The experience of musculoskeletal discomfort amongst bank tellers who just sit, just stand or sit and stand at work

Andrea ROELOFS [(a)], Leon STRAKER [(b)]

(a) Bankwest, 108 St Georges Terrace, Perth,6000, Australia,
Andrea_Roelofs@bankwest.com.au
(b) School of Physiotherapy, Curtin University of Technology, GPO Box U1987, Perth, Western Australia
L.Straker@curtin.edu.au

Abstract

Bank tellers are an occupational group at risk of musculoskeletal disorders due the physical and mental task demands. In an effort to reduce physical demands banks have introduced stools for tellers. However the literature suggests that constrained sitting or constrained standing are risk factors and that alternating work postures may be preferable. This study recorded the discomfort and preferences of 30 bank tellers who worked in just sitting, just standing and alternating sitting and standing work postures. Greatest discomfort in the upper limb was noted in the just sitting posture and greatest discomfort in the lower limb and back was reported for the just standing posture. Alternating between sitting and standing resulted in least discomfort and was reported as the preferred posture by 70% of subjects. Possible mechanisms for this pattern of results are discussed and alternating work postures recommended for bank tellers.

Keywords: discomfort, posture, sit, stand

1. Introduction

Musculoskeletal disorders (MSD) such as work related neck and upper limb disorders and work related back disorders are widely recognised for their adverse impact upon employee productivity and wellbeing. Work related MSDs constitute about one half of all MSDs (Westgaard and Winkel, 1997) and account for some 15 - 22% of all work place sick leave across industry in general (Hettinger as cited in Cakir, 1988). Straker (1998) reported 44% of compensation cases were for 'sprains and strains' and that these cost an average of $7,400 Australian dollars per case.

Whilst MSDs have traditionally been associated with physically strenuous or intensive occupations, there is increasing evidence that sedentary office work and other work requiring constrained sitting or standing postures are associated with a high incidence of MSD (for example, Attwood, 1989; Westgaard and Winkel, 1996).

Kuorinka (1998) suggests that office based work that requires frequent access to and interaction with VDUs has the potential for incompatibility between the human element and demands of modern technology, and that enhanced compatibility and interaction between these two elements are required for the risk of MSD to be minimised.

Risk factors relating to MSD development amongst VDU operators have been identified to relate to both physical (Aaras, Fostervold, Ro, Thoresen and Larsen, 1997; Hunting, Laubli and Grandjean, 1981; Pustinger, Dainoff and Smith, 1985) and psychosocial factors (Hagen, Magnus, and Vetlesen, 1998; Hales, Sauter, Peterson, Fine, Putz-Anderson, Schleifer, Ochs, and Bernard, 1994; Smith, 1997).

Physical factors have been identified to include the workplace environment, equipment layout and furniture characteristics. The impact of these physical factors may be best summarised through recognising that constrained body postures are frequently the product of unsuitable workplace layouts and environmental design, and that constrained body postures are associated with musculoskeletal complaints and reports of discomfort by employees (Helander and Zhang, 1997; Hunting et al, 1981; Hagberg and Sundelin, 1986; McPhee, 1993).

Waersted and Westgaard (1997) proposed that neck and shoulder MSDs may also be impacted upon by the variables of level, repetitiveness and duration of load exposure. These authors report that even at low levels there is a significant risk of MSD development where repetitiveness and /or duration are too high. Accordingly, physical risk factors may be seen to relate to work organisation as well as the physical environment.

Smith (1997) has identified potentially important psychosocial factors such as work pressure, decision making and supervisor relations. Further, he suggests that jobs which entail heavy daily computer use may be inherently stressful, possibly due to high information processing demands and electronic monitoring of work performance (Hales et al., 1994).

Bank tellers are an employee group familiar with working within constrained postures and using VDUs and other technological equipment. Bank telling provides limited opportunity for tellers to move away from their work stations during working hours. Consequently, tellers are required to maintain constrained postures for prolonged periods and undertake tasks that are essentially repetitive in nature. Further, high mental workload demands for information processing demanding speed and accuracy compound with social stresses of difficult customers, long customer cues and security concerns. Bank tellers can therefore been seen as an employee group at risk of MSDs.

In recent times, numerous financial institutions have tried to reduce the risk for employees by reducing the need for prolonged standing through the introduction of teller stools. The impact of this move remains unclear. Where tellers historically have maintained constrained standing postures whilst undertaking teller duties, the introduction of teller stools has seen a trend emerge for tellers to now adopt constrained sitting postures.

The existence of musculoskeletal symptoms amongst individuals who stand for prolonged periods is well recognised (Aaras et al., 1997; Genaidy and Karwowski, 1993; Grandjean, 1985; Zhang, Drury, and Woolley, 1991), as is the existence of these symptoms amongst individuals who sit for prolonged periods (Aaras et al., 1997; Graf, Guggenbuhl and Krueger, 1995; Grandjean and Hunting, 1977; Mandal, 1981).

Beyond the specifics of aetiology, static effort and subsequent muscle fatigue remain recognised as significant contributors to the experience of discomfort for those who undertake prolonged standing (Grandjean, 1985; Jorgensen, Hansen, Lundager and Winkel, 1993; Miedema, Douwes and Dul, 1997). In particular, prolonged standing has been associated with discomfort in the feet, legs (Grandjean and Hunting, 1977; Ryan, 1989) and lower back (Jorgensen et al., 1993; Ryan, 1989).

