To investigate the effect of a backrest and seatpan inclination on sitting discomfort and trunk muscle activation in subjects with extension-related low back pain

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ABSTRACT

Few studies have demonstrated that seating modifications reduce low back pain (LBP). One recent study found that a forward-inclined seatpan reduced low back discomfort (LBD), however this was only examined in people with flexion-related LBP. No study has yet investigated its effectiveness among people with extension-related LBP. This crossover study examined 12 subjects with extension-related LBP. Sitting discomfort, and surface electromyography of three trunk muscles, were recorded during a ten minute typing task while sitting with two different seatpan inclinations, both with and without a backrest. LBD ($p<0.001$) and overall body discomfort (OBD) ($p=0.016$) were significantly greater on the forward-inclined seatpan. The backrest did not alter trunk muscle activation or sitting discomfort. The results demonstrate that in a specific extension-related subgroup of people with LBP, increasing forward seatpan inclination significantly increased LBD and OBD. Future research should consider matching ergonomics prescriptions according to the individual presentation of people with LBP.
Practitioner Summary

Sitting on a forward-inclined seatpan resulted in greater low back discomfort (LBD) and overall body discomfort (OBD) than sitting on a flat seatpan during a typing task among people with extension-related low back pain (LBP). Future research should examine matching ergonomics prescriptions to the individual presentation of people with LBP.

Keywords: low back pain; seatpan inclination; backrest; sitting discomfort; muscle activation
1. Introduction

Low back pain (LBP) is a very prevalent and costly musculoskeletal disorder (Woolf and Pfleger 2003). Sitting is frequently reported as an aggravating factor for LBP (Womersley and May 2006). As prolonged sitting alone does not seem to be associated with the development of LBP (Lis et al. 2007, Bakker et al. 2009, Roffey et al. 2010), there has been much research investigating various seating modifications in the management of this condition.

The use of lumbar supports (Williams et al. 1991) or devices (Reinecke et al. 1994) aiming to increase seated lumbar lordosis have been well documented for the management of LBP. This proposes that lordotic postures are favourable, which is further supported by healthcare professionals (O'Sullivan et al. 2012d), the general public (O'Sullivan et al. 2013a) and ergonomics recommendations (Corlett 2006). This increase in seated lumbar lordosis may reduce LBP temporarily (Williams et al. 1991). However, hyper-lordotic sitting postures increase levels of trunk muscle activation in pain-free populations (O'Sullivan et al. 2006b) and this may result in discomfort and fatigue (Lander et al. 1987, Carcone and Keir 2007).

Dynamic sitting devices which cause slight spinal movement have been advocated as an approach to reduce LBP (Van Dieen et al. 2001). It has been proposed that LBP subjects maintain more sustained, static postures during sitting, with large infrequent postural shifts, as opposed to regular spinal movements (Dankaerts et al. 2006b, Telfer et al. 2009). However, recent systematic reviews (O'Sullivan et al. 2012c, O'Sullivan et al. 2013b) revealed there was no evidence that dynamic sitting alone significantly alters trunk muscle activation or reduces LBP.

The effect of altering seatpan inclination has been investigated in a number of studies. Forward-inclined seatpans have been reported to encourage lumbar lordosis (Gadge and Innes 2007, O'Sullivan et al. 2012b). However, it is unclear as to whether low back
discomfort (LBD) is decreased (Gadge and Innes 2007) or increased (Bendix et al. 1988) with a forward-inclined seatpan. Additionally, it has been documented that although LBD may be reduced, there can actually be an increase in discomfort in other body areas (Gadge and Innes 2007).

Another commonly advocated seating modification is the use of a backrest (Carcone and Keir 2007, Kingma and van Dieen 2009). Backrests have become customary in the workplace, although their use may be suboptimal among seated occupational tasks (Vergara and Page 2000). It had been suggested that backrests reduce trunk muscle activation (Hardage et al. 1983, Lander et al. 1987, Gregory et al. 2006). However, it is unclear if a backrest affects sitting discomfort as most studies investigated pain-free populations. Therefore this should be further analysed among LBP subjects.

Therefore, there is very limited evidence to validate most seating modifications in the management of LBP (Driessen et al. 2010). This suggests either these modifications are ineffective, or have been applied to the wrong subjects, or possibly a combination of these factors. There is evidence that people with LBP may not present with the same maladaptive postures and movement patterns (Dankaerts et al. 2006b). It is proposed therefore that seating modifications should reflect the individual clinical presentation of a person with LBP, which might involve greater or less lumbar lordosis (Dankaerts et al. 2006b).

