The impact of sit–stand office workstations on worker discomfort and productivity: A review

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1. Introduction

Prolonged seated work has been shown to result in increasing worker discomfort with respect to time (Fenety and Walker, 2002; McLean et al., 2001; Callaghan et al., 2010). Adjusting posture at an increased frequency throughout the workday is a proposed strategy used in an attempt to reduce discomfort (Karwowsk et al., 1994; Liao and Drury, 2000). Posture adjustment can be accomplished in a range of different ways spanning from interventions as basic as increased breaks (McLean et al., 2001), or treadmill walking while changing whole body posture from a sitting to a standing position, adjusting seating position, to more extreme interventions such as increased frequency throughout the workday is a proposed strategy met at least three of the five selection criteria. Seven of the identified studies reported either local, whole body or both local and whole body subjective discomfort scores. Six of these studies indicated implementing sit–stand workstations in an office environment led to lower levels of reported subjective discomfort (three of which were statistically significant). Therefore, this review concluded that sit–stand workstations are likely effective in reducing perceived discomfort. Eight of the identified studies reported a productivity outcome. Three of these studies reported an increase in productivity during sit–stand work, four reported no affect on productivity, and one reported mixed productivity results. Therefore, this review concluded that sit–stand workstations do not cause a decrease in productivity.

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(Zhang et al., 1996). Although measuring the feeling of discomfort is by its very nature subjective, there has been a link found between alternative objective measures (ex. pressure distribution) and subjective discomfort scores (De Looze et al., 2003). This link, combined with logistical limitations of worksite objective measures, has led to discomfort being used as a common outcome measure in assessing the effectiveness of sit–stand workstations. There is also evidence to suggest that musculoskeletal discomfort may be a predictor of future pain (Hamberg-van Reenen et al., 2008). Peak discomfort has been shown as a predictor of low-back, neck, and shoulder pain in a study of 1800 workers from 34 different companies. An important research question to be derived from all this is: does the sit–stand paradigm result in decreased worker perceived discomfort?

Worker productivity is another potential outcome measure that can be used in assessing the effectiveness of sit–stand workstations (Nerhood and Thompson, 1994; Dainoff, 2002; Husemann et al., 2009). Chapter 10 of the United States Department of Labor — Bureau of Labor Statistics (BLS) Handbook of Methods (BLS, 1997) defines productivity as, “output per hour”. The BLS Handbook goes on to explain that output is: “measured net of price change and inter-industry transactions.” (p. 90) With respect to the scientific and ergonomics literature reviewed here, price change and inter-industry transactions are difficult to obtain. In contrast, in the ergonomics literature office productivity is reported using alternative measures such as total keystrokes, completion of typing tasks, absenteeism rates, etc. Beyond this, many other factors can also contribute to BLS defined productivity (price and inter-industry transactions). Experience, communication, and creativity can also play a role in productivity; however, these concepts are extremely difficult to quantify and are rarely included in the sit–stand ergonomics literature.

There has been work showing a potential association between increasing discomfort and decreasing productivity, as measured by the completion of short typing tests and typing speed (Haynes and Williams, 2008; Liao and Drury, 2000). It has also been suggested that there may be an association between certain postures, other than a traditional sitting posture, and decreased worker productivity (Liao and Drury, 2000). A combination of the potentially opposing associations between increased productivity resulting from decreased worker discomfort in a sit–stand paradigm, and a decrease in productivity resulting from a standing posture leads to the question: does the sit–stand paradigm result in increased worker productivity?

This review is focused on the effectiveness of the sit–stand paradigm. Effectiveness can be measured as decreased worker discomfort and increased worker productivity. Specifically, measures of reduction in discomfort and increases in productivity through the introduction of specialized workstations, which allow for alternating between sitting and standing periodically throughout the office workday (sit–stand workstations), were examined.