Conversely, prolonged sitting has been associated with a high incidence of back complaints (Mandal, 1981), increased spinal muscular activity and intradiscal pressure (Grandjean and Hunting, 1977; Lindh, 1989), discomfort in the lower extremities (Westgaard and Winkel, 1996) and increased muscle loading of the neck and shoulder muscles when sitting with the forearms unsupported as compared to standing with the forearms unsupported (Aaras et al., 1997; Lannersten and Harms-Ringdahl, 1990).

Although consensus amongst the literature as to what constitutes the optimal work posture for VDU use has not been achieved (Mandal, 1981; Graf, Guggenbuhl and Krueger, 1993; Graf et al., 1995; Grandjean and Hunting, 1977), their is a growing need to determine how the risk of MSD development amongst employees who maintain constrained work postures can be minimised.

Visser and Straker (1994) identified, in a study examining the experience of discomfort by dental assistants and therapists at work, that breaking up constrained work postures allowed for increased postural change which assisted in delaying the onset of musculoskeletal discomfort and fatigue in most body areas. Graf et al. (1995) offer support to this finding identifying work tasks with less frequent and less marked opportunity for postural change as being associated with a higher prevalence of MSD. Hagberg and Sundelin (1986) proposed benefits of rest intervals reporting that frequent rest intervals can assist in reducing the perception of postural discomfort, offering further support to the notion that postural variation and a break away from constrained postures can be effective in reducing or delaying the experience of musculoskeletal discomfort.

Where constrained sit and stand postures can be identified as having a concentrated impact upon different body parts when maintained for prolonged periods, an alternating sit/stand work posture provides opportunity to reduce this impact and alter the amount of load experienced by body parts throughout the day. Alternation between two postures allows for increased rest intervals of specific body parts, and reduced potential for the adverse impact of risk factors commonly associated with MSD development.

Given the theoretical benefit of breaking up prolonged constrained sitting and standing, one would expect the ergonomics literature to provide good evidence that this benefit can be realised in real work situations. However only two directly relevant studies were found.

Work stations which allowed both sitting and standing were introduced to postal workers by Nerhood and Thompson (1994), with a subsequent reduction in discomfort reported. Similarly, Paul (1995a; 1995b) reported decreased foot swelling and increased perceived energy and less tiredness in a group of VDU workers given office workstations which allowed sitting and standing. These workers were encouraged to stand for 15 minutes every hour.

Whilst the results of these studies are supportive of alternating postures, they are not conclusive and did not compare sitting and standing with just sitting and just standing.

Therefore, this study aimed to compare the experience of discomfort amongst bank tellers who just sit, just stand, or sit and stand at work, to determine whether greater postural variability in sit and stand environments impacted upon the experience of musculoskeletal discomfort.

2. Methods

2.1 Study Design

The study design was a two factor repeated measures field trial that allowed for musculoskeletal discomfort data to be collected throughout the day from subjects that assumed just sit, just stand and sit/stand work postures.

2.2 Subjects

28 branches of a large bank in the Perth metropolitan area were selected and reviewed as to their adherence with the organisation's own workstation design criteria. 20 branches with direct public access were identified as meeting the set criteria (having teller bays that were 1030mm in height and between 640 - 670mm in width, VDUs with screen raises [10 - 20cm in height and matched to subject eye height], adjustable teller stools with a 5 castor base adjustable seat height [to 810mm] and back rest components).

The 20 branches were randomly ordered from 1 - 20. According to this order, subjects were invited to participate in the study. A total of 30 subjects agreed to participate in the study and were recruited from a total of 16 branches. Employees selected to participate in the study were aged between 18 and 52 years (mean age = 26.5 years). Subjects worked between 32 and 38 hours each week ('fulltime') as bank tellers, had no musculoskeletal condition that had required medical, physiotherapy or chiropractic treatment within the preceding 3 months, were not pregnant, and were not taking analgesic or anti-inflammatory medication. Employees who did not meet this selection criteria were excluded from the study. Withdrawal criteria included severe discomfort ratings experienced during the study, the receipt of an injury during the study, and retraction of consent (no subjects withdrew). The mean height of subjects in the study was 168cm (range 149-188cm). 24 of the subjects were female, 6 male.

2.3 Variables

The study included two independent variables, posture and time.

The posture variable had three levels, 'just sit', 'just stand' and 'sit/stand'.

The 'just sit' posture required subjects to use a teller stool that was adjustable in height to a maximum of 810mm from the floor, had an adjustable footring and adjustable backrest. Subjects were introduced to the adjustable features of the teller stools and had their stool adjusted to their postural needs by the first author before commencement of the study (refer to Figure 1).


Fig 1. Bank teller in 'just sit' posture at teller bay Fig 2. Bank teller in 'just stand' posture at teller bay

The 'just stand' posture required subjects to stand at the teller bay whilst undertaking bank telling functions. Subjects were instructed not to sit whilst undertaking work tasks (refer to Figure 2).

The 'sit/stand' posture required subjects to alternate between a sit and a stand posture every 30 minutes. All subjects commenced this posture in sitting and where instructed to ensure that they remained aware of the time throughout the day so as to change posture at the required 30 minute interval.

