made because sedentary behaviours, while including seated postures, also include lying down and reclining which we consider different enough to warrant separate analysis. Secondly, there was no limitation of language or time, which would minimize the chance of missing potential papers to include. Thirdly, the protocol from this review was registered prior to starting the project. With the exception of not being able to combine the data quantitatively in a meta-analysis due to heterogeneity (seat types, populations, study designs and study locations), there were no significant deviations from the planned protocol.

There were several limitations in the current review. First, while one field study did include exposures up to 6.96 hours/day for 5 days, the majority of the studies (8/10) were conducted in laboratories with sitting duration ranging from one hour to 3 hours often without control for postures and activities adopted by the participants prior to the data collection; therefore, these results may not be generalizable to the public. Second, six of the included studies used convenience sampling and 4/10 of the sample populations included participants between the ages of 18-35 which means that the results of this review may not be generalizable to the entire working population. Third, the majority of the included studies used a cross-sectional design. Given the short follow-up duration, the dose-response relationship between sitting duration and LBP in the long term remains unclear. Third, the quality assessment tool used, QUIPS, was designed to assess prognostic studies and not the cross-sectional studies that were included in this review. Since only the "prognostic factor" criteria was adapted to fit

these studies, it is the contention of the authors that the use of the tool in this case should provide an accurate assessment of risk of bias. Further, we developed a scheme to provide an overall score, which also deviates from the recommendation of the tool's authors [28]. The issue with this could be that a high risk of bias in any one domain would invalidate an otherwise good study. In our situation, this limitation does not change the overall interpretation of our findings and the method provided our reviewers with a straightforward and objective way to capture a summary risk of bias for each individual study. Finally, the sample sizes of the included studies were small, with each having less than 100 participants. As such, large-scale field-based experiments with long term follow-ups that objectively monitor sitting exposure with temporally linked ratings of LBP are warranted to better understand the relationship between sitting time and clinical episodes of LBP.

5. Conclusion

Objective measures of sitting time is associated with immediate increased ratings of perceived LBP in adults with and without a clinical history of LBP. It remains unknown whether this increase has clinical implications. No conclusion between sitting and clinically relevant episodes of LBP can be made. Future prospective studies should match objectively measured exposure with temporally related measures of pain to determine whether sitting time is a trigger of a clinical episode of LBP.

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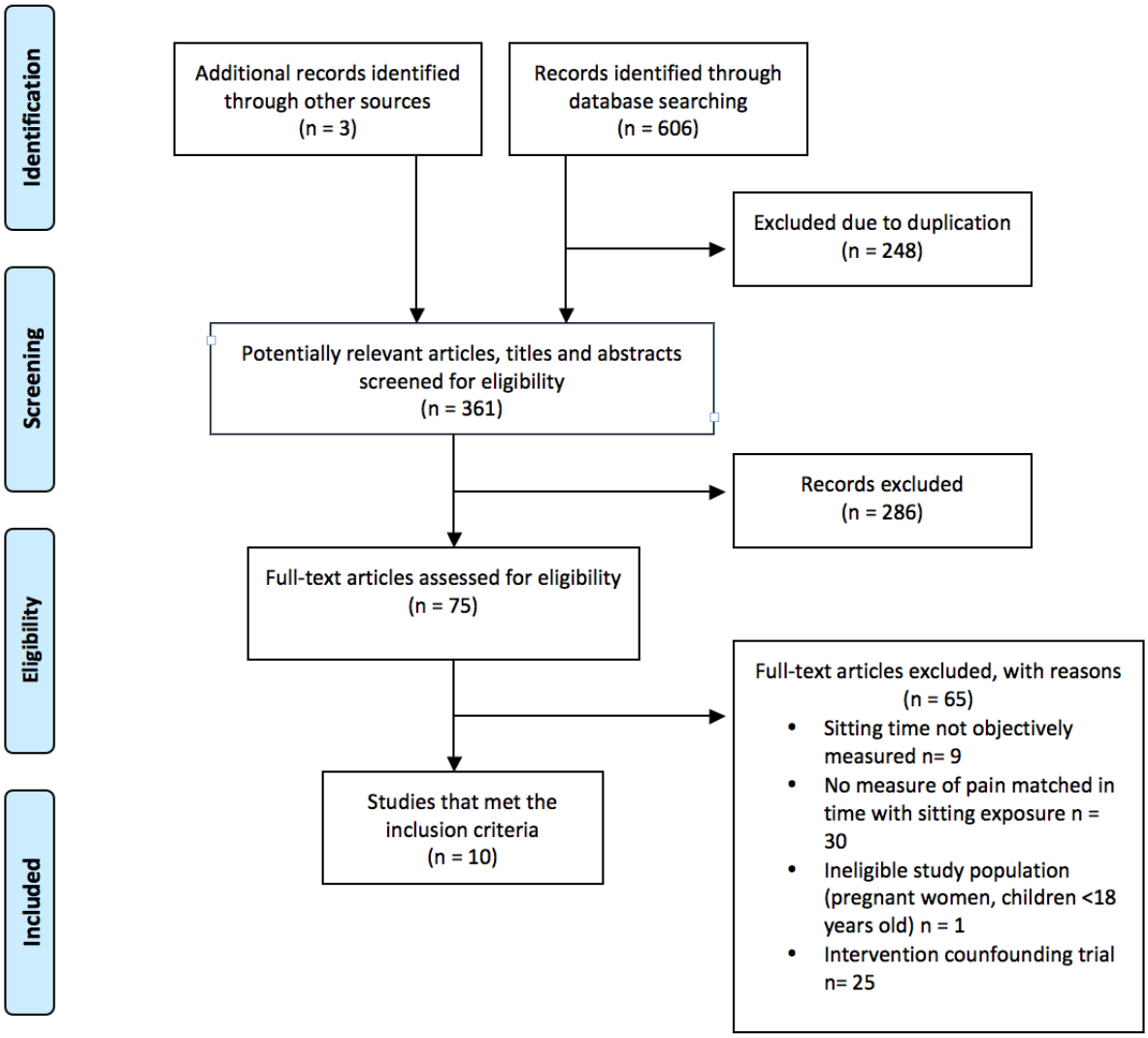