2. Methods

2.1. Criteria for selecting studies for inclusion

2.1.1. Types of studies

All empirical research studies, which examined the effectiveness of sit–stand workstations or a sit–stand work paradigm in an office setting, were included. Both laboratory and field studies were included. Due to language restrictions, only studies published in the English language were included.

2.1.2. Types of participants

All included studies were performed on participants aged 18 or older. Studies conducted using experienced office workers and/or inexperienced office workers were both included. Studies examining healthy populations and/or populations with current, or a history of, low back pain were included.

2.1.3. Sit–stand workstation interventions

A sit–stand workstation was defined as a workstation that allowed a worker to perform the same task from either a seated or standing position with a self-adjustable worksurface height. Thus, the sit–stand work paradigm consists of a worker performing their duties while periodically alternating between sitting and standing positions throughout the day. All studies included involved a comparison of outcome measures for the sit–stand work condition to either: prolonged seated work, prolonged standing work, or both prolonged seated and prolonged standing work. All studies concerning the intervention of a sit–stand work paradigm were identified.

2.2. Search methods for identification of studies

Four databases (PubMed, ScienceDirect, Ergonomics Abstracts and Google Scholar) were searched using the following terms: “sit–stand” AND (“workstation” OR “workstations”). Searches were conducted between the dates of October 10th and October 20th, 2011, and were limited to articles published between 1950 and 2011. Included articles met at least the first three of the following five inclusion/exclusion criteria:

1. Primary research study that examined participants using sit–stand workstations
2. Participants were not an operator in a manufacturing process of any kind. Participants worked in an office setting (i.e. VDT users and call center agents) or simulated office work in a laboratory setting
3. Sufficient detail about experimental methods was provided to critically assess quality. Such detail must have included: number of subjects, type of subject population, description of sit–stand paradigm(s) employed, description of randomization/controls, and description of outcome measures.
4. At least one outcome measure was participant subjective discomfort
5. At least one outcome measure was a productivity criteria (i.e. keystrokes per minute, errors per keystroke, sick days, break time, etc.)

One additional criterion for the study was also considered, although the following was not deemed an inclusion/exclusion criteria:

6. Discomfort outcome measure included a specific low back discomfort score.

2.3. Study selection

The eligibility of each study found through the database searches was assessed by first reviewing the abstract and if there was potential for the inclusion criteria to be met the entire paper was obtained. Relevant data were extracted and the quality of the experimental design and relevance were evaluated. Population characteristics (age, gender, office work experience, history of low back pain), specific intervention paradigm (amount of time standing versus sitting, standing worksurface height, sitting worksurface height), worker adherence to intervention (how well did the worker follow the intervention), and outcome measures (discomfort, productivity, other kinematic measures) were extracted.
The quality of each study was assessed based on four conditions: a) randomization and a control condition in the study design, b) sit–stand intervention, c) worker adherence to intervention, and d) direct industrial applicability of the outcome measures reported. The scoring system was based on the following:

a) Randomization/control: (Score = 2) a sit–stand group and an at least one control group AND subjects randomly assigned to each group; (Score = 1) no control group OR no randomization; (Score = 0) no control group AND no randomization.

b) Intervention: (Score = 2) participants were either instructed to follow a sit–stand ratio or participants were allowed to self select time spent sitting/standing and time spent sitting/standing was measured by the experimenter AND sitting condition was not a high chair; (Score = 1) time spent sitting/standing was not measured OR sit was in a high chair; (Score = 0) time not measured AND sit was in a high chair.

c) Adherence: (Score = 2) participants strictly followed the instructed sit–stand ratio OR for self selected studies, alternated between sitting/standing at least once per day; (Score = 1) participant adherence was unclear; (Score = 0) participants did not alternate between sitting/standing at least once per day.

d) Applicability: (Score = 2) study conducted in the field (ie. not a laboratory study) AND at least one outcome variable either discomfort or productivity; (Score = 1) not in the field OR did not have discomfort or productivity as an outcome variable; (Score = 0) not in the field AND did not have discomfort or productivity as an outcome.