The time variable consisted of 6 levels; the commencement of telling duties (9.30am), mid morning (10.30am), pre lunch, post lunch, mid afternoon (3.00pm) and at the completion of work (4.30pm on Mondays and Thursdays and 5.30pm on Fridays due to extended work hours). The pre and post lunch times reflected scheduled lunch breaks of 45 minutes duration that commenced at 11.30am, 12.15pm or 1.00pm.

The main dependent variable was body part discomfort. Body part discomfort data was collected through use of a Visual Analogue Discomfort Scale (VADS) (Straker 1999). The VADS allowed for specific body part discomfort to be recorded from 13 body areas and constituted a 100mm line bound by the descriptors of 'no discomfort' and 'extreme discomfort'. To assist in body part identification a body map was used in conjunction with the VADS. This map reflected each of the 13 body parts (head and neck, lower back, hips, and right and left shoulder and arm, right and left elbow and forearm, right and left wrist and hand, right and left thigh and knee, right and left leg and foot).

At the conclusion of the study subjects were asked to rank each posture in order of preference so as to provide data to enable the most and least preferred postural options to be identified.

2.4 Procedure

All subjects were required to complete a demographic questionnaire and consent form prior to involvement in the study. Each subject's work station was checked to ensure uniformity of equipment provision (eg teller terminal, key board and screen raise) and that the screen raises available were suitable to place the top of the screen at the subject's eye height. Subjects were instructed in the adjustment of their teller stools and were individually positioned in their stool according to ergonomic principles by the first author. Subjects were provided with the VADS sheets for completion and an addressed envelope to return completed ratings to the first author.

Subjects were advised as to the postures that were required of them within the study, the days and order in which these were to be undertaken and how to complete the VADS ratings. The order in which the three postures were required to be undertaken were randomly allocated to each subject and subjects were advised of the need to cease any posture that caused extreme discomfort.

Subjects were required to work for one day in each of the three postures whilst performing their normal bank telling tasks. Monday, Thursday and Friday were selected as data collection days as they were identified by all branch managers as being the most uniform and consistently busy days across the course of the week.

Subjects were required to maintain each designated work posture for a day. Subjects were only able to move from each posture when required to undertake alternate work functions away from the teller bay or when attending rostered work breaks.

Subjects were required to complete VADS reflecting their body part discomfort whilst in each of the three postures. VADS were completed at each of the 6 time intervals previously identified throughout the day. The study was approved by the Human Research Ethics Committee at Curtin University of Technology.

2.5 Data Management / Analysis

Data collected from the study reflected specific body part discomfort as recorded by subjects on the VADSs. Following initial analysis, data were collapsed from 13 specific body areas into 3 body regions; lower back (comprising scores from 2 body areas - lower back and hips data), lower limb (comprising scores from 4 body areas - left and right thigh and knee and leg and foot data) and upper limb (comprising scores from four body areas - neck and head, dominant side shoulder and arm, elbow and forearm and wrist and hand data [there was minimal discomfort reported in non dominant upper limb]). Data collected for each body region were divided by the relevant number of areas so data results for each of the three regional areas would be on a scale of 0 to 100.

A fourth composite score, total body discomfort, was created from the three regional scores (back, lower limb and upper limb), again divided by the number of components to be on a scale of 0 to 100.

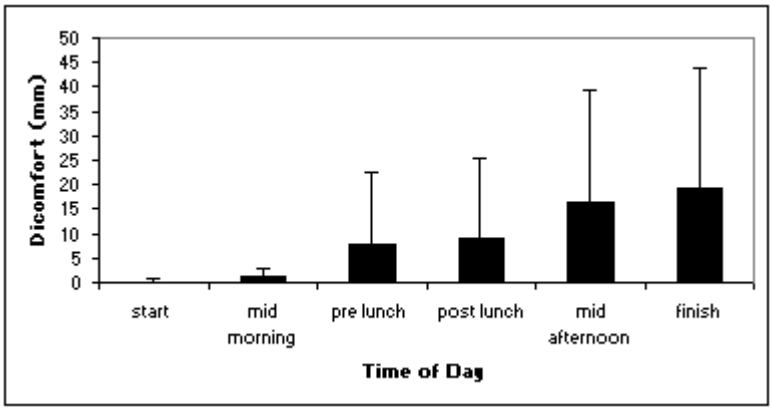
The parametric assumptions of sample normality and homogeneity of variance could not be met with the collected data. Accordingly, Friedman's One Way Analysis of Variance by Ranks was used to test for differences in the experience of musculoskeletal discomfort across the three postures used. Separate Friedman's analyses were used to test for differences across times. Where a significant effect of posture was found Wilcoxon's Signed Rank Test was used to determine which postures were different. Discuss This

3. Results

Study results are presented as they relate to the two independent variables of time and posture and the dependent variables of musculoskeletal discomfort and preference.

3.1 Time and discomfort

Study results demonstrated a trend for musculoskeletal discomfort to increase over the day. Figure 3 illustrates this trend for total body discomfort.



f

Figure 3. Mean (SD) total body discomfort experienced by bank tellers over a working day.

Friedman's analysis found the increase in total body discomfort experienced by subjects over the course of the day to be significant ($X2= 95.8$, $p = .0001$). The increase over the day followed a similar pattern and was also significant for back

region discomfort, (X2 = 33.0, p = .0001), lower limb discomfort (X2 = 42.9, p = .0001) and upper limb discomfort (X2 = 21.0, p = .0008), see Table 1. Of note is that the lunch break between the pre and post lunch interval appears to stall the increase in discomfort over the day.