Figure 1: Prisma flow diagram outlining the results of our search strate

Table 1. Characteristics and results for the eleven included studies in alphabetical order. BMI: Body Mass Index; cm: centimeter; min: minutes; mm: millimeters; VAS: Visual Analog Scale.

Article	Design	Population	Exposure	Pain Measure	Pain Result	Pain Increase (*Clinically Relevant)
Akkarakittichoke and Janwantanakul 2017 (Thailand) [37]	Cross-Sectional (Lab)	46 participants (23 LBP, average age 29.6 years +/- 5.3; 23 control, average age 29.6 years +/- 5.1), reporting sitting at least 4 hours/work day with no current or past history of known spinal disorders, neurological defect, osteoarthritis, rhumatoid arthritis, gout, kidney diseases, open wound or contusion at the buttocks or posterior thigh region, hemorrhoids, current pregnancy, and BMI < kg/m^2 or > 23 kg/m^2.	Participants were exposed to sitting at a computer workstation on a backless office chair while typing a standardized text passage for **1 hour**.	C-10 Borg scale taken at 10 minute intervals throughout the sitting trial.	Pain rating data estimated from graphs: healthy participants at 0 min = 0.9 and 60 min = 2.9 (+2); LBP participants at 0 min = 0.9 and 60 min = 5.5 (+4.6).	Yes*
Aota et al., 2007 (Japan) [30]	Cross-Sectional (Lab)	31 male participants (average age 21.2 years +/- 0.6). Participants were free of backpain for a period of 6 months before and at the time of the study.	Participants were exposed to a **2 hour** exposure of constrained sitting in an experimental chair in 3 conditions (no lumbar support, with lumbar support and with continuous passive motion (CPM) lumbar support. Testing was completed on 3 consecutive days in a randomized presentation. For all sessions participants were free to read books and no specific instruction was given regarding sitting posture.	10 cm VAS with anchors of 0 cm "least" and 10 cm "the most discomfort experienced" taken immediately after the 2-hour sitting trial.	Mean pain rating data from the "no lumbar support"/control trial = 8.1cm +/- 1.5 following exposure. **Assume increase since participants were "free of backpain at the time of the study"*.	Yes*

Baker et al., 2018 (Australia) [31]	Cross-Sectional (Lab)	20 participants: 7 male (average age 32 SD 9.3 years, weight 49.6 SD 4.4 kg and height 180-.6 SD 6.2 cm) and 13 female (average age 36.2 SD 7.6 years, weight 64.2 SD 15.4 kg and height 166.5 SD 7.3 cm. Inclusion criteria were ages between 18-65 years, English and computer literacy and physical ability to sit for 2 hours. Exclusion criteria height and weight ranges that precluded proper setup of the workstation and individuals with pre-existing pain.	Participants were exposed to a **2 hour** exposure of sitting in a standard office chair, with backrest, at a workstation that had been adjusted to their size. Participants were free to sit and move as normally as possible, including the ability to stand up if needed (only 1 person did this). The standardized computer task invovlved a series of cognitive function tests that required both mouse and keyboard input.	Modified version of the Nordic Musculoskskletal Questionnaire to rate intensity of MSK discomfort between anchors of 0 ="no discomfort" and 100="discomfort as bad as it can be". Data were collected at baseline and at 30 minute intervals throughout the sitting trial.	Discomfort rates increased significantly over time for all body areas (Low back at 0 min = 4.8 (+/-7.2) and at 120 min = 16.3 (+/-14.3). Clinically meaningful discomfort increases from baseline were apparent by 90 or 120 minutes were statistically significant for the low back (120 min IRR= 4.20, $p \leq 0.001$).	Yes*
Cardoso et al., 2018 (Canada) [33]	Cross-Sectional (Field)	40 participants (20 male, 20 female; average age 50.4 years +/- 13.4) with a valid class 1,2 or 3 driver's license and experience driving a standard transmission.	Participants were recruited to drive a long haul truck (without a trailor) for a **90 minute** round trip along a portion of the Trans Canada Highway on two separate days in a random presentation. Prior to each driving session the participants were fitted to each truck seat according to best ergonomic practices and preferred configuration.	100 mm VAS with anchors of 0 mm "no discomfort" and 100 mm "worst discomfort imaginable" taken at baseline and after 45 and 90 minutes of driving.	Mean pain rating data averaged between left and right sides = increase of 9.65% over the exposure.	Yes

