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Evaluating the low back biomechanics of three different office workstations: Seated, standing, and perching

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ABSTRACT

The objective of this study was to evaluate how different workstations may influence physical behavior in office work through motion and how that may affect spinal loads and discomfort. Twenty subjects performed a typing task in three different workstations (seated, standing, and perching) for one hour each. Measures of postural transitions, spinal loads, discomfort, and task performance were assessed in order to understand the effects of workstation interaction over time. Results indicated that standing had the most amount of motion (6–8 shifts/min), followed by perching (3–7 shifts/min), and then seating (<1 shift/min). Standing had the highest reports of discomfort and seating the least. However, spinal loads were highest in A/P shear during standing (190N posterior shear, 407N anterior shear) compared to perching (65N posterior shear, 288N anterior shear) and seating (106N posterior shear, 287 anterior shear). These loads are below the risk threshold for shear, but may still elicit a cumulative response. Perching may induce motion through supported mobility in the perching stool, whereas standing motion may be due to postural discomfort. Office workstation designs incorporating supported movement may represent a reasonable trade-off in the costs-benefits between seating and standing.

1. Introduction

Prolonged sitting has been associated with many health concerns including increased risk of obesity, cardiovascular, metabolic disorders, and low back pain (LBP) (Brown et al., 2003; Callaghan and McGill, 2001; Frymoyer et al., 1980; Hales and Bernard, 1996; Katzmarzyk et al., 2009; Marras et al., 1995; Mummery et al., 2005). Many working adults in occupations involving prolonged periods of seating tend to spend about a half to two thirds of their workday seated within an office environment (Jans et al., 2007; Toomingas et al., 2012). To mitigate the risks associated with prolonged seated work movement is encouraged (Callaghan and McGill, 2001; Holmes et al., 2015).

The lack of motion within a seated environment imposes a physical risk to the musculoskeletal system because the tissues are not being challenged (Straker and Mathiassen, 2009). In turn, tissue tolerances decrease and intermittent external loading above the tolerance that was once able to be endured become risky (Marras and Hoboken, 2008). Prolonged sitting has also been shown in induce passive loading onto the spine (Callaghan and Dunk, 2002). This poses a problem due to the constant loading of the passive tissues. Without rest, it may induce microdamage to the ligamentous tissues and increase risk for a neuromuscular disorder (Solomonow, 2006). Encouraging movement may allow for rest of muscular and passive tissue loads.

Standing desks have become popular as an approach to counteract the effects of seating and encourage movement (Miyachi et al., 2015; MacEwen et al., 2015). In theory, standing has been reported to enhance cognition due to the stimulation of the cardiovascular system (Watanabe et al., 2007), which in turn may increase awareness (Caldwell et al., 2003). However, in terms of productivity, increased motion during standing poses concerns of loss of performance due to dual-task cost (Kahneman, 1973; Pashler, 1994). As tasks increase in difficulty and require higher cognition, the costs may be even greater (Thompson and Levine, 2011). Physically, prolonged standing has been shown to induce LBP in people who did not have a history of low back injury (Gallagher et al., 2014; Marshall et al., 2011; Tissot et al., 2009) and standing has had reports of lower extremity discomfort from blood pooling and mechanical pressure (Cham and Redfern, 2001). It is

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possible that movement from prolonged standing is due to discomfort rather than movement encouraged from the workstation. To alleviate the physical discomfort from standing, adjustable desks allowing for intermittent sitting and standing were introduced (Alkhajah et al., 2012; Ebara et al., 2008; Straker et al., 2013). Davis and Kotowski (2014) found that sit-stand workstations had lower reports of back discomfort. However, it has been found that although many workers were enthusiastic at the introduction of the sit-stand, most did not adopt the intervention due to the inability to find an acceptable posture or had lack of motivation to adjust the desk (Wilks et al., 2006).

Recently, perching has been introduced as an approach in between sitting and standing. During perching, the person leans against a spring-loaded stool to distribute the load between the legs and buttocks area while allowing for the ease of transition from perch to stand. During the perch, movement is encouraged through the mobility of the seat pan and flexion/extension of the knees. Previous studies have shown that movement during office work has been recommended to reduce swelling in the lower extremities (Stranden, 2000) and increase motion in the spine (O'Sullivan et al., 2006). The shifts in posture may allow periodic resting of the musculature through load migration between the passive tissues and to mitigate fatigue (Veiersted et al., 1990). In particular, prolonged periods of standing were associated with reports of fatigue in the lower extremities (King, 2002) and back (Kim et al., 1994). As fatigue sets in, antagonistic muscular coactivation increases in order to stabilize the posture (Granata et al., 2004) resulting in higher spinal loads (Granata and Marras, 2000). Rest breaks due to postural changes would assist in reducing prolonged static loads onto the spine (Callaghan and McGill, 2001). Previous studies have suggested adopting multiple postures and postural variation to reduce spinal loads (Callaghan and McGill, 2001; Davis and Kotowski, 2014). Hence, in our study it was postulated that a posture incorporating supported movement from perching may incur less spinal loading relative to prolonged periods of standing. However, a void exists in which we do not know how much movement is too much or not enough. It has been postulated that a moderate amount of workload (movement) may be necessary to counteract the risk (Winkel and Westgaard, 1992).