Table 1. Mean (SD) total body and body region discomfort experienced by bank tellers over a working day.

	start	mid morning	pre lunch	post lunch	mid afternoon	finish
Total Body	0.16 (0.46)	1.30 (1.75)	7.98 (14.70)	8.91 (16.64)	16.21 (22.94)	19.30 (24.39)
Back	0.21 (0.96)	1.85 (2.98)	5.67 (9.25)	4.95 (11.30)	9.64 (16.24)	11.82 (18.92)
Lower Limb	0.15 (0.59)	1.68 (3.36)	5.24 (12.52)	4.46 (13.53)	12.93 (19.82)	15.16 (21.09)
Upper Limb	0.13 (0.49)	0.38 (0.92)	1.93 (6.11)	1.77 (6.16)	2.88 (6.28)	3.47 (6.57)

3.2 Posture and discomfort

The mean total body discomfort rating for subjects was highest in the 'just stand' posture, followed by the 'just sit' and then 'sit/stand' posture (See Figure 4). Friedman analysis found the differences due to posture significant (X2 = 22.0, p = .0001). Wilcoxon pairwise comparisons found 'stand' to result in greater total body discomfort than 'just sit' and 'sit/stand' (Z = 2.48, p =.013 and Z = 4.49, p =.0001 respectively) and a strong trend for 'just sit' to result in greater discomfort than 'sit/stand' (Z = 1.63, p =.102).

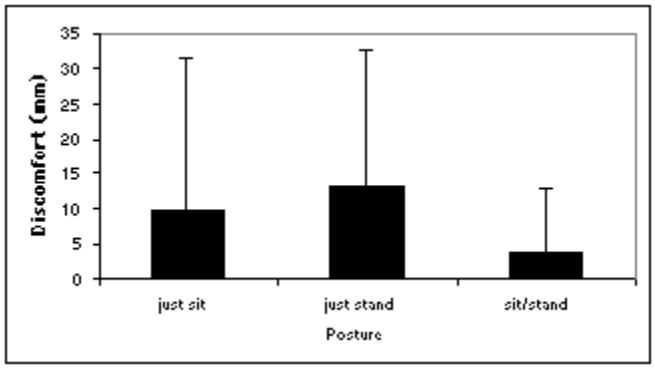


Figure 4 The mean (SD) total body discomfort experienced by bank tellers working in 3 postures.

Figure 5 shows a similar pattern for discomfort experienced in the back region. Friedman analysis confirmed differences between postures (X2 = 12.7, p = .0018). Wilcoxon pairwise comparisons found 'stand' to result in greater back discomfort than 'sit/stand' (Z = 3.62, p = .0003) and a strong trend for 'just stand' to result in greater back discomfort than 'just sit' and for 'just sit' to result in greater discomfort than 'sit/stand' (Z = 1.90, p = .057 and Z = 1.61, p = .107 respectively).

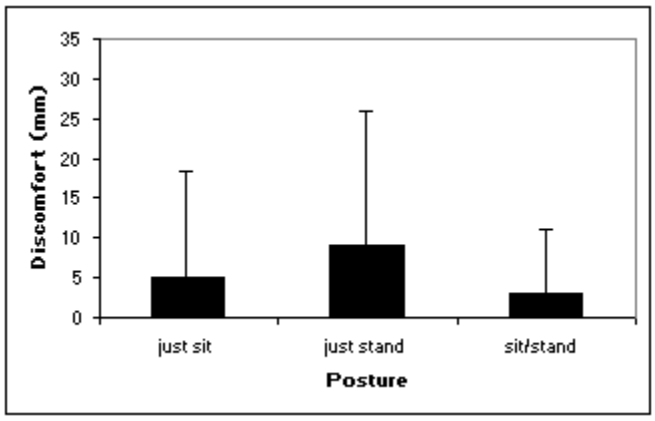


Figure 5 The mean (SD) back discomfort experienced by bank tellers working in 3 postures.

Lower limb discomfort also showed a similar pattern, though with a more marked difference for standing, as shown in Figure 6. Friedman analysis confirmed a significant difference between postures (X2 = 32.1, p = .0001) and Wilcoxon comparisons found significant differences between 'just stand' and 'just sit' and 'just stand' and 'sit/stand' (Z = 3.32, p = .0009 and Z = 4.02, p = .0001 respectively) but no difference between 'just sit' and 'sit/stand' (Z = 0.36, p = .722).

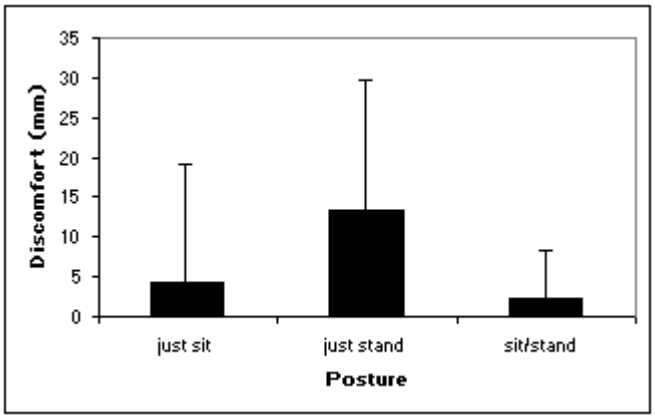


Figure 6 The mean (SD) lower limb discomfort experienced by bank tellers working in 3 postures.

