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The effect of rest break schedule on acute low back pain development in pain and non-pain developers during seated work

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ABSTRACT

A significant portion of the population (25–50%) is known to develop acute low back pain (LBP) within a bout of prolonged sitting. Previous research has supported the use of frequent rest breaks, from seated office work, in order to reduce self-reported LBP, however, there is limited consensus about the recommended frequency and duration of rest breaks. This may be due to the limited consideration of individual differences in acute LBP development. The purpose of this study was to examine the effect of three different standing rest-break conditions on a group of pain developers (PD) and non-pain developers (NPD) engaged in prolonged seated work. Twenty participants completed four one-hour-long bouts of seated typing: Condition A – no rest; Condition B – 5 min of standing rest every 30 min; Condition C – 2.5 min of standing rest every 15 min; Condition D – 50 s of standing rest every 5 min. Self-reported LBP, self-reported mental fatigue and 30-s samples of EMG were collected every 10 min throughout each session. Eight out of 20 participants (40%) reported LBP during Condition A (classified as PD). Only PD demonstrated clinically relevant increases in LBP across conditions where Conditions B, C, or D provided some relief, but did not restore pain scores to their original level, prior to sitting. PD and NPD developed mental fatigue equally, with Conditions B and D helping to reduce fatigue. No differences in productivity were observed between conditions or groups and no main effects were observed for muscle activity, median power frequency or co-contraction. These data suggests that frequent, short, standing rest breaks may help to reduce symptoms of LBP, however they are only a temporary solution as PD still developed clinically important LBP, even with frequent rest breaks.

1. Introduction

Prolonged sitting is a work-related factor commonly associated with the development of acute low back pain (LBP) (Andersson, 1999; Kelsey and Golden, 1988). Considering the average American spends approximately 8 h per day engaged in various forms of sitting (Matthews et al., 2008), LBP continues to be a significant and increasing concern in workplaces (American Association of Orthopedic Surgeons NOW, 2009). Given the ubiquitous nature of sitting in Western society, proactive methods for reducing acute LBP should be at the forefront of research efforts.

Curiously, not all those who sit or stand for long periods develop LBP. In controlled laboratory studies, during prolonged sitting or standing, 25–50% of participants develop self-reported back pain where this sub-population has been termed "responders" or "pain developers" (PD) (Schinkel-Ivy et al., 2013; Nairn et al., 2013; Mork and Westgaard, 2009; Nelson-Wong and Callaghan, 2010b). Within this paradigm, individuals are classified as PD if they self-report VAS discomfort scores that increase substantially over time. The definition for substantial increase has varied between 10 mm on a 100 mm VAS scale (Nelson-Wong and Callaghan, 2010b; Schinkel-Ivy et al., 2013; Nairn et al., 2013) to 2 units on a 10 unit VAS scale (Mork and Westgaard, 2009). In prolonged sitting situations, PD demonstrate unique movement and muscle activation characteristics (Mork and Westgaard, 2009; Schinkel-Ivy et al., 2013; Nairn et al., 2013). For example, elevated co-contraction indices (CCI) and muscle activation in the trunk region were observed in PD, when completing two hours of prolonged sitting (Nairn et al., 2013; Schinkel-Ivy et al., 2013). Additionally, participants who develop acute-LBP while sitting demonstrate increased sagittal plane trunk movement, more fidgeting and larger whole body shifts during sitting (Willigenburg et al., 2013; Dunk and Callaghan, 2010). While it is unclear if PD have developed these alternate responses as a precursor, or consequence of increasing pain; it is clear that PD and

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non-PD (NPD) represent different responses. As such, it is important to study how interventions might affect both PD and NPD.

At present, with respect to rest-breaks while working, workplace guidelines in Ontario state that “An employer shall give an employee an eating period of at least 30 min at intervals that will result in an employee working no more than five consecutive hours without an eating period” (Ministry of Labour, 2004). Given emerging evidence suggesting that PD and NPD respond differently to prolonged sitting; employers, policymakers and employees may benefit from considering individual differences between workers when trying to establish ergonomic hazard controls, such as a rest break schedule.