Two hypotheses are presented to evaluate the biomechanical cost-benefit of each of the different workstations. First, perching would encourage a moderate amount of movement relative to sitting and standing. Second, supported movement from perching over time would be associated with lower spinal loads relative to unsupported movement (standing). The objective of this study is to explore the biomechanics of how different postures induced by different workstations may affect spinal loads and discomfort in relation to movement.

2. Methods

2.1. Approach

A laboratory study was conducted in an attempt to understand the biomechanical and physiological cost-benefit of different workstations. Three different workstations were tested using electromyography (EMG) and motion capture and processed as a part of a biologically-driven, EMG-assisted spine model to understand the physical loads. Discomfort was recorded as a subjective report and as a function of heart rate variability (HRV) over each hour of testing. The results of this study provide output measures of spinal loads, postural transitions, and relative discomfort in relation to the workstations.

2.2. Participants

Twenty subjects (10 males and 10 females) were recruited throughout the community (age 26.5 ± 8.5 years, mass 76.5 ± 11.5 kg, and height 174.9 ± 11.5 cm). All of the subjects provided informed consent and had no reports of previous or current low back pain in the past 6 months. This study was approved by the university's institutional review board.

2.3. Experimental design

The order of the workstations was counter-balanced. A repeated measures design was utilized since each level was collected at multiple time points.

2.3.1. Independent variables

Only one condition was tested with three different levels of workstations: seated, standing, and perching. Each level was tested for 1 h with a 20-min period of recovery between levels and a 10-min period to adjust the workstation. The 1-h period of testing was chosen based upon previous studies of seating discomfort showing increased motion and physiological changes after 30–45 min (Le et al., 2014). The 20-min recovery period was chosen based upon a pilot study with 4 subjects at different rest intervals (10 min, 20 min, and 30 min) for all workstation conditions. An assessment of residuals did not show any order effects with the 20-min rest interval. During each level the subjects completed a typing task (Typing Queen Software).

2.3.2. Dependent variables

Biomechanical measures of multi-level spinal loads (compression, anterior/posterior shear, and lateral shear), postural transitions, localized subjective discomfort, physiological discomfort, and task performance were assessed.

The rationale behind the measure of spinal loading was to understand load influences between workstations as they may contribute to a cumulative response over time. Postural transitions were collected in order to evaluation possible associations between movement, spinal loading, and discomfort. Physiological discomfort (HRV) assessed to objectively quantify discomfort over time since subjective measures are highly variable in their reports (Le et al., 2014). Studies from Thayer and colleagues (Thayer and Brosschot, 2005; Thayer and Lane, 2000, 2009) as well as Appelhans and colleagues (Appelhans and Luecken, 2008), and Cohen and colleagues (Cohen et al., 2000) have discussed an interaction between pain and variability in heart rate. The heart beat is regulated by the parasympathetic branch of the autonomic nervous system. Under homeostatic (normal) conditions, both the parasympathetic and sympathetic nervous systems are in a tonic flux, thereby contributing to higher variability in the heart rate. However, during painful or stressful events the parasympathetic tone is reduced as sympathetic tone increases. As one system overrides the other, the tonic fluctuation ceases and variability decreases, which may be indicative of the brain-heart interaction response to pain. Since pain and discomfort are related, we believed that discomfort may be objectively assessed via HRV. Lastly, results from a typing task was assessed in order to evaluate the influence of working posture on task performance.

2.4. Apparatus

Three workstations were tested: seated (Aeron Chair, Herman Miller, Inc. Zeeland, MI, USA), standing, and perching (Locus Sphere, Focal Upright, North Kingstown, RI, USA). An adjustable desk was used for both seating and standing conditions (TiMOTION

Technology, New Taipei City, Taiwan). Kinematics were captured using a 24 infrared camera OptiTrack optical motion capture system (NaturalPoint, Corvallis, OR, USA). Electromyography was collected using a 16-channel Model 12 Neuradata Acquisition System (Grass Technologies, West Warwick, RI, USA). EMG signals were sampled at 1000 Hz, band-pass filtered between 30 Hz and 450 Hz, notch filtered at 60 Hz along with its aliases with 0.25 Hz sidebands. The signals were then rectified and smoothed using a zero-phase moving average filter and normalized based upon a non-max routine as described by Dufour et al. (2013). Physiological discomfort was assessed via heart rate from the FirstBeat Bodyguard 2™ device (Firstbeat Technologies, Jyväskylä, Finland). Reports of localized subjective discomfort was gathered from a 10 cm visual analog scale for different regions of the body.