Figure 7 shows the trend for lower overall discomfort levels in the upper limb region, but for 'just sit' to appear to result in greater discomfort. However, Friedman analysis failed to identify differences between postures (X2 = 1.18, p = .556).

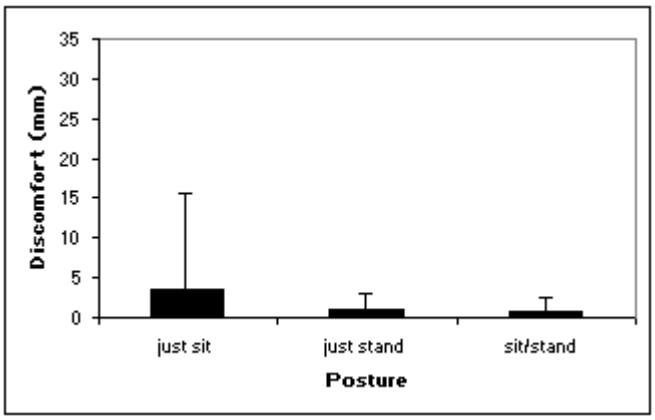


Figure 7 The mean (SD) upper limb discomfort experienced by bank tellers working in 3 postures.

Figure 8. provides a pictorial representation of the mean musculoskeletal discomfort reported by subjects for the three body regions (lower back, lower limb and upper limb) for each of the 'just sit', 'just stand' and 'sit/stand' postures.

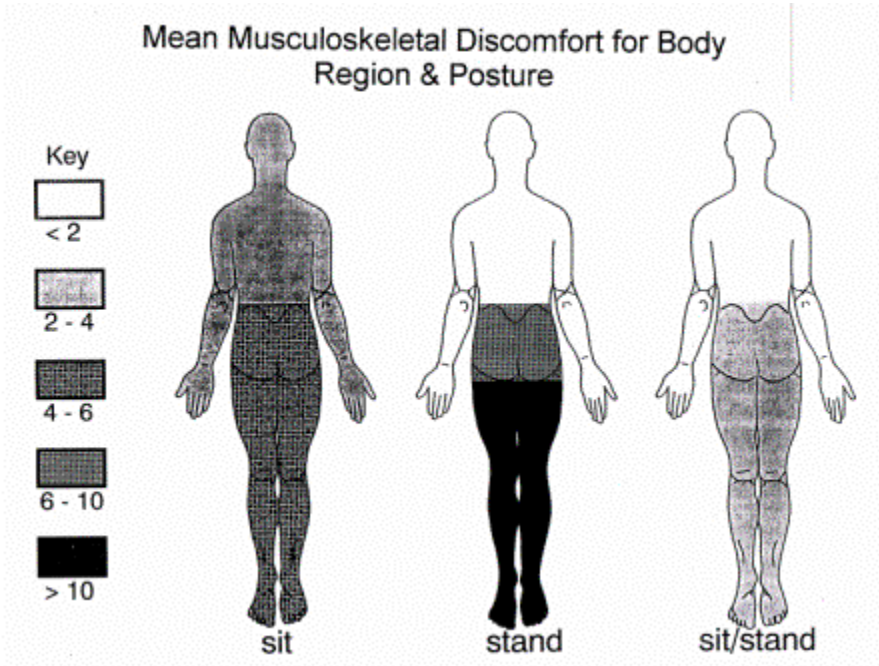


Figure 8. Mean musculoskeletal discomfort experienced by bank tellers in 'just sit', 'just stand' and 'sit/stand' work postures for three body regions (lower back, lower limb and upper limb).

3.3 Preference and Posture

The 'sit/stand' posture was identified as being the most preferred by 70% of subjects, with 'just sit' being rated as most preferred by 20% and 'just stand' by 10%.

4. Discussion

4.1 Time and discomfort

The experience of musculoskeletal discomfort reported by subjects was found to increase across all three body regions over the course of the day. This trend was evident for all time intervals except that between the pre lunch and post lunch rating. Mean musculoskeletal discomfort ratings were found to be consistently less for the post lunch interval when compared to the preceding pre lunch interval for the lower back, upper limb and lower limb regions. Subjects had taken a 45 minute lunch break between the two rating intervals, the lower mean post lunch rating of discomfort indicating that rest intervals positively impact upon the experience of musculoskeletal discomfort.

This finding supports that of Hagberg and Sundelin (1986) and Visser and Straker (1994) who reported that frequent rest intervals positively impact upon the postural discomfort perceived by office workers and dental workers respectively.

The low mean musculoskeletal discomfort rating for start time interval for total body data is thought to reflect an absence of discomfort 'carry over' amongst subjects from one day to the next. One rationale proposed for this finding is that the time interval over which subjects are away from work over night (and able to freely alter their posture) is sufficient to negate any experience of work related musculoskeletal discomfort by subjects who maintain a constrained posture throughout the day.