Cardoso et al., 2018 (Canada) [32]	Cross-Sectional (Lab)	20 participants (10 male average age 22.3 years +/- 2.16, 10 female average age 22.1 years +/- 0.8) with no history of back injury or pain within the previous month.	Participants completed two, **2 hour** laboratory sessions, on separate days in a random order where they completed a simulated driving trial in a control and test truck seat.	100 mm VAS with anchors of 0 mm "no discomfort" and 100 mm "worst discomfort imaginable" taken at 15 minute intervals throughout the sitting trial.	Mean pain rating data averaged between left and right sides = increase of 6% of over the exposure.	Yes
De Carvalho and Callaghan, 2011 (Canada) [36]	Cross-Sectional (Lab)	20 participants (10 male average age 26.4 years +/- 3.5 and 10 female average age 25.2 +/- 3.2) free of low back pain.	Participants were exposed to **2 hours** of simulated driving in an automobile seat.	10 cm VAS for head/neck, shoulders, upper and low back pain at baseline, after 1 hour and after 2 hours. Anchors of 0 = "no discomfort at all" and 10 = "worst discomfort imaginable" taken at baseline and after the first and second hour of sitting.	Perceived pain ratings for males: baseline = 0 cm, 2 hours = 18 cm (+18) and females: baseline = 0 cm, 2 hours = 20 cm (+20).	Yes*

Dunk and Callaghan, 2010 (Canada) [69]	Cross-Sectional (Lab)	32 participants (16 with sitting aggravated low back pain were age and gender matched to 16 asymptomatic controls). Exclusion criteria included a previous diagnosis of a neurological deficit and/or lower extermity impairment, stenosis, spondylolisthesis, recent fracture, severe structural deformity or previous surgical intervention.	Participants were exposed to **90 minutes** of sitting while completing simulated office tasks in 15 minute intervals: (1) mouse task, (2) typing task (3) combination mouse and typing task. The three tasks were presented in a random order and then repeated in the same order.	10 cm VAS at baseline and 15 minute intervals throughout the sitting trial for three regions of the low back: central and right and left sides. Anchors of 0 = "no discomfort" to 10 = "worst discomfort imaginable".	Perceived back pain ratings were presented as differences from baseline and were approximated from graphs: asymptomatic participants 0 min = 0 mm, 90 = 2 mm (+2 mm), and clinical participants 0 mm, 90 min = 20 mm (+20 mm).	Yes*
Foley et al., 2016 (Australia) [25]	Non-Randomized Cross-over (Field)	78 adult participants (50 males and 38 females) ranging in age from 22-63 who had ongoing employment with the company and no planned upcoming leave and sufficient English language proficiency.	Participants completed three phases: baseline (regular office, **5 days**), intervention (activity-based work, 4 weeks) and then follow up (regular office, 5 days). Meaurements in each environment were collected over a 5 day period during work hours. Sitting exposure measured by accelerometer: (Percentage of sedentary time) Baseline = 80.28%, Intervention = 81.41% and Follow up = 82.01%. Average hours per week = 43.39; therefore, these percentages approximately translate to an 8.678 hour workday. Baseline = **6.96** Intervention = 7.06, and Follow up = 7.11 hours of sitting per day.	MSK discomfort in the last 7 days was rated with the Nordic Musculoskeletal Discomfort Questionnaire) at baseline, after at least 2 weeks of the 4 week intervention and 3 weeks following the end of the intervention.	MSK discomfort results: Participants were twice as likely to report low back pain at baseline compared with during the intervention (OR 1.98, 95% CI 1.06 to 3.67); lower odds of reporting pain were found comparing baseline with follow-up (OR 1.43, 95% CI 0.81-2.51) and intervention with follow-up (OR 0.72 95% CI 0.38-1.37).	Yes