2.5. Procedure

Subjects were briefed on the study design and then gave informed consent per university institutional review board guidelines. Anthropometric measures were collected and EMG sensors were placed on the 10 power-producing trunk muscles of the torso based upon placement guidelines from Mirka and Marras (Mirka and Marras, 1993). Motion capture markers were placed on 41 different locations on the torso. A heart rate monitor was also placed with an electrode on the superior-right aspect of the chest and another electrode on the contralateral, inferior aspect of the rib cage. After the subjects were prepped with sensors, they went through a series of lifting motions for a no-max calibration procedure (Dufour et al., 2013). Then, the workstations were adjusted to fit the subject per ANSI/HFES 100-2007 standards (ANSI/HFES, 2007). Basic workstation parameters were set relative to general guidelines of: 1) torso to thigh angles $\geq 90^\circ$, 2) elbow flexion between 70 and 135° (aimed for 90°), 3) wrist flexion < 30°, wrist extension < 30°, 4) monitor distance within 50–100 cm, and 5) viewing angle located 15–25° below horizontal eye level for all workstations. The stool post of perching workstation was adjusted relative to the subject's vertical inseam height as suggested by the manufacturer and the Locus desk to 5 degrees of inclination. A 10-min adaptation period was provided before the study commenced with a continuous typing task for 1 h. At the end of the hour, subjects filled out a discomfort survey and were encouraged to move around to recover until the next condition. The procedure was then repeated for the two other conditions. An example of the various setups for the study can be seen in Fig. 1.

2.6. Data analysis

The data were analyzed in three different areas: physical loading, task performance, and discomfort.

Physical loading was assessed using the outputs from a biologically-driven, EMG-assisted spine model (Granata and Marras, 1993, 1995; Marras and Sommerich, 1991a; Marras and Sommerich, 1991b; Theado et al., 2007) which included compression, anterior/posterior shear, and lateral shear loads for the superior and inferior endplate levels from T12 to S1. Another assessment of physical loading was through postural transitions. One minute of data were sampled every 5 min throughout the hour (0, 5, 10 min marks, etc.). Within each minute, shifts of the hip segment from the kinematic data were assessed in the sagittal, lateral, and axial directions. The hip segment was defined as a six-point rigid body relative to the global coordinate system. Using pilot data, postural transitions were operationally defined as shifts beyond 2 standard deviations from the mean which was approximately 1 cm. This was used to estimate the number of shifts per minute over the hour. However, it is also understood that natural postural sway may confound the findings. Task performance data were also collected continuously over the hour, but analyzed in five minute sections. Measures of speed, accuracy, and the number of errors were collected. Discomfort was evaluated physiologically through the analysis of heart rate variability (HRV) using Kubios-HRV analysis software as described in a paper by Tarvainen and colleagues (Tarvainen et al., 2014). HRV has been previously used in studies of pain (Thayer and Brosschot, 2005; Thayer and Lane, 2000; Appelhans and Luecken, 2008; Cohen et al., 2000; Pumprla et al., 2002), but to our knowledge has not been commonly applied in ergonomics studies. The frequency content of the signal was assessed using the ratio of the low frequency and the high frequency components (LF/HF) as described in a set of guidelines (Heart rate variability, 1996). The low frequency component is representative of the parasympathetic and sympathetic response, whereas the high frequency component is representative of the parasympathetic component. The ratio represents the balance between the two systems. HRV gave an overall rating of discomfort while localized discomfort was assessed using a subjective VAS report (Hawker et al., 2011; Huskisson, 1974).

2.7. Statistical analysis

Post-processed data were analyzed using JMP 11.0 one-way

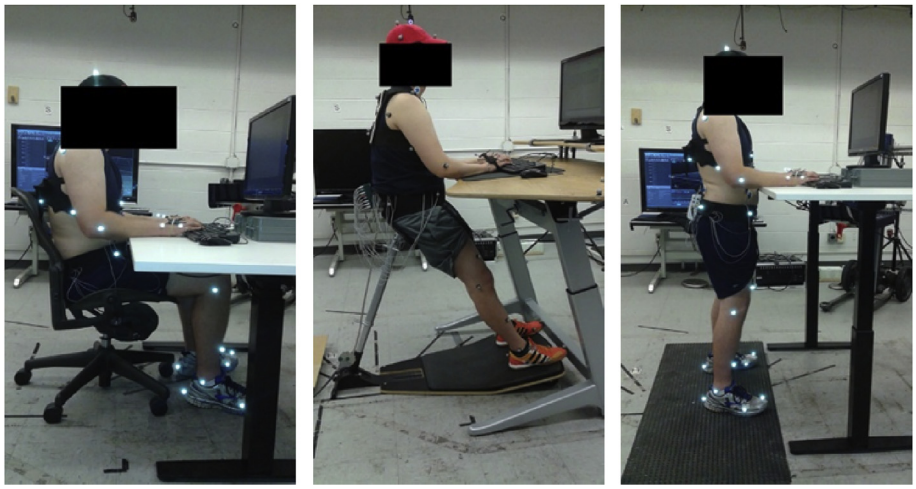

Fig. 1. Experimental setup for seating (left), perching (middle), and standing (right).

repeated measures ANCOVA with blocks of time over the 1 h duration (Independent Variable: Workstation, Covariate: Gender, $\alpha = 0.05$) for all measures except the subjective discomfort because it was only collected at the end of the testing of each level.