4.2 Posture and discomfort

The total body discomfort data provided evidence that the experience of musculoskeletal discomfort was more when bank tellers worked in the prolonged 'just stand' and 'just sit' postures compared with the postural variety provided in the 'sit/stand' posture. To understand the possible mechanisms for this difference, each region will be discussed separately.

4.2.1 Back region

Subjects were found to experience the least amount of musculoskeletal discomfort for the back region when assuming the 'sit/stand' posture and the most discomfort in 'just stand', with intermediate discomfort in 'just sit'.

One rationale for the experience of most discomfort in the standing posture relates to the need for the body's postural muscles to remain constantly active during standing and for the back extensors to maintain the body's upright alignment and counter balance any forward trunk movement (Lindh, 1989). Bank telling tasks require tellers to repetitively lean forward so as to write, reach and access cash and push queue call buttons that signal customers to approximate the telling bay. Such task demands result in repetitive activity demands on the back extensor muscle group over the course of the day.

Similarly task demands also require tellers to lean forward when assuming a sitting posture, causing them to assume unsupported sitting postures for periods throughout the day. Leaning forward in a sitting posture increases the kyphotic curve in the spinal column and is associated with high tensile stresses in the soft tissue structures within the back, increased intradiscal pressure and static loading of the lumbar muscles (Lindh 1989) which may explain the experience of discomfort by subjects in the lower back when sitting. In maintaining a sitting posture whilst telling it is of interest to note that subjects may be susceptible to twisting their backs so as to access cash draws and printers instead of using the swivel mechanism on the stools available. As reported by Graf et al. (1995) although the provision of swivel chairs should theoretically reduce the need for cashiers to assume twisting postures, it requires less effort to twist the upper body when seated than to lift and push with the leg so as to activate the swivel mechanism. Accordingly it is thought that there remains susceptibility for bank tellers, who work in an environment similar to that of supermarket cashiers, to undertake twisting postures whilst at work.

4.2.2 Lower limb

The experience of lower limb discomfort was greatest in the standing posture with little difference between 'just sit' and 'sit/stand' postures.

These findings are consistent with those of Grandjean and Hunting (1977) and Ryan (1989) who reported that prolonged standing had been associated with discomfort in the feet and legs, and lower back. Ryan (1989) reported from a study examining musculoskeletal symptoms in supermarket workers and the proportion of time spent standing. Increased lower limb discomfort was reported by those spending more than 50% of their work time standing and increased lower back

discomfort was reported in those spending more than 25% of their work time standing. From this study a positive association between the prevalence of symptoms in each body area and the time spent standing was identified.

The experience of musculoskeletal discomfort by bank tellers in the lower limbs whilst standing may also be attributed to circulatory insufficiencies. In constrained standing there is little opportunity for bank tellers to undertake gross muscular activity thus little assistance is rendered to venous circulation in the lower limbs.

This rationale may also be proposed to have contributed to the experience of discomfort in the lower limbs in the 'just sit' posture, as this posture like standing provides little opportunity for muscular contraction within the lower limbs. As reported in Westgaard and Winkel (1996), occupational inactivity due to prolonged sitting may strongly influence micro- and macro- circulation and perceived discomfort in the dependent lower extremities. Although the mean discomfort in the 'just sit' posture was not as high as that for the 'just stand' posture, it is of interest is that there was a hint that if may have been higher than that for the 'sit/stand' posture which allowed for postural variation and subsequent large muscle activity.

Alternative factors that may also have potential to impact upon the experience of discomfort by subjects in sitting relate to the design of the teller stools utilised within the study. Where the teller stools were equipped with an adjustable footring, these were reported by numerous subjects to be difficult to use. Additionally it was noted that the seat depth in the teller stools used were uniform, thereby causing the stools to offer less support to the thighs of subjects with a longer leg length than those with a shorter leg length. Potential for less support under the thighs and movement of the footring whilst sitting, combined with the low level of muscle activity able to be undertaken by the lower limbs whilst sitting, are factors worthy of consideration in reviewing the degree of lower limb discomfort experienced by subjects whilst assuming the 'just sit' posture.

4.2.3 Upper limb

In contrast to other body regions, the highest mean discomfort rating in the upper limb area occurred in the 'just sit' posture. This finding offers support to the notion that a constrained sitting posture is more likely to impact upon the musculoskeletal health of the upper body whereas constrained standing is more likely to impact upon the musculoskeletal health of the lower body.

The experience of musculoskeletal discomfort in the upper body region in the sitting posture is thought to relate to the task demands required of bank tellers and the reduced accessibility of tellers to the teller counter when in a seated posture. Additional factors such as workplace layout, task location, manual /visual requirements of the task and the anthropometric characteristics of the worker all have potential to impact upon the discomfort experienced whilst working in a sitting posture (Li and Haslegrave, 1995).

Numerous tasks demands performed by bank tellers require the arms to be unsupported and the shoulders to be abducted away from the trunk for prolonged periods of time, thereby demanding increased static contractions of the upper limb musculature. Reports by Attwood (1989) that lower levels of musculoskeletal discomfort have been reported by keyboard operators when provided with hand/arm supports than when working in unsupported postures indicates that the provision of forearm supports may have a beneficial role in minimising risk of MSD development in the upper limbs.