Kowalsky et al., 2018 (USA) [35]	Randomized Cross-over (Lab)	25 overweight participants (16 male and 9 female) with an average age of 42 years (SD 12) were recruited from the general population. Inclusion criteria required all participants to be in active (<90 min of moderate to vigorous activity per week), not be taking any medications that could effect cardiometabolic responses and spend at least 20 hours/week sitting at a desk. Exclusion criteria included a cardiovascular event in the past 6 months, atrial fibrillation, being in a weight loss program, being treated for heart disease, cancer, end stage renal disease or any other serious condition, smoking on most day sof the week, being pregnant in the past 6 months, breastfeeding in the past 3 months or not being able to stand.	Participants were randomized to a SIT or SIT/STAND condition on two separate days at least 5 days, but not more than 14 days apart. The study schedule (including breakfast and lunch) were standardized (30% daily caloric need: 55% carbohydrate, 35% fat and 10% protein) and they completed non-standardized desk work for two 3 hour and 40 minute periods (morning and afternoon, total exposure time = **7.3 hours**). To increase generalizability participants were able to go to the washroom as needed and move as naturally as they could in each condition with the goal of remaining at the desk (sitting or standing).	Discomfort rated on a 100 point scale that ranged from no discomfort to extreme discomfort for 15 separate body regions was taken at baseline and then every 2 hours during the trial.	Discomfort ratings were significantly higher in the SIT condition compared to the SIT-STAND condition. Percentage of participants reporting discomfort following the SIT trial: 45% (OR=0.32). Increase in rating (log points) from 0.4 to 1.0.	No
Li et al., 2017 [29] (China)	Cross-Sectional (Lab)	18 healthy subjects (12 males and 6 females) ranging in age from 18-39 years.	Participants were seated for **3 hours** in three different seat pitch (32 inches, 30 inches and 28 inches) conditions in a laboratory.	Discomfort (collected using a body map and 5-point Numerical Rating Scale). Taken after 5 minutes of the sitting trial and then at 30 minute intervals until the end of the trial.	Overall discomfort rating for the 28 inch pitch (control) condition: 0 hr = 1.02, 3.0 hr = 3.31 (+2.29).	Yes*

Table 2: Assessment of reporting quality using the AXIS tool.

			Akkarakittichoke, N. and Janwantanakul,P. (2017)	Aota,Y et al. (2007)	Baker et al. (2018)	Cardoso, M. et al. (Lab, 2018)	Cardoso, M. et al. (Field, 2018)	De Carvalho D. and Callaghan J.P. (2011)	Dunk, N. M. and Callaghan ,J. P. (2010)	Foley,B et al. (2016)	Kowalsky et al. (2018)	Li W. et al. (2017)
Introduction	1	*Were the aims/objectives of the study clear?*	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Methods	2	*Was the study design appropriate for the stated aim(s)?*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	3	*Was the sample size justified?*	Yes	No	No	No	No	No	No	No	No	No
	4	*Was the target/reference population clearly defined? (Is it clear who the research was about?)*	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	5	*Was the sample frame taken from an appropriate population base so that it closely represented the target/reference population under investigation?*	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No
	6	*Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?*	No	No	No	No	No	No	No	No	No	No
	7	*Were measures undertaken to address and categorise non-responders?*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	8	*Were the risk factor and outcome variables measured appropriate to the aims of the study?*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	9	*Were the risk factor and outcome variables measured correctly using instruments/measurements that had been trialled, piloted or published previously?*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	10	*Is it clear what was used to determined statistical significance and/or precision estimates? (e.g. p-values, confidence intervals)*	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
	11	*Were the methods (including statistical methods) sufficiently described to enable them to be repeated?*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Results	12	*Were the basic data adequately described?*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	13	*Does the response rate raise concerns about non-response bias?*	No	No	No	No	Unsure	No	No	No	No	No
	14	*If appropriate, was information about non-responders described?*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	15	*Were the results internally consistent?*	Yes	No	Unsure	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	16	*Were the results presented for all the analyses described in the methods?*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Discussion	17	*Were the authors' discussions and conclusions justified by the results?*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	18	*Were the limitations of the study discussed?*	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes	Yes
Other	19	*Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?*	No	No	No	No	No	No	No	No	No	No
	20	*Was ethical approval or consent of participants attained?*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3: Assessment of Methodological Quality using the QUIPS Tool for the 10 included articles in alphabetical order.

Article	Study Population	Study Attrition	Prognostic Factor Measurement	Outcome Measure	Study Confounding	Statistical Analysis and Presentation	Overall Risk of Bias
Akkarakittichoke and Janwantanakul 2017	Low Risk	Low Risk	Low Risk	Low Risk	Moderate Risk	Low Risk	Low Risk
Aota et al., 2007	Moderate Risk	Low Risk	Low Risk	Low Risk	Low Risk	Moderate Risk	Moderate Risk
Baker et al., 2018	Moderate Risk	Low Risk	Low Risk	Low Risk	Moderate Risk	Low Risk	Moderate Risk
Cardoso et al., 2018a	Moderate Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Cardoso et al., 2018b	Moderate Risk	Low Risk	Low Risk	Low Risk	Moderate Risk	Low Risk	Moderate Risk
De Carvalho and Callaghan, 2011	Moderate Risk	Low Risk	Low Risk	Low Risk	Moderate Risk	Low Risk	Moderate Risk
Dunk and Callaghan, 2010	Moderate Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Foley et al., 2016	Low Risk	Moderate Risk	Moderate Risk	Low Risk	Moderate Risk	Low Risk	Moderate Risk
Kowalsky et al., 2018	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Moderate Risk	Low Risk
Li et al., 2017	Low Risk	Low Risk	Low Risk	Low Risk	Moderate Risk	Low Risk	Low Risk

REFERENCES

1. Hartvigsen J, Hancock MJ, Kongsted A, et al. What low back pain is and why we need to pay attention. *Lancet*. 2018;391(10137):2356-2367.