A high quality study (score = 8) was one that fully met all the quality conditions.

Unfortunately, many of the studies identified did not report results in a manner appropriate for statistical pooling (i.e. they did not report means and standard deviations). Also, there was considerable variation in the implementation of the sit–stand interventions. The ratio of time sitting compared to time standing varied greatly between studies. Due to these limiting factors, a meta-analysis was not included in this review.

3. Results

3.1. Literature search

3.1.1. Results of literature search and study selection

The Google Scholar search found 326 articles. The ScienceDirect search found 44 articles, 13 of which were unique and not found in the other database searches. The Ergonomics Abstracts search found 10 articles, four of which were not found in the other databases. The PubMed search found 5 articles, one of which was not found in the other databases. From the searches, a total of 12 studies were identified as meeting at least the first three of five inclusion/exclusion criteria. Screening references cited in the 12 identified studies revealed two additional identified studies for a total of 14 studies.

3.1.2. Criteria met for each identified study

All 14 identified studies met the inclusion criteria concerning a primary research study examining sit–stand workstations (#1), participants not being operators in a manufacturing process (#2), and sufficient detail about experimental methods (#3).

For the criterion stating that at least one outcome measure was productivity (#5), eight of the 14 identified studies met this criterion (Table 1).

3.1.3. Study outcome measures

Five of the identified studies measured time spent performing standing work at sit–stand workstations, two did not, and the remaining seven studies controlled the time standing as a requirement in their experimental design (Table 2). Seven studies included a comfort measure. Eight included a productivity measure. Three studies included an alertness measure, and three included a frequency of minor posture adjustments (not sitting to standing) measure. Foot swelling and spinal shrinkage were outcomes measures each recorded in a different single study.

3.1.4. Quality of included studies

For the identified studies in the review, the average overall quality was scored 5.8/8, with a standard deviation of 1.5 (Table 3). Generally, the quality of the intervention was very strong. No study received a full score for applicability of the outcome measures. The applicability criterion was an assessment of how appropriate the outcome measures of a particular study were for industrial use. This indicates that although combined results from multiple studies may provide strong evidence for increased sit–stand workstation use, at the present time, no single study can be used to fully quantify either the benefits or drawbacks of sit–stand workstations in the field.

3.2. Studies’ findings

3.2.1. Sit–stand interventions and discomfort

Results from six of the seven identified studies meeting criteria #4 showed reduced trends in discomfort for sit–stand work when compared to sit only work. The only exception was a study by Ebara et al. (2008), who found an increase in discomfort for sit–stand. The study consisted of a three way comparison between: a normal sitting only condition, a ‘high’ sitting only condition, and a ‘high’ sit to stand condition. The study found trends of generally higher discomfort in the ‘high’ sit only and ‘high’ sit–stand when compared to the normal sitting only condition. Although the study found statistically significant increases in discomfort for ‘high’ sit–stand forearm and wrist/hand discomfort when compared to normal sitting only; the comparison is not a true indication of the differences between sit–stand and sitting only work since the seated position in the sit–stand condition was not the same as the position in sitting only. Of the remaining six included studies that reported trends of reduced discomfort, three studies found

<table>
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<tr>
<th>Study Criteria</th>
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statistically significant decreases in worker discomfort when comparing sit–stand work to sitting only work (Hedge and Ray, 2004; Husemann et al., 2009; Vink et al., 2009). For the final three studies, either the decrease in worker discomfort reported was not significant or the statistical methods were not reported in enough detail to determine significance.

3.2.2. Sit–stand interventions and productivity

Results from three of the eight included studies meeting criteria #5 showed an increase in productivity for sit–stand work when compared to sit only (Dainoff, 2002; Hedge and Ray, 2004; Ebara et al., 2008). Four studies meeting criteria #5 showed no affect on productivity (Nerhood and Thompson, 1994; Hedge et al., 2005; Davis et al., 2009; Husemann et al., 2009), while the remaining study by Hasegawa et al. (2001) found a mixed result of a higher volume of work performed for sit–stand workers but lower quality of work.