3. Results

The summary of statistically significant differences for the various measurement categories are shown in Table 1 ($\alpha = 0.05$). Spinal loads in A/P shear were only statistically significant for the main effect of workstation. Spinal compression and lateral shear were not statistically significant for any of the main effects or interaction. Performance measures of speed and accuracy from the typing task were not statistically significant for the main effects or interaction. Postural transitions of the torso, and extremities were highly correlated with the transitions in the hip ($r = 0.87$), therefore only the hip was analyzed. Reports of subjective discomfort showed statistical significance ($p < 0.01$, $\alpha = 0.05$) in the low back, distal upper extremities (hand/wrist), and distal lower extremities (lower leg, ankle, and foot).

3.1. Postural transitions

The average number of postural transitions per minute in the lateral and anterior/posterior (A/P) directions were statistically significant for the main effect of the workstation condition and interaction of workstation and time. Hip transitions were statistically significant in the lateral and superior/inferior directions for time. Subjects moved the most during standing, followed by perching, and the least amount of movement was during seating. Gender was found to be a significant covariate for the A/P and lateral directions. Between genders, males tended to move more than females overall. However, no significant differences were found when males and females were separated into blocks. An interaction plot of hip transitions over time is shown in Fig. 2.

3.2. Spinal loads

Spinal loads in A/P shear were statistically different between the workstation conditions. Therefore, only A/P shear loads were presented. Differences in loading patterns between levels can be seen in Fig. 3. Perching had the lowest amount of A/P shear in the upper levels, followed by seating, and then standing. Although lower in values, perching was not statistically significant from the seated condition. However, it was found that perching and seating were significant different from standing. No statistical differences were seen in the assessments of time or the interaction of workstation and time (Fig. 4).

3.3. Discomfort

Physiological discomfort from LF/HF from HRV showed statistically significant differences between seating and standing, with seating having the least discomfort. Perching had less discomfort than standing, but was not significantly different from seated or standing.

The univariate analysis of discomfort across time showed that all workstations displayed an increasing trend of discomfort over time. However, the when evaluating the interaction between workstation and discomfort ($p = 0.07$), the growth in discomfort across time appears to be lower during seated conditions compared to perching or standing (Fig. 5).

Subjective discomfort from VAS reports showed statistically significant differences between baseline and the levels of workstation condition for the low back, hands, and lower extremities (Fig. 6). The highest reports of discomfort were observed in the low back followed by the foot while in the standing condition. The reports for the low back in the seated and perching conditions were different from baseline, but not different from each other. In the lower extremities, the lower leg, ankle, and foot reports were highest during standing and lowest during seating. Discomfort reports in the hand and wrist were statistically different from baseline, but not between workstations.

4. Discussion

The results indicated that motion increased as a function of the workstation constraints. Seating had the most restriction in movement, followed by perching, and then standing. Freedom of movement and postural constraints appeared to be related to physiological and subjective discomfort as well as spinal loading patterns. Through cursory inspection of Fig. 5, motion appeared to have an association with HRV discomfort measures during standing over time. As motion was more pronounced, discomfort followed

Table 1
Summary of the statistically significant main effects and interactions for the dependent measures (*p < 0.05, **p < 0.01, ***p < 0.001).

	Dependent measure	Workstation	Time	Workstation*Time
HRV	LF/HF	*	**	
Postural transitions	Hip (Lateral)	**	**	**
	Hip (Sup/Inf)		*	
	Hip (A/P)	***		*
Spinal loads (Anterior/Posterior shear)	T12/L1 Superior	***		
*Compression and lateral shear were not statistically significant	T12/L1 Inferior	***		
	L1/L2 Superior	***		
	L1/L2 Inferior	***		
	L2/L3 Superior	***		
	L2/L3 Inferior	**		
	L3/L4 Superior	***		
	L3/L4 Inferior			
	L4/L5 Superior			
	L4/L5 Inferior	*		
	L5/S1 Superior	**		
	L5/S1 Inferior	**		
Typing performance	Gross Speed			
	Net Speed			
	Errors/Characters			
	Errors/Keystrokes			
	Accuracy			