The repetitive requirement for tellers to reach anteriorly with one or both arms and undertake tasks at a distance from their body thereby making increased demands on postural musculature is thought to in greater part explain the experience of upper limb discomfort by bank tellers when in a sitting posture. Support is offered to this notion by Aaras et al. (1997) who report that an increased load is experienced by the trapezius muscle when in a sitting posture with arms unsupported than when in a standing posture with arms unsupported. Similarly, Lannersten and Harms-Ringdahl (1990) found higher neck and shoulder muscle EMG activity in supermarket cashiers when working in sitting compared with standing posture.

4.3 Sit/stand posture

Benefits of postural variation as seen in the 'sit/stand' posture where reflected in study results that identified this posture as being associated with the least amount of total body and body region discomfort by subjects. Graf et al. (1995) offered support to this finding identifying work tasks with less frequent and less marked opportunity for postural change as being associated with a higher incidence of MSD.

The alternate 'sit/stand' posture was devised to provide subjects with increased opportunity to vary their posture. To provide an assurance that the set conditions were followed by tellers, video observation was done on a sub sample. Three subjects were recorded for three and a half hours during work in each posture to provide an indication of the variability in each work posture condition. The range of durations (shortest to longest time periods) for which a sitting or standing posture was maintained in the three posture conditions were:

- 50 seconds to 52 minutes 45 seconds and (sitting in 'just sit'),
- 5 seconds to 6 minutes 50 seconds and (sitting in 'sit/stand') and
- 10 seconds to 13 minutes 45 seconds and (standing in 'just stand'), and
- 20 seconds to 6 minutes and 40 seconds and (standing in 'sit/stand').

From video data collected it was evident that tellers did achieve a higher level of posture variability in the 'sit/stand' condition. It is also clear that tellers may be inclined to alternate their posture with greater frequency than the specified 30 minute intervals as the average maximum duration was just under 7 minutes for sitting and standing in the 'sit/stand' condition.

4.4 Posture and preference

Whilst the 'sit/stand' posture was consistently associated with the least amount of muscular discomfort, it was still a little surprising that the majority of tellers preferred the 'sit/stand' condition as observations by the authors prior to study suggested tellers tended to just sit.

4.5 Limitations

Although the study revealed significant findings, there remain limitations that require acknowledgment. These limitations relate to the number of subjects and the duration over which subjects were requested to work in each of the test postures. It is thought that a larger study sample may have assisted in a greater data gathering capacity and the subsequent application of parametric data analysis. Similarly the study only required subjects to work in each posture for one day. Thus the methodology and data collected was insufficient to determine the impact of maintaining a specific work posture for consecutive days on the experience of musculoskeletal discomfort.

A further limitation of the study was that postural preference amongst subjects was not determined prior to study commencement. Accordingly where subject's post data collection identified their most preferred work posture, these preferences can not be compared to prestudy preferences. Consequently it is not possible to draw conclusions as to the impact of involvement in the study upon work posture preference.

Finally, it is unknown whether video recordings of entire day durations and all tellers would have provided any different data relating to the range of time frames tellers maintained each of the test postures.

4.5 Future Research

It is hoped that results from this study will give rise to further research relating to constrained work postures and the experience of musculoskeletal discomfort, and prompt workplace recommendations that may reduce the risk of MSD development amongst bank tellers. Of particular interest would be an evaluation of the experience of musculoskeletal discomfort amongst bank tellers who alternate between a sit and stand posture at different time intervals. Similarly the impact of frequent scheduled rest intervals versus alternate work demands upon the experience of musculoskeletal discomfort amongst bank tellers assuming each of the test postures would be of interest.

5. Conclusion

This study has highlighted the experience of musculoskeletal discomfort amongst bank tellers who maintained constrained sit, stand and alternating sit/stand work postures. Study results provide evidence that postural variation is effective in reducing the experience of musculoskeletal discomfort for total body, back, lower limb, and upper limb areas and that the duration for which a posture is maintained effects the experience of musculoskeletal discomfort experienced by bank tellers. These results support a move away from constrained work postures amongst bank tellers within the finance industry and toward the introduction of systematic postural variation.

Whilst future bank telling work practices are likely to be impacted upon by technological advances, changing work loads, new systems and modified environmental layouts, a reduction in the risk in MSD development may be achieved by encouraging postural variety.

References

Discuss This

Aaras A., Fostervold, K.I., Ro, O., Thoresen, M. and Larsen, S. 1997. Postural load during VDU work: a comparison between various work postures. Ergonomics 40(11), 1255-1268.

Attwood, D. 1989. Comparison of discomfort expereinced at CADD, word processing and traditional drafting workstations. International Journal of Industrial Ergonomics 4, 39-50.

Cakir, A. 1988. Work related musculoskeletal disorders in the Federal Republic of Germany. In Proceedings of the Tenth Congress of the International Ergonomics Association, Sydney: International Ergonomics Association, pp 394.

Genaidy, A.M. and Karwowski, W. 1993. The effects of neutral posture deviations on perceived joint discomfort ratings in sitting and standing postures. Ergonomics 36(7), 785-792.

Graf, M., Guggenbuhl, U. and Krueger, H. 1993. The dynamics of sitting behaviours. Advances in Industrial Ergonomics and Safety V: 251-256.

Graf, M., Guggenbuhl, U. and Krueger, H. 1995. An assessment of seated activity and postures at five workplaces. International Journal of Industrial Ergonomics 15, 81-90.