2. Damkot DK, Pope MH, Lord J, Frymoyer JW. The relationship between work history, work environment and low-back pain in men. *Spine*. 1984;9(4):395-399.

3. Majeske C, Buchanan C. Quantitative description of two sitting postures. with and without a lumbar support pillow. *Phys Ther*. 1984;64(10):1531-1535.

4. De Carvalho DE, Callaghan JP. Influence of automobile seat lumbar support prominence on spine and pelvis postures: A radiological investigation. . 2009.

5. Dunk NM, Callaghan JP. Gender-based differences in postural responses to seated exposures. *Clin Biomech (Bristol, Avon)*. 2005;20(10):1101-1110.

6. Gregory DE, Dunk NM, Callaghan JP. Stability ball versus office chair: Comparison of muscle activation and lumbar spine posture during prolonged sitting. *Hum Factors*. 2006;48(1):142-153.

7. Grondin DE, Triano JJ, Steven T, Soave D. The effect of a lumbar support pillow on lumbar posture and comfort during a prolonged seated task. *Chiropr Man Therap*. 2013;21(1):21.

8. Nairn BC, Azar NR, Drake JD. Transient pain developers show increased abdominal muscle activity during prolonged sitting. *J Electromyogr Kinesiol*. 2013;23(6):1421-1427.

9. O'Sullivan K, McCarthy R, White A, O'Sullivan L, Dankaerts W. Lumbar posture and trunk muscle activation during a typing task when sitting on a novel dynamic ergonomic chair. *Ergonomics*. 2012;55(12):1586-1595.

10. Schinkel-Ivy A, Nairn BC, Drake JD. Investigation of trunk muscle co-contraction and its association with low back pain development during prolonged sitting. *J Electromyogr Kinesiol*. 2013;23(4):778-786.

11. De Carvalho DE, Soave D, Ross K, Callaghan JP. Lumbar spine and pelvic posture between standing and sitting: A radiologic investigation including reliability and repeatability of the lumbar lordosis measure. *J Manipulative Physiol Ther*. 2010;33(1):48-55.

12. De Carvalho D. *Spine biomechanics of prolonged sitting: Exploring the effect chair features, walking breaks and spine manipulation have on posture and perceived pain in men and women.* [Doctor of Philosophy]. University of Waterloo; 2015.

13. Solomonow M. Ligaments: A source of musculoskeletal disorders. *J Bodywork Movement Ther*. 2009;13(2):136-154.

14. Alexander LA, Hancock E, Agouris I, Smith FW, MacSween A. The response of the nucleus pulposus of the lumbar intervertebral discs to functionally loaded positions. *Spine*. 2007;32(14):1508-1512.

15. McGill SM, Hughson RL, Parks K. Lumbar erector spinae oxygenation during prolonged contractions: Implications for prolonged work. *Ergonomics*. 2000;43(4):486-493.

16. Fenety A, Putnam C, Walker JM. In-chair movement: Validity, reliability and implications for measuring sitting discomfort. *Appl Ergon*. 2000;31(4):383-393.

17. Beach TA, Parkinson RJ, Stothart JP, Callaghan JP. Effects of prolonged sitting on the passive flexion stiffness of the in vivo lumbar spine. *Spine J*. 2005;5(2):145-154.

18. De Carvalho DE, Callaghan JP. Passive stiffness changes in the lumbar spine and effect of gender during prolonged simulated driving. *Int J Ind Ergonomics*. 2011;41(6):617-624.

19. Lis AM, Black KM, Korn H, Nordin M. Association between sitting and occupational LBP. *Eur Spine J*. 2007;16(2):283-298.

20. Hartvigsen J, Leboeuf-Yde C, Lings S, Corder EH. Is sitting-while-at-work associated with low back pain? A systematic, critical literature review. *Scand J Public Health*. 2000;28(3):230-239.

21. Clemes SA, O'Connell SE, Edwardson CL. Office workers' objectively measured sedentary behavior and physical activity during and outside working hours. *J Occup Environ Med*. 2014;56(3):298-303.

22. Jans MP, Proper KI, Hildebrandt VH. Sedentary behavior in dutch workers: Differences between occupations and business sectors. *Am J Prev Med*. 2007;33(6):450-454.

23. Kazi A, Duncan M, Clemes S, Haslam C. A survey of sitting time among UK employees. *Occup Med (Lond)*. 2014;64(7):497-502.