3.2.3. Sit–stand interventions and other outcome measures

Three studies identified in this review primarily examined outcome measures other than discomfort or productivity. Paul and Helander (1995) measured spinal shrinkage and found that office workers that stood for 30 min every 2 h, had significantly less spinal shrinkage than those that stood 15 min every hour. In another study, Paul (1995a,b) found that average foot swelling in office workers with sit–stand furniture was significantly less than workers without sit–stand furniture. Finally, Hedge et al. (2005) measured wrist posture, and found that wrist posture changed between sitting and standing.

3.2.4. Study descriptions

A table summarizing details of each study under the headings: methods, participants, sit–stand paradigm, outcome measures, and additional notes were created. This table can be found in the Appendix.

4. Discussion

4.1. Optimal sit–stand ratio

From this review of the literature, 12 of the 14 identified studies found at least some benefit to using a sit–stand work paradigm. However, one major limitation to implementing a sit–stand work paradigm in an office setting was the lack of an optimal ratio between time sitting and time standing being established. Paul and Helander (1995) and Paul (1995a,b) used a ratio of 3:1 sit versus standing to examine the effectiveness of the sit–stand paradigm on foot swelling, spinal shrinkage, or worker energy; dividing the day with either 15 min of standing every hour or 30 min every 2 h, with no outcome measures concerning discomfort or productivity.

![Table 2](image)

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome measure</th>
<th>Time standing</th>
<th>Discomfort</th>
<th>Productivity</th>
<th>Alertness/sleepiness</th>
<th>Minor posture adjustments</th>
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For studies where the time spent standing was incorporated into the experimental design, time standing was an independent rather than dependent variable and was therefore not applicable (N/A).
Husemann et al. (2008) used a 2:1 sit versus stand paradigm to look at discomfort and productivity over 4-h work periods, finding significantly lower discomfort and no change in productivity. With only one ratio used, results from this study cannot be used to extrapolate an optimal ratio to maximize the decrease in discomfort. Hasegawa et al. (2001) used a ratio of 1:1 sit versus standing. Hasegawa divided both 60 and 90-min work blocks with combinations of 15, 30, or 45-min sit or stand sub-blocks, finding a mixed result of increased workload and reduced productivity as a result. This result may be interpreted as a sit–stand ratio of 1:1 involved too frequent changes to standing postures, and the decrease in productivity as a result of such posture changes is not offset by the potential productivity increase from a reduction in discomfort.

Hedge and Ray (2004) reported that when employees were given a sit–stand workstation, on average the employees increased the amount of time they spent standing while working, from 8.3% to 21.2% of their workday. This increase of 12.9% of the workday resulted in an average 27.5% decrease in musculoskeletal discomfort prevalence. This corresponds to about 8 additional minutes standing per hour.

With respect to discomfort and body region, Roelofs and Straker (2002) found lower limb discomfort was greatest in their standing only condition, with little difference found between sitting only and sit/stand. Their study used a sit/stand ratio of 1:1, alternative between sitting and standing every 30 min. Additional studies have shown a strong association between low back pain and standing occupations (Andersen et al., 2007; Roelen et al., 2008) or prolonged constrained standing work (Nelson-Wong and Callaghan, 2010). This suggests that if the standing portion of the sit–stand cycle is too long, there may be no reduction in discomfort resulting from sit–stand.

The diverging outcome measures used across each study reviewed prevents a clear conclusion to be drawn with respect to the optimal sit–stand time ratio. Perhaps no such optimal ratio exists, or if a ratio does exist, estimation of such involves an interaction with the type and distribution of the work being performed and the individual worker. Depending on the type of outcome the employer wishes to maximize (ex. reduced discomfort or increased productivity), there may be a different optimal sit–stand ratio. As such, employers should encourage their employees to experiment with various sit–stand time ratios in order to determine the optimal ratio for their specific personal and job requirements. A study by Alkhajah et al. (2012) reported that when office workers in Australia were given sit–stand workstation and minimal instructions, the workers chose an average sit–stand ration of 15 min sitting to 5 min standing.