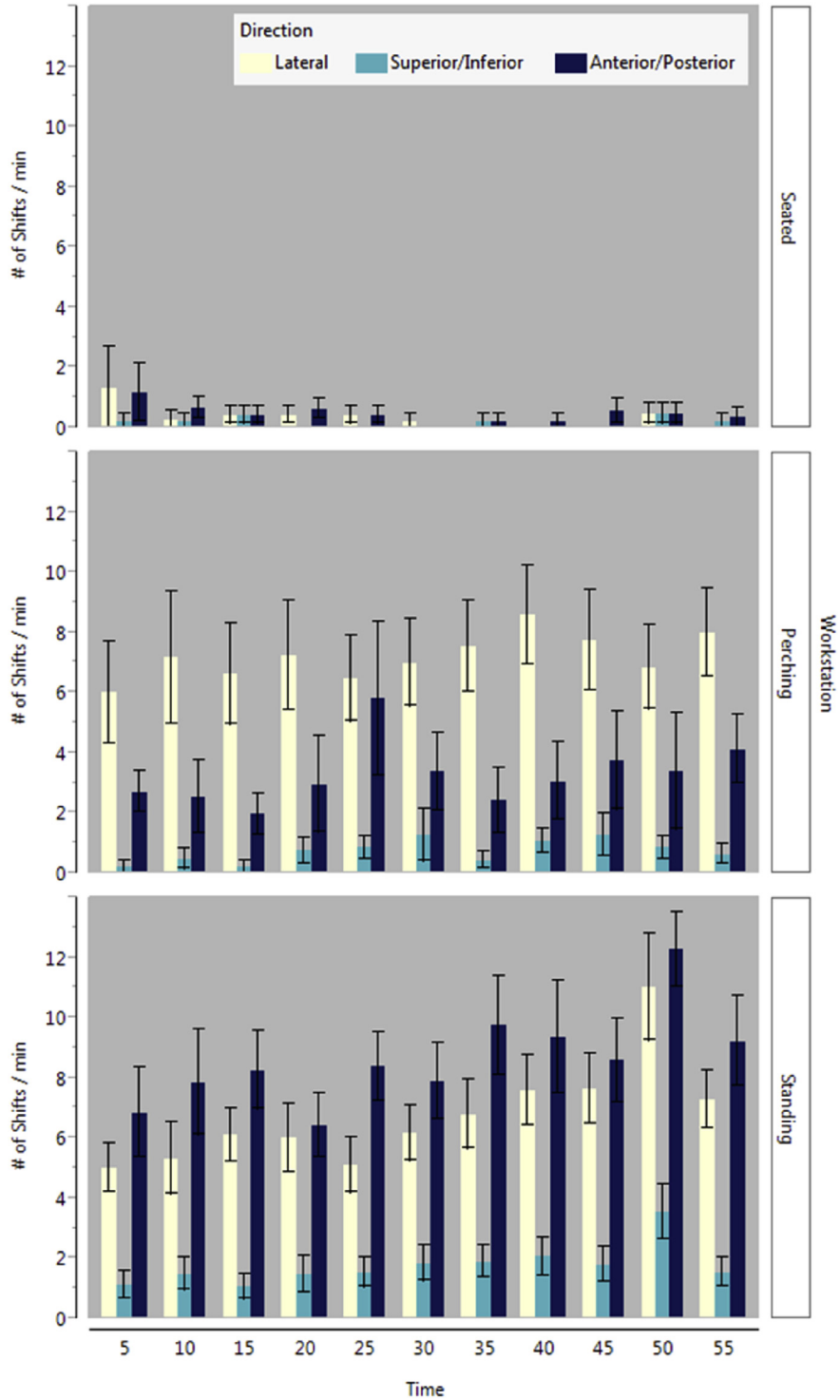

Fig. 2. Interaction of postural transitions across time for the different workstations for all subjects (mean ± standard error).

suit. A study from Gregory and Callaghan (Gregory and Callaghan, 2008) found similar trends linking increased motion with increased discomfort during prolonged standing. In contrast, Davis and Kotowski (Davis and Kotowski, 2014) showed that increased postural variability was associated with reduced discomfort. The key to their study was the introduction of reminder software to promote movement throughout the workday. Hence, it is possible that discomfort may be a response to a cascade of physiological events due to prolonged loading. Intermittent shifts in loading through postural variability may reduce the time to discomfort. Moderate levels of motion have also been shown to be beneficial for the spine (Andersson, 1985).

In order to understand the possible links between posture, motion, loading, and discomfort, an objective approach was needed. One of the components within the physiological cascade of events leading to the reporting of discomfort may be associated