24. van der Ploeg HP, Moller SV, Hannerz H, van der Beek AJ, Holtermann A. Temporal changes in occupational sitting time in the danish workforce and associations with all-cause mortality: Results from the danish work environment cohort study. *Int J Behav Nutr Phys Act*. 2015;12:71-015-0233-1.

25. Foley B, Engelen L, Gale J, Bauman A, Mackey M. Sedentary behavior and musculoskeletal discomfort are reduced when office workers trial an activity-based work environment. *J Occup Environ Med*. 2016;58(9):924-931.

26. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Int J Surg*. 2010;8(5):336-341.

27. Downes MJ, Brennan ML, Williams HC, Dean RS. Development of a critical appraisal tool to assess the quality of cross-sectional studies (AXIS). *BMJ Open*. 2016;6(12):e011458.

28. Hayden JA, van der Windt DA, Cartwright JL, Cote P, Bombardier C. Assessing bias in studies of prognostic factors. *Ann Intern Med*. 2013;158(4):280-286.

29. Li W., Yu S., Yang H., Pei H., Zhao C. Effects of long-duration sitting with limited space on discomfort, body flexibility, and surface pressure. *Int J Ind Ergon*. 2017;58:12-24. doi: 10.1016/j.ergon.2017.01.002.

30. Aota Y, Iizuka H, Ishige Y, et al. Effectiveness of a lumbar support continuous passive motion device in the prevention of low back pain during prolonged sitting. *Spine (Phila Pa 1976)*. 2007;32(23):E674-7.

31. Baker R, Coenen P, Howie E, Williamson A, Straker L. The short term musculoskeletal and cognitive effects of prolonged sitting during office computer work. *Int J Environ Res Public Health*. 2018;15(8):10.3390/ijerph15081678.

32. Cardoso M, McKinnon C, Viggiani D, Johnson MJ, Callaghan JP, Albert WJ. Biomechanical investigation of prolonged driving in an ergonomically designed truck seat prototype. *Ergonomics*. 2018;61(3):367-380.

33. Cardoso M, Fulton F, McKinnon C, Callaghan JP, Johnson MJ, Albert WJ. Ergonomic evaluation of a new truck seat design: A field study. *Int J Occup Saf Ergon*. 2018:1-13.

34. Dunk NM, Callaghan JP. Lumbar spine movement patterns during prolonged sitting differentiate low back pain developers from matched asymptomatic controls. *Work*. 2010;35(1):3-14.

35. Kowalsky RJ, Perdomo SJ, Taormina JM, et al. Effect of using a sit-stand desk on ratings of discomfort, fatigue, and sleepiness across a simulated workday in overweight and obese adults. *J Phys Act Health*. 2018;15(10):788-794.

36. De Carvalho DE, Callaghan JP. Passive stiffness changes in the lumbar spine and effect of gender during prolonged simulated driving. *Int J Ind Ergonomics*. 2011;41(6):617-624.

37. Akkarakittichoke N, Janwantanakul P. Seat pressure distribution characteristics during 1 hour sitting in office workers with and without chronic low back pain. *Saf Health Work*. 2017;8(2):212-219.

38. Li W, Yu S, Yang H, Pei H, Zhao C. Effects of long-duration sitting with limited space on discomfort, body flexibility, and surface pressure. *International Journal of Industrial Ergonomics*. 2017;58:12-24. doi: https://doi.org/10.1016/j.ergon.2017.01.002.

39. Dunk NM, Callaghan JP. Lumbar spine movement patterns during prolonged sitting differentiate low back pain developers from matched asymptomatic controls. *Work*. 2010;35(1):3-14.

40. Pengel LH, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: Systematic review of its prognosis. *BMJ*. 2003;327(7410):323.

41. Sokka T. Assessment of pain in rheumatic diseases. *Clin Exp Rheumatol*. 2005;23(5 Suppl 39):S77-84.

42. Lis AM, Black KM, Korn H, Nordin M. Association between sitting and occupational LBP. *Eur Spine J*. 2007;16(2):283-298.

43. Frymoyer JW, Pope MH, Costanza MC, Rosen JC, Goggin JE, Wilder DG. Epidemiologic studies of low-back pain. *Spine (Phila Pa 1976)*. 1980;5(5):419-423.

44. Magora A. Investigation of the relation between low back pain and occupation. 3. physical requirements: Sitting, standing and weight lifting. *IMS Ind Med Surg*. 1972;41(12):5-9.

45. Wilder DG, Pope MH, Frymoyer JW. The biomechanics of lumbar disc herniation and the effect of overload and instability. *J Spinal Disord*. 1988;1(1):16-32.

46. Akinbo SR, Odebiyi DO, Osasan AA. Characteristics of back pain among commercial drivers and motorcyclists in lagos, nigeria. *West Afr J Med*. 2008;27(2):87-91.

47. Andrusaitis SF, Oliveira RP, Barros Filho TE. Study of the prevalence and risk factors for low back pain in truck drivers in the state of sao paulo, brazil. *Clinics*. 2006;61(6):503-510.