4.2. Selection bias

Although an extensive search strategy was used to identify all studies on the topic of sit–stand workstations in an office setting, there is a possibility some studies may have been missed. While reference checking was employed in an attempt to trap any missed studies, there still exists the possibility that some relevant studies may not have contained the keywords used in the database searches or the studies appeared in publications not indexed in the databases used.

4.3. Discomfort versus productivity

Since half of the studies identified concerning sit–stand work did not include any measure of discomfort, it appears as though injury prevention is not the sole motivation for researchers examining sit–stand workstations. Three studies did measure a biomechanical variable other than discomfort (Paul and Helander, 1995; Paul, 1995a; Hedge et al., 2005) indicating injury prevention was a driving factor in those studies. However, the remaining four studies made no biomechanical, or ergonomic, measure whatsoever. Furthermore, of the seven included studies which did measure discomfort, four measured additional outcomes related to productivity (Nerhood and Thompson, 1994; Ebara et al., 2008; Husemann et al., 2009; Davis et al., 2009). Three of these studies found sit–stand had no affect on productivity, while one study found sit–stand was associated with increased productivity.

4.4. Injury trade-offs

Sit–stand work is likely advantageous when considered in terms of reducing low back discomfort (Nerhood and Thompson, 1994; Roelofs and Straker, 2002; Hedge and Ray, 2004; Husemann et al., 2009; Vink et al., 2009; Davis et al., 2009). Conversely, there is evidence that alternating between sitting and standing may lead to higher wrist discomfort (Ebara et al., 2008). Most sit–stand workstations can be quickly and easily adjusted in height, however, do not have quick and easy to adjust keyboards and mouse pads for optimal wrist postures. Ideal wrist position while standing is different than ideal wrist position while sitting (Hedge et al., 2005). The study completed by Roelofs and Straker (2002) found that greatest upper limb discomfort was found in the sitting posture. This is in contradiction with the arguments made by both Hedge et al. (2005) and Dainoff (2002), resulting in an interesting quandary. Knowing that ideal wrist posture is different between sitting and standing, perhaps in the case of Roelofs and Straker (2002), less upper limb discomfort was experienced while standing because the workstation was better adjusted for wrist posture while standing rather than sitting. However, this is purely speculative as none of the workstations’ configuration descriptions provided were sufficient to assess this hypothesis.

4.5. Worker productivity

Productivity can be measured in a number of different ways. In terms of total volume of work and quality of work accomplished, Husemann et al. (2009) found a small but not significant decrease in number of keystrokes and a small but not significant increase in error rate between sit–stand and sit only. This result of either little or no decrease in productivity measures was found quite consistently across all included studies (Hasegawa et al., 2001; Hedge et al., 2005; Ebara et al., 2008). At this point, it is important to note that although this evidence does suggest sit–stand resulted in little or no decrease in productivity in a lab setting, the way in which these laboratory results will transfer into industry is still unknown. Though efforts were made in all studies to best simulate real industry work, many of the well-known limitations of laboratory work still exist.

From another perspective, Dainoff (2002) suggested that implementing a sit–stand protocol could create greater worker productivity by decreasing the break time a worker will take if using a sit–stand paradigm. Somewhat contrary to this idea, Nerhood and Thompson (1994) found when tracking absenteeism for a 6-month period, no significant difference between sit–stand workstation users and sit only workstation users. While a small number of studies have examined productivity related issues in sit–stand stations, none have found a definitive detrimental impact of using sit–stand workstations when compared to seated work. None of the identified studies reported outcome measures related to experience, communication, or creativity. Further research is needed including these outcome measures as sit–stand workstations can change an office environment, and some literature has shown that the office environment can have an effect on creativity (Ceylan et al., 2008).
4.6. Sit—stand workstation implementation and utilization

Cost is likely a contributing factor when considering whether or not to implement sit—stand workstations in an office environment. Height adjustable desks capable of supporting a sit—stand paradigm can range in price from approximately US$500 to $2000 (www.ergodepot.com). A reduced worksurface area, when compared to fixed height workstations, has also been previously associated with sit—stand workstations (Wilks et al., 2006). This reduced worksurface area may not meet the requirements for certain occupational groups (Grunseit et al., 2013).