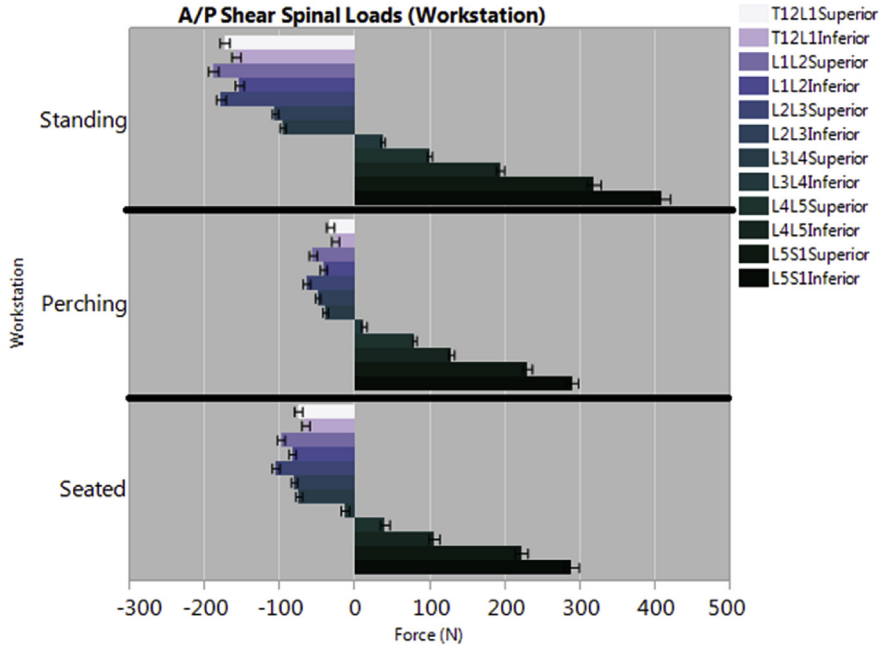

Fig. 3. Main effect plot of workstation for A/P shear across all levels (mean ± standard error).

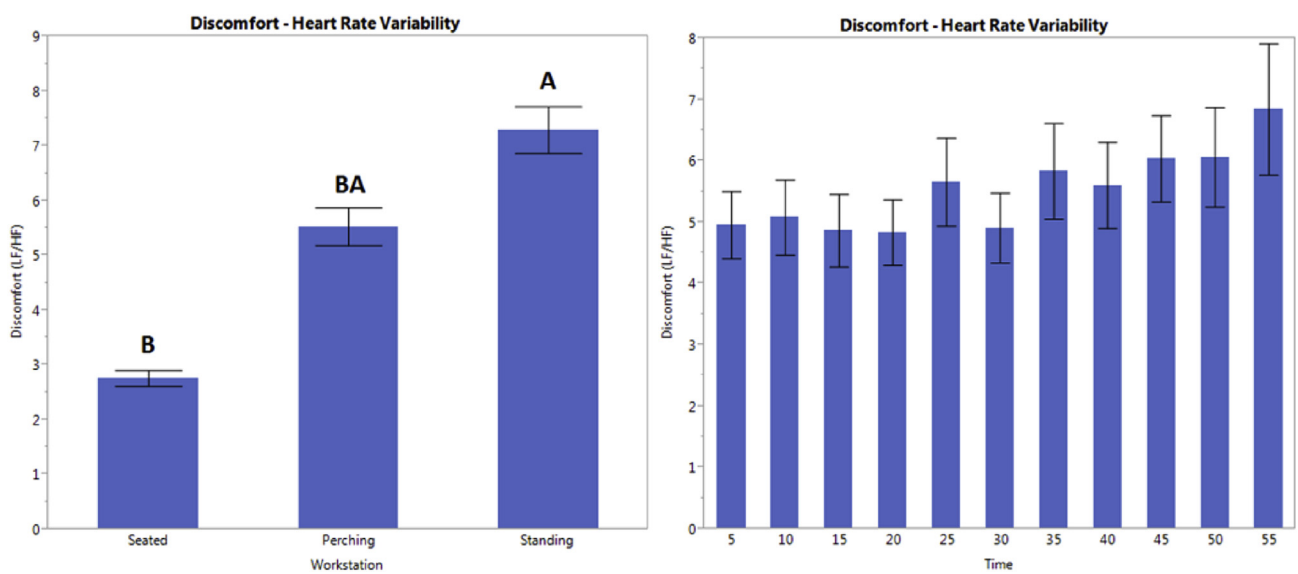

Fig. 4. LF/HF measure of discomfort for workstation (left) and time (right) (mean ± standard error).

with the heart. Contrary to popular belief, the heart is not a metronome (Shaffer et al., 2014). Under normal conditions, variability in the heart beat occurs due to tonic fluctuations between the parasympathetic and sympathetic systems. However, under stress or pain the sympathetic system dominates as the parasympathetic influence is reduced, thereby reducing the variation in heart rate (Thayer and Brosschot, 2005; Thayer and Lane, 2000; Appelhans and Luecken, 2008; Cohen et al., 2000). Currently, no studies have been found in the ergonomics literature using HRV as a measurement of discomfort. Since discomfort and pain are related, this study provides an initial understanding of physiologically defined discomfort in ergonomics. In our study, discomfort was lowest during seating, followed by perching and standing. Although this data may agree with the motion characteristics, it contradicts spinal loading data (perching lowest, followed by seating, and then standing). Therefore, even though discomfort is often a reported factor within office work health, it may not paint the full picture of the health effects, especially in the low back.