48. Chen JC, Chang WR, Chang W, Christiani D. Occupational factors associated with low back pain in urban taxi drivers. *Occup Med (Lond)*. 2005;55(7):535-540.

49. Costa G, Sartori S, Facco P, Apostoli P. Health conditions of bus drivers in a 6 year follow up study. *J Hum Ergol (Tokyo)*. 2001;30(1-2):405-410.

50. Gyi DE, Porter JM. Musculoskeletal problems and driving in police officers. *Occup Med (Lond)*. 1998;48(3):153-160.

51. Krause N, Rugulies R, Ragland DR, Syme SL. Physical workload, ergonomic problems, and incidence of low back injury: A 7.5-year prospective study of san francisco transit operators. *Am J Ind Med*. 2004;46(6):570-585.

52. Okunribido OO, Shimbles SJ, Magnusson M, Pope M. City bus driving and low back pain: A study of the exposures to posture demands, manual materials handling and whole-body vibration. *Appl Ergon*. 2007;38(1):29-38.

53. Pietri F, Leclerc A, Boitel L, Chastang JF, Morcet JF, Blondet M. Low-back pain in commercial travelers. *Scand J Work Environ Health*. 1992;18(1):52-58.

54. Szeto GP, Lam P. Work-related musculoskeletal disorders in urban bus drivers of hong kong. *J Occup Rehabil*. 2007;17(2):181-198.

55. Korshoj M, Jorgensen MB, Hallman DM, Lagersted-Olsen J, Holtermann A, Gupta N. 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(5):530-538.

56. Chen SM, Liu MF, Cook J, Bass S, Lo SK. Sedentary lifestyle as a risk factor for low back pain: A systematic review. *Int Arch Occup Environ Health*. 2009;82(7):797-806.

57. Kwon BK, Roffey DM, Bishop PB, Dagenais S, Wai EK. Systematic review: Occupational physical activity and low back pain. *Occup Med (Lond)*. 2011;61(8):541-548.

58. Roffey DM, Wai EK, Bishop P, Kwon BK, Dagenais S. Causal assessment of occupational sitting and low back pain: Results of a systematic review. *Spine J*. 2010;10(3):252-261.

59. Lunde LK, Koch M, Knardahl S, Veiersted KB. 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(3):269-278.

60. Hartvigsen J, Leboeuf-Yde C, Lings S, Corder EH. Does sitting at work cause low back pain? *Ugeskr Laeger*. 2002;164(6):759-761.

61. Korshoj M, Hallman DM, Mathiassen SE, Aadahl M, Holtermann A, Jorgensen MB. 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(1):96-105.

62. Clark BK, Thorp AA, Winkler EA, et al. Validity of self-reported measures of workplace sitting time and breaks in sitting time. *Med Sci Sports Exerc*. 2011;43(10):1907-1912.

63. Gardiner PA, Clark BK, Healy GN, Eakin EG, Winkler EA, Owen N. Measuring older adults' sedentary time: Reliability, validity, and responsiveness. *Med Sci Sports Exerc*. 2011;43(11):2127-2133.

64. Marshall AL, Miller YD, Burton NW, Brown WJ. Measuring total and domain-specific sitting: A study of reliability and validity. *Med Sci Sports Exerc*. 2010;42(6):1094-1102.

65. Aguilar-Farias N, Brown WJ, Olds TS, Geeske Peeters GM. Validity of self-report methods for measuring sedentary behaviour in older adults. *J Sci Med Sport*. 2015;18(6):662-666.

66. Pedersen SJ, Kitic CM, Bird ML, Mainsbridge CP, Cooley PD. Is self-reporting workplace activity worthwhile? validity and reliability of occupational sitting and physical activity questionnaire in desk-based workers. *BMC Public Health*. 2016;16(1):836-016-3537-4.

67. Lagersted-Olsen J, Korshoj M, Skotte J, Carneiro IG, Sogaard K, Holtermann A. Comparison of objectively measured and self-reported time spent sitting. *Int J Sports Med*. 2014;35(6):534-540.

68. Wong AYL, Chan TPM, Chau AWM, et al. Do different sitting postures affect spinal biomechanics of asymptomatic individuals? *Gait Posture*. 2019;67:230-235.

69. Dunk NM, Kedgley AE, Jenkyn TR, Callaghan JP. Evidence of a pelvis-driven flexion pattern: Are the joints of the lower lumbar spine fully flexed in seated postures? *Clin Biomech (Bristol, Avon)*. 2009;24(2):164-168.