Periodic rest breaks have been identified as a way to reduce the onset and severity of acute LBP. Previous research has shown that scheduled rest breaks can reduce self-report discomfort at the low back by as much as 35%; while maintaining, and in some cases, improving work productivity (Henning et al., 1997; Balci and Aghazadeh, 2004; McLean et al., 2001). At one of two worksites, Henning et al. (1997) found that both productivity and overall body comfort improved with the introduction of rest breaks at 15-min intervals over the course of a six-week intervention. Compared to a no-break group, productivity was also improved by 5% with the introduction of the rest breaks. These findings however, were not replicated at the second, larger worksite during the study. Elsewhere, Balci & Aghazadeh (2004) support scheduling breaks at 15-min intervals as the most effective schedule for reducing physical discomfort at the neck, low back and chest, while improving worker productivity, speed and accuracy during prolonged sitting. A 5-min rest break every 30 min, during seated work was most beneficial however, for reducing blurred vision, eyestrain and physical discomfort at a number of other body locations. Implementing these recommendations poses a challenge as the exact nature of the prescribed rest breaks were not well described (i.e., standing, sitting, talking with a coworker, stretching). It is likely that the activities completed during a rest interval can affect the utility of the break in alleviating physical and mental discomfort. Given the evidence suggesting that a combination of sitting and standing is beneficial for reducing musculoskeletal discomfort (Gallagher et al., 2014), recording the exact nature of these rest breaks is paramount. When considering the effectiveness of a rest break schedule, and the ability to translate resulting evidence to the practitioner community, it is important to consider and control the nature of the activities conducted during the rest break.

Therefore, the purpose of this study was to examine the effect of three different standing rest-break schedules on groups classified as PD and NPD, engaged in prolonged seated work in a controlled laboratory environment. Objective measures of productivity, muscle activation amplitude, median power frequency (MdPF) and co-contraction were calculated, in addition to subjective measures of self-report mental fatigue and low back pain. It was hypothesized that 25%–50% of the participants would develop acute LBP during an uninterrupted bout of prolonged seated work, thereby classifying them as PD. Furthermore, it was expected that the rest break schedule that offered more frequent rest opportunities would be most effective at reducing LBP among PD. Lastly, we expected PD to demonstrate higher levels of trunk muscle activation and co-contraction, relative to NPD, where these measures would also increase during a bout of prolonged sitting for this sub-group.

2. Methods

2.1. Participants

Ten males (mean weight = 79.19 kg, mean height = 181.48 cm) and ten females (mean weight = 65.19 kg, mean height = 166.63 cm; group mean weight = 72.4 kg, group mean height = 173.8 cm) were recruited from the university population. Participants were excluded from the study if they had previously been diagnosed with chronic LBP or other neuromuscular disorders. Participants were asked to refrain from any vigorous low back or core exercise 24 h prior to the participation in any of the sessions. Additionally, our classification of PD or NPD was based on self-report discomfort findings obtained during Condition A of the protocol (see Section 2.3). Informed consent was obtained from all participants. The study protocol was approved by the University's General Research Ethics Board.

2.2. Instrumentation

Electromyography (EMG) data, sampled at 2000 Hz, were recorded from select muscles of the trunk. Participants' skin was prepared over the location of the muscle belly of the right and left rectus abdominus (RRA and LRA respectively) and lumbar erector spinae (RES and LES respectively) (Cholewicki et al., 2005). RRA and LRA were identified by palpating 3 cm from the sagittal plane of the umbilicus. The LES and RES were identified by first palpating the spinous processes of L4, and then moving laterally 2 finger widths from this location (Cholewicki et al., 2005). Wireless EMG electrodes (Delsys Trigno, Delsys Inc: Natick, MA) were attached to the skin at these sites using double-sided adhesive strips, where the system specifications are reported in the Delsys Trigno™ Wireless System User's Guide (2013). Maximal voluntary contractions (MVC) were collected for the RA and ES according to protocols outlined by Moraes et al. (2009) and Imai et al. (2010), respectively. All MVC trials were five seconds in length where participants were asked to ramp up to maximum force over the first two seconds, maintaining maximum effort for the remaining time.

Upon completion of the MVC, participants were seated at a computer workstation to begin a typing session. The workstation was set-up for each individual according to the office ergonomics guidelines outlined by the Canadian Standard Association's Guideline for office ergonomics (2012). The locations of the monitor, input devices, and chair as well as any height and width adjustments were then recorded in order to standardize each individual's setup for subsequent sessions.

2.3. Protocol

On four separate, non-consecutive days, participants reported to the laboratory and participated in conditions A, B, C and D (Table 1). The order of completion was randomized using a random number generator and participants were asked to complete all sessions at the same time of day in order to reduce the effect of diurnal changes in the material properties of the trunk (Adams et al., 1987). During each session, participants typed out a written document into a word processing file on a desktop computer. At appropriate intervals, the experimenter would enter the workspace and notify the participant of their rest-break. Participants were then required to stand in the middle of the room without leaning or stretching. They were permitted to access their mobile phones or converse

Table 1
Four separate rest break conditions provided to participants.

Condition	Rest break frequency	Break duration (minutes)	Total rest time (minutes)	Total collection time (minutes)
A	None	n/a	0	60
B	Every 30 min	5	5	65
C	Every 15 min	2.5	7.5	67.5
D	Every 5 min	50 s	9.2	69.2