Grandjean, E and Hunting, W. 1977. Ergonomics of posture- review of various problems of standing and sitting posture. Applied Ergonomics 8(3), 135-140.

Grandjean, E. 1985. Fitting the Task to the Man: An Ergonomic Approach (3rd ed.) Taylor and Francis, London.

Hagberg, M. and Sundelin, G. 1986. Discomfort and load on the upper trapezius muscle when operating a wordprocessor. Ergonomics 29(12), 1637-1645.

Hagen, K.B., Magnus, P., and Vetlesen, K. 1998. Neck/shoulder and low-back disorders in the forestry industry: relationship to work tasks and perceived psychological stress. Ergonomics 41 (10), 1510-1518.

Hales,T.R., Sauter, S.L., Peterson, M.R., Fine, LJ., Putz-Anderson, V., Schleifer, L.R., Ochs,T.T and Bernard, B.P. 1994. Musculoskeletal disorders among visual display terminal users in a telecommunications company. Ergonomics 37(10), 1603-1621

Helander, M.G,. and Zhang, L. 1997. Field studies of comfort and discomfort in sitting. Ergonomics 40 (9), 895-915.

Hunting,W., Laubli, T. and Grandjean, E. 1981. Postural and visual loads at VDT workplaces: 1. Constrained postures. Ergonomics 24(12), 917-931.

Jorgensen, K., Hansen, L., Lundager, K. and Winkel, J. 1993. Low back muscle reactions to constrained standing in relation to shock absorbing properties of floor and shoes. Advances in Industrial Ergonomics and Safety V: 279-283.

Kuorinka, I. 1998. The influence of industrial trends on work related musculoskeletal disorders (W MSDs). International Journal of Industrial Ergonomics 21, 5-9.

Lannersten, L. and Harms-Ringdahl, K. 1990. Neck and shoulder muscle activity during work with different cash register systems. Ergonomics 23 (1), 49-65.

Li, G. and Haslegrave, C.M. 1995. Effects of task postion and task difficulty on seated work posture In: Robertson, SA. (Ed) Contemporary Ergonomics. Taylor and Francis, London pp. 416-421.

Lindh, M. 1989. Biomechanics of the lumbar spine. In: Nordin, M. and Frankel, V.H. (Eds) Basic Biomechanics of the Musculoskeletal System. Lea and Febiger, Philadelphia pp.183-207.

Mandal, A.C. 1981. The seated man (homo sedens): the seated work position. Theory and practice. Applied Ergonomics 12(1), 19-26.

McPhee, B. 1993, Musculoskeletal complaints in workers engaged in repetitive work in fixed postures. In Bullock M.(2nd ed): Ergonomics - The Physiotherapist in the Workplace. Longman , Singapore.

Miedema, M., Douwes, M., and Dul, J. 1997. Recommended maximum holding times for prevention of discomfort of static standing postures. International Journal of Industrial Ergonomics 19, 9-18.

Nerhood, H.L. and Thompson, S.W. 1994. Adjustable sit-stand workstations in the office. In: People and Technology in Harmony, Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting, Nashville, USA. Human Factors and Ergonomics Society, Santa Monica. pp 668-672.

Paul, R.D. 1995a. Effects of office layout and sit-stand adjustable furniture: a field study. In: Designing for the Global Village, Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting, San Diego, USA. Human Factors and Ergonomics Society, Santa Monica. pp 422-426.

Paul, R.D. 1995b. Foot swelling in VDT operators with sitting and sit/stand workstations. In: Designing for the Global Village, Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting, San Diego, USA. Human Factors and Ergonomics Society, Santa Monica. pp 568-572.

Pustinger, C., Dainoff , M.J. and Smith, M. 1985. VDT workstation adjustability: effects on worker posture, productivity and health complaints. Trends in Ergonomics/ Human Factors II, 445 - 451.

Ryan, A.G. 1989. The prevelance of musculo-skeletal symptoms in supermarket workers Ergonomics 32(4), 359-371.

Smith, M. 1997. Psychosocial aspects of working with video display terminals (VDTs) and employee physical and mental health. Ergonomics 40(10), 1002-1015.

Straker, L.M. 1998. An overview of occupational injury/disease statistics in Australia. Ergonomics Australia 12, 11-16.

Straker, L.M. 1999. Body discomfort assessment tools. In Karwowski W and Marras W (Eds): The Occupational Ergonomics Handbook. Boca Raton, USA: CRC Press, pp. 1237-1250.

Visser, J.L and Straker, L.M. 1994. An investigation of discomfort experienced by dental therapists and assistants at work. Australia Dental Journal 39(1), 39-44.

Waersted, M. and Westgaard, R.H. 1997. An experimental study of shoulder muscle activity and posture in a paper version versus a VDU version of a monotonous work task. International Journal of Industrial Ergonomics 19, 175-185.

Westgaard. R.H. and Winkel, J. 1996. Guidelines for occcupational musculoskeletal load as a basis for intervention: a critical review. Applied Ergonomics 27 (2), 79-88.

Westgaard. R.H. and Winkel, J. 1997. Ergonomic intervention research for improved musculoskeletal health: a critical review. International Journal of Industrial Ergonomics 20, 463-500.

Zhang, L., Drury, C.G. and Woolley, S.M. 1991. Constrained standing: Evaluating the foot/floor interface. Ergonomics 34(2), 175-192.