Appendix

Search Specifics:

PubMed

Conducted 20 October 2017, 189 results

("Back Pain"[Mesh] OR ((discomfort[tw] OR pain*[tw] OR ache*[tw] OR aching[tw]) AND (back[tw] OR thoracic[tw] OR thorax[tw] OR lumbar[tw])) OR backache*[tw] OR dorsalgia[tw] OR LBP[tw] OR lumbago[tw] OR "Sciatica"[Mesh] OR sciatica[tw] OR "Radiculopathy"[Mesh] OR radiculopath*[tw]) AND (sitting[tw]) AND ("Monitoring, Ambulatory"[Mesh] OR "Monitoring, Physiologic"[Mesh] OR "Video Recording"[Mesh] OR "Task Performance and Analysis"[Mesh] OR "Accelerometry"[Mesh] OR "Actigraphy"[Mesh] OR acceleromet*[tw] OR actigraph*[tw] OR gyroscop*[tw] OR sensor[tw] OR sensors[tw] OR device*[tw] OR wearable[tw] OR inertial[tw] OR "motion capture"[tw] OR "motion analysis"[tw] OR lab[tw] OR laborator*[tw] OR video[tw] OR videorecord*[tw] OR videotap*[tw] OR "objectively measured"[tw])

Embase

Conducted 20 October 2017, 248 results

('backache'/exp OR ((discomfort:ab,ti OR pain*:ab,ti OR ache*:ab,ti OR aching:ab,ti) AND (back:ab,ti OR thoracic:ab,ti OR thorax:ab,ti OR lumbar:ab,ti)) OR backache*:ab,ti OR dorsalgia:ab,ti OR lbp:ab,ti OR lumbago:ab,ti OR 'sciatica'/de OR sciatica:ab,ti OR 'radiculopathy'/exp OR radiculopath*:ab,ti) AND sitting:ab,ti AND ('ambulatory monitoring'/de OR 'physiologic monitoring'/exp OR 'videorecording'/de OR 'task performance'/de OR 'accelerometry'/de OR 'actimetry'/de OR acceleromet*:ab,ti OR actigraph*:ab,ti OR gyroscop*:ab,ti OR sensor:ab,ti OR sensors:ab,ti OR device*:ab,ti OR wearable:ab,ti OR inertial:ab,ti OR 'motion capture':ab,ti OR 'motion analysis':ab,ti OR lab:ab,ti OR laborator*:ab,ti OR video*:ab,ti OR 'objectively measured':ab,ti)

CINAHL

Conducted 20 October 2017, 78 results

(MH "Back Pain" OR ((TI discomfort OR TI pain* OR TI ache* OR TI aching OR AB discomfort OR AB pain* OR AB ache* OR AB aching) AND (TI back OR TI thoracic OR TI thorax OR TI lumbar OR AB back OR AB thoracic OR AB thorax OR AB lumbar)) OR

TI backache* OR AB backache* OR TI dorsalgia OR AB dorsalgia OR TI LBP OR AB LBP OR TI lumbago OR AB lumbago OR MH "Sciatica" OR TI sciatica OR AB sciatica OR MH "Radiculopathy" OR TI radiculopath* OR AB radiculopath*) AND (MH "Sitting" OR TI sitting OR AB sitting) AND (MH "Monitoring, Physiologic" OR MH "Videorecording" OR MH "Task Performance and Analysis" OR MH "Accelerometry" OR MH "Actigraphy" OR TI acceleromet* OR AB acceleromet* OR TI actigraph* OR AB actigraph* OR TI gyroscop* OR AB gyroscop* OR TI sensor OR AB sensor OR TI sensors OR AB sensors OR TI device* OR AB device* OR TI wearable OR AB wearable OR TI inertial OR AB inertial OR TI "motion capture" OR AB "motion capture" OR TI "motion analysis" OR AB "motion analysis" OR TI lab OR AB lab OR TI laborator* OR AB laborator* OR TI video* OR AB video* OR TI "objectively measured" OR AB "objectively measured")

SPORTDiscus
Conducted 20 October 2017, 28 results
(DE "BACKACHE" OR DE "LUMBAR pain" OR ((TI discomfort OR TI pain* OR TI ache* OR TI aching OR AB discomfort OR AB pain* OR AB ache* OR AB aching) AND (TI back OR TI thoracic OR TI thorax OR TI lumbar OR AB back OR AB thoracic OR AB thorax OR AB lumbar)) OR TI backache* OR AB backache* OR TI dorsalgia OR AB dorsalgia OR TI LBP OR AB LBP OR TI lumbago OR AB lumbago OR DE "SCIATICA" OR TI sciatica OR AB sciatica OR DE "RADICULOPATHY" OR TI radiculopath* OR AB radiculopath*) AND (DE "SITTING position" OR TI sitting OR AB sitting) AND (DE "PATIENT monitoring" OR DE "ACCELEROMETERS" OR DE "SPEEDOMETERS" OR TI acceleromet* OR AB acceleromet* OR TI actigraph* OR AB actigraph* OR TI gyroscop* OR AB gyroscop* OR TI sensor OR AB sensor OR TI sensors OR AB sensors OR TI device* OR AB device* OR TI wearable OR AB wearable OR TI inertial OR AB inertial OR TI "motion capture" OR AB "motion capture" OR TI "motion analysis" OR AB "motion analysis" OR TI lab OR AB lab OR TI laborator* OR AB laborator* OR TI video* OR AB video* OR TI "objectively measured" OR AB "objectively measured")