Standing had the highest reports of discomfort, the most overall motion, and highest spinal loads. From the data, it was inferred that the increased amount of motion may be due to discomfort due to the posture sustained rather than being induced by the workstation itself. In order to maintain postural stability of the torso and respond to discomfort, the muscles surrounding the torso coactivate to sustain the load. Based on the Cinderella fiber hypothesis (Hägg, 1991), over time the smaller motor units fatigue and the load is transferred to the larger motor units, thereby increasing the muscle force and spinal loads. Increased forces from the

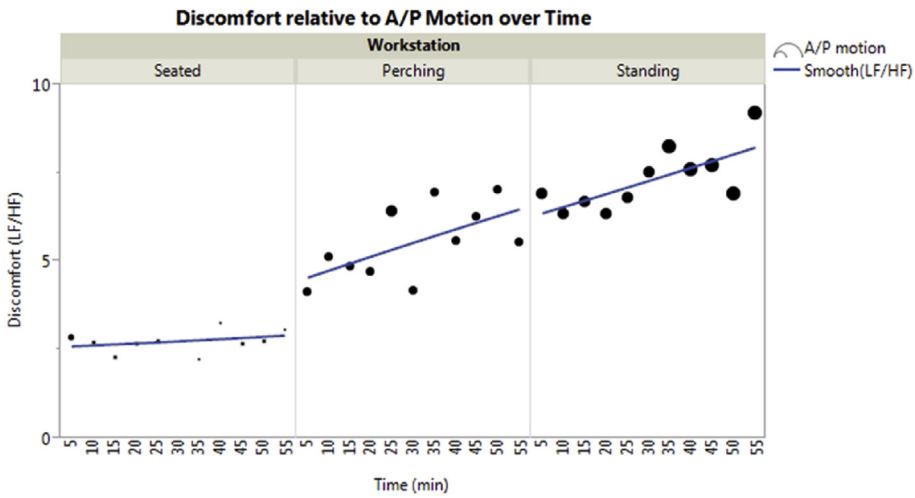

Fig. 5. LF/HF measure of discomfort for the interaction of workstation and time. The size of the points is related to the amount of A/P motion in the hip segment at that time point. The larger the point, the more motion occurred.

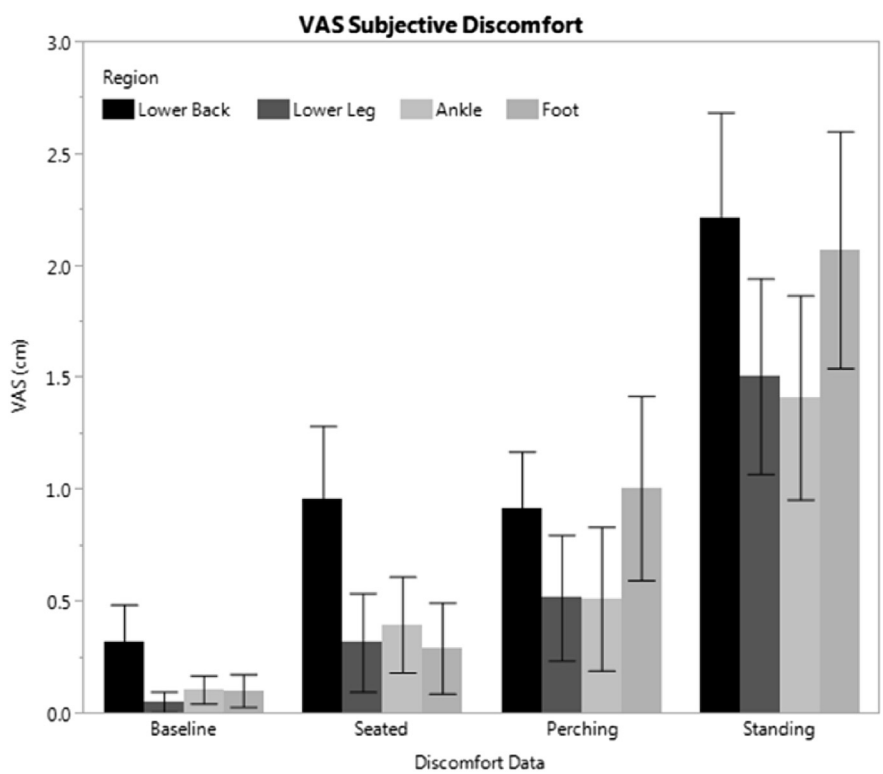

Fig. 6. VAS discomfort reports for the low back and lower extremities assessed after each one-hour work period (mean ± standard error).

musculature may stimulate the nociceptors, thus inducing discomfort and prompting movement. Svensson and colleagues (Svensson et al., 1996) suggested that typical adaptation of the motor system from musculoskeletal pain may occur via reflex pathways. That adaptation may occur through postural transitions. A study by Madeleine and colleagues (Madeleine et al., 1998) showed that postural transitions were typically triggered by the postural control system to alleviate discomfort. Discomfort increases coactivation, which change the shear loading patterns onto the spine. Although the shear values reported were below the threshold for tissue tolerance in shear (<700N) (Gallagher and Marras, 2012), cumulative effects from low-level loading may occur and pose a risk for LBD over time.