Height adjustable workstations are considered more flexible than fixed height workstations (Wilks et al., 2006). This increased flexibility may allow for one desk to be shared by several different persons; therefore, reducing the total number of desks required in an office. Fewer desks can result in both purchase cost savings and reduced floor space requirements.

Utilization is another factor likely considered in the decision to implement sit—stand workstations. Although literature dating back to the 1990s has shown the potential positive effects of the sit—stand paradigm (Nerhood and Thompson, 1994), a study from 2006 found that as few as one in ten workers actually use the sit—stand feature of their workstation on a daily basis (Wilks et al., 2006). From their study, Wilks and colleagues developed a series of recommendations to improve the implementation of sit—stand workstations. These recommendations included: consider different personnel groups’ differing needs for table area; and be conscious that the correct use of sit—stand workstations requires education and motivation.

Wilks also found that if a worker either constantly or intermittently experienced pain while working, that worker was more than twice as likely than a worker whom experiences no pain, to use the sit—stand feature at least once a day. Instruction also appeared to be a factor, with workers that received instruction from either a physiotherapist or ergonomist being nearly twice as likely to use the sit—stand feature at least once a day. This further highlights the need for proper education and motivation to ensure the successful implementation and utilization of sit—stand workstations.

5. Conclusions

The majority of the current literature surrounding sit—stand workstations indicates implementing such a system in an office environment will lead to lower levels of reported whole body discomfort among employees, without resulting in a significant decrease in performance. There is also sufficient evidence to conclude sit—stand workstations are effective in reducing local discomfort reported in the low back.

From the performed review, there are two areas with little definitive information that exist in the sit—stand literature. First, even though it appears that sit—stand workstations can effectively reduce whole body and low back discomfort, some evidence suggests sit—stand workstations can increase reported discomfort in the upper extremities (specifically hand and wrist). Further research exploring changes in whole body posture during sitting and standing work are needed to assess this potential confounding negative outcome. Second, there are no generally agreed upon usage ratios for time spent between sitting and standing at workstations. A number of different ratios have been used in sit—stand workplace/laboratory interventions, with little or no justification given. Although the majority of ratios have shown positive results, differences in outcome measures reported do not allow for a comparison between ratios. Further research exploring an optimal suggested sit—stand ratio would be beneficial in guiding usage guidelines and training.

Appendix

### Characteristics of included studies

<table>
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<tr>
<th>Study</th>
<th>Participants</th>
<th>Sit—stand paradigm</th>
<th>Outcome measures</th>
<th>Notes</th>
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<td>Subjects: number/gender of subjects not reported</td>
<td>Sit—stand paradigm 2</td>
<td>Discomfort — local discomfort questionnaire, Absenteeism</td>
<td>Statistical analysis was unclear, Study was conducted in the field</td>
</tr>
<tr>
<td>Paul and Helander (1995)</td>
<td>Subjects: 13 VDT operators</td>
<td>Sit—stand paradigm 2</td>
<td>Spinal shrinkage</td>
<td>Study was conducted in a laboratory setting</td>
</tr>
<tr>
<td>Paul (1995a)</td>
<td>Subjects: 6 office employees (5 female, 1 male, age: 39.0)</td>
<td>Sit—stand paradigm 2</td>
<td>Foot volume</td>
<td>Study was conducted in a laboratory setting</td>
</tr>
<tr>
<td>Paul (1995b)</td>
<td>Subjects: 12 office employees (3 male, age: 36.5, 9 female, age 37.67)</td>
<td>Sit—stand paradigm 2</td>
<td>Employee satisfaction with work environment, Tiredness</td>
<td>Conditions were not presented in random order, Study was conducted in the field</td>
</tr>
<tr>
<td>Hasegawa et al. (2001)</td>
<td>Subjects: 18 male (age 19–25)</td>
<td>Sit—stand paradigm 60 min and 90 min work sessions</td>
<td>Critical flicker fusion, Subsidiary behaviors, Subjective feelings of fatigue, Performance</td>
<td>Study was conducted in the laboratory setting</td>
</tr>
<tr>
<td>Dainoff (2002)</td>
<td></td>
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</tr>
</tbody>
</table>