On the other end of the spectrum, prolonged seating incurred reports of the least discomfort, the least motion, and lower spinal loads than in standing. Contrary to the findings of Callaghan et al. (Callaghan and McGill, 2001), our study found that spinal loads were lower during sitting as a backrest was used. Previous studies support our findings as the part of the load is distributed into the backrest during reclining (Nachemson, 1981; Makhsous et al., 2009). This also opens the hip angle (torso to thigh), thus shifting the spinal loads. In addition, the arms were placed on the desk, further offloading of the spine (Andersson, 1985). The reports of low discomfort were likely due to the subject being supported by

the seat as well as subjects being used to the seated environment. However, the posture endured did not allow for much movement across time which poses a potential problem for LBP due to either fatigue from sustained muscle activation to maintain the posture or passive loading from a more slumped posture over time. This slumped posture has been reported to induce a flexion/relaxation response in the passive tissues (Callaghan and Dunk, 2002). In turn, viscoelastic changes in the tissues from passive loading affect the coactivation patterns in the spine to support the load, thereby affecting the directionality of the spinal loads (i.e. shear loading). In addition, the disc has few nociceptors suggesting that pain cannot be perceived until damage occurs (Adams et al., 2010; Coppes et al., 1997; Stefanakis et al., 2012). Therefore, low discomfort reports within office work do not necessarily mean that the condition is beneficial for the spine.

Perching had reports of discomfort as well as number of postural transitions in between seated and standing conditions, and lower A/P spinal loads than both seating and standing. It was believed that a combination of postural support and freedom of movement may have contributed to these findings. The three points of support from the perching stool (feet and seat pan) may have allowed for supported motion in order to adequately distribute the postural load. In turn, perching had the lowest A/P shear of the three conditions. The forward slope of the seat pan relative to the seat post allowed for an open hip angle (sagittal thigh to torso angle) of approximately 135°. This slope has been associated with anterior tilt of the pelvis (Hamaoui et al., 2016) which has been associated with increased lordosis in the spine, thus decreasing the loads onto the intervertebral discs (Adams and Hutton, 1985). The combination of supported mobility and work posture endured allowed for a moderate amount of motion. It is understood that moderate motion is good for intervertebral disc (Andersson, 1985; Nachemson, 1985). Motion patterns showed that perching had more lateral sway than the standing and seated conditions. In relation to the study by Madeleine and colleagues (Madeleine et al., 1998) stated previously, it was inferred that perhaps the mobility of the perching stool may encourage those shifts before the postural control system due to discomfort. The supported mobility of the stool may have induced perturbations that encouraged sway in which the subject proprioceptively adapted to stabilize the torso and shift the loads. The intermittent coactivation for postural stability allowed the muscles to contract and relax so that they were not constantly activated to support the postural load, yet at the same time not relaxed while incurring passive loading. Therefore, the result was lower posterior shear loads onto the spine when compared to sitting and standing.

4.1. Limitations

In order to place this study into context, a few limitations must be noted. First, the study was run under laboratory conditions with a continuous typing task. Results may change if the task changes. In particular, the task was meant to be a low cognitive intensive task in order to mitigate cognitive effects in the spinal load data. Tasks requiring higher cognition may increase coactivation and spinal loads (Davis et al., 2002). Also, cognitive factors may distract the experience of pain/discomfort (Hashmi et al., 2013; Bushnell et al., 2013). Since the primary purpose of this study was the physical loading patterns, only a low cognition task was used. Secondly, subjects were to consistently be in contact with the seat for the entire hour. In some workstations, it is encouraged to shift posture (i.e. sit to stand, perch to stand, etc.). Constant contact was maintained for each subject in order to not confound the condition due to the change in posture. Third, subjects may have not been accustomed to perching or standing. The majority of subjects were typically familiar with seating environments. Future studies observing longer periods for adaptation may be needed. Fourth, although the workstation assignments were counterbalanced, they were all utilized in the same session. Carryover effects from fatigue may occur. However, pilot tests of different time intervals (10-min, 20-min, and 30-min) as well as the results from the study did not show order effects based upon analysis of the residuals. Fifth, sampling of data in fixed intervals (every 5 min) may not capture out-of-phase motions (between collections). Sampling at random intervals may adequately capture motions that may be missed during the data collection. Lastly, the majority of subjects were younger. An older population may interact with the seats differently. Future studies plan to address these concerns. However, even with these limitations, the differences between the different workstations were notable.

5. Conclusion

Collectively, this study suggests that a perching workstation environment represents a reasonable tradeoff between the costs and benefits of sitting and standing office workstations. This study has shown that posture supported, moderate dynamic seating or movement during office work may assist in reducing spinal loads and discomfort from standing. It appears that moderate, supported movement may have better effects when induced. Particularly in the lateral (frontal) plane because it helps induce a moderate amount of workload while offsetting postural loads. This suggests that dynamic seating designs should incorporate mechanisms that have supported mobility to allow for movement to happen before the postural control system activates movement due to discomfort. However, further research is necessary to understand how much motion is enough motion to induce positive effects for the worker.

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