### Methods

- Intervention/no control
- Within subject design
- Two interventions/no control
- Within subject design
- Office layout/worker energy
- Within subject design
- Within subject design, random presentation
- Within subject design
- Critical flicker fusion, Subsidiary behaviors, Subjective feelings of fatigue, Performance
- Study was conducted in a laboratory setting
- Training was provided
- Inclusion: UPS office employees
- Exclusion: N/A
- Exclusion: unknown
Participants Subjects: 12 undergraduates (6 male/6 female, age range: 18–52, mean age: 26.5)  
Methods Within subject design, random presentation  
Ebara et al. (2008)  
Notes Study protocol changed after first 3 subjects  
Outcome measures Wrist posture  
Sit–stand paradigm 3 Conditions:  
1) Just sit  
2) Just stand  
3) Sit/stand (alternate between sitting and standing every 30 min)  
Outcome measures Discomfort  
Notes Study was conducted in the field

Roelofs and Straker (2002)  
Methods Within subject design, random presentation  
Participants Subjects: 24 female, 6 male (age range: 18–52, mean age: 26.5)  
Sit–stand paradigm 3 Conditions:  
1) Just sit  
2) Just stand  
3) Sit/stand (alternate between sitting and standing every 30 min)  
Outcome measures Discomfort  
Notes Subject preferred posture

Hedge and Ray (2004)  
Methods RCT  
Participants Subjects: 54 intensive computer users (34 from a high tech company/20 from an insurance company, 31 males/23 females, age: 38.8 ± 2.1)  
Sit–stand paradigm 2 Conditions:  
1) Standard sitting workstation provided  
2) Height adjustable workstation provided  
Outcome measures Frequency of standing work — survey  
Musculoskeletal discomfort — survey (zero to ten scale)  
Notes Control group only had 10 participants  
Outcome measures Discomfort  
Notes Study was conducted in the field

Wilks et al. (2006)  
Methods Survey  
Participants Subjects: 192 across four different companies  
Sit–stand paradigm N/A  
Outcome measures Various regarding attitude, compliance and satisfaction with sit–stand workstations  
Notes Nil

Hedge et al. (2005)  
Methods Within subject design, random presentation  
Participants Subjects: 18 university students (12 women, 6 men, age: 19.7)  
Sit–stand paradigm N/A  
Outcome measures Wrist posture  
Comfort  
Typing performance  
Body movements  
Notes Study was conducted in a laboratory setting

Ebara et al. (2008)  
Methods Within subject design, random presentation  
Participants Subjects: 12 undergraduates (6 male/6 female, age: 21.2 ± 1.1), 12 aged (6 male/6 female, age: 62.7 ± 1.6)  
Inclusion criteria: normal vision with or without glasses, experienced using a word processor and spreadsheet application, ability to type on a keyboard with both-hands, right-handed  
Exclusion criteria: height less than 150 cm or greater than 180 cm, previous history of MSD within last year  
Outcome measures Health perception—Giebener Beschwerdebogen (10 min sit, 5 min stand)  
Notes Study was conducted in the field
References


Databases


Science Direct: http://www.sciencedirect.com/

Ergonomics Abstracts: http:// tandf.informaworld.com/smpp/home~db=all.

Google Scholar: http://scholar.google.ca/.