One recent study (O’Keeffe et al. 2013) took into account the existence of distinct movement subgroups among people with LBP, and investigated an ergonomics intervention among those with flexion-related LBP. This study examined a forward-inclined seatpan (‘Back App’) which features a dynamic component and does not have a backrest, and investigated its effect on sitting discomfort among subjects with flexion-related LBP. Results demonstrated a significant reduction in LBD while sitting on the forward-inclined seatpan when compared to a flat seatpan with a backrest. As the forward-inclined seatpan encourages
lumbar lordosis (O'Sullivan et al. 2012b), it was therefore proposed that LBD reduced as a result of the directional nature of the disorder. However, it is also possible that there may have been an enhanced placebo effect due to the novel appearance of the forward-inclined seatpan. Additionally, this study involved patients with low levels of functional disability and a primarily mechanical behaviour of their LBP. This means their LBP was aggravated/eased by spinal postures and movements and not primarily driven by psychosocial factors. This study raised a number of issues to be investigated. These include examining whether seated LBD would also be reduced in a different LBP population e.g. those with extension-related LBP. This would clarify if the effects seen in the previous study (O'Keeffe et al. 2013) were primarily related to the directional nature of the disorder (flexion-related LBP) and/or the fact that subjects had low disability levels, or simply reflected the placebo effect. Additionally, the forward-inclined seatpan may have reduced sitting discomfort as a result of an increase in lumbar lordosis and a reduction in trunk muscle activation (O'Keeffe et al. 2013). As a backrest is proposed to reduce trunk muscle activation in pain-free subjects, it is therefore beneficial to determine whether a backrest could be as effective in reducing sitting discomfort and trunk muscle activation, among those with LBP.

Therefore, in order to address these varying factors, a similar study is warranted, in which subjects with higher levels of disability are selected, and who are possibly less likely to benefit from a forward-inclined seatpan which increases lumbar lordosis i.e. people with extension-related LBP. Additionally, as previously highlighted, there is limited evidence conducted on the effect of backrests among LBP patients, therefore, it needs to be investigated to determine any effect backrests may have on muscle activation and sitting discomfort. The hypothesis of this study is that LBD and overall body discomfort (OBD) among this subgroup will be increased rather than decreased on the forward-inclined seatpan.
It is also hypothesised that trunk muscle activity will be reduced on the forward-inclined seatpan and the presence of the backrest may reduce LBD, OBD and trunk muscle activity. Therefore, the aims of this study were to compare LBD, OBD and trunk muscle activity when sitting on a forward-inclined seatpan with sitting on a flat seatpan during a controlled typing task in subjects with extension-related LBP, and also to determine the effect of a backrest on these parameters.

2.0 Methods

2.1 Study Design

A single session, repeated measures, crossover design was conducted, corresponding to previous, similar studies (O'Keeffe et al. 2013). The dependent variables were trunk muscle activation and sitting discomfort, and the independent variables were backrest and seatpan inclination. All subjects completed the same protocol on a single day, with the order of testing randomised using sealed opaque envelopes. Ethical approval was obtained from a local Research Ethics Committee.

2.2 Subjects

12 subjects (7 female, 5 male) who were referred to a local pain medicine centre were recruited. Subjects were given an information sheet and written informed consent was obtained from all subjects prior to testing. Subjects were informed that they were free to withdraw from the study at any time. Subjects were included if they were aged > 18 years and had LBP aggravated by extension-related activities (e.g. standing/walking/upright sitting) and eased by spinal flexion, consistent with an active extension pattern classification (Dankaerts et al. 2006b). Subjects were excluded if they were pregnant, had LBP for less
than three months, had any red flags, had a specific spine disorder (e.g. fracture, tumour, stenosis) or had previous spinal surgery.

Subject demographics were obtained prior to testing (Table 1). The Numerical Rating Scale (NRS) was used to measure average LBP over the previous week (Childs et al. 2005), fear of physical activity was determined using the physical activity subscale of the fear avoidance beliefs questionnaire (Waddell et al. 1993), functional disability was measured using the Oswestry disability index (Fairbank and Pynsent 2000) and the depression, anxiety and stress scale (DASS-21) measured depression, anxiety and stress (Lovibond and Lovibond 1995).

2.3 Trunk Muscle Activation

Surface electromyography (sEMG) was used to analyse the activation of three trunk muscles. The Motion Lab Systems MA-300 multi-channel EMG system (Motion Lab Systems Inc., Baton Rouge, Louisiana, USA) was used to collect the sEMG data. Self-adhesive disposable Ag/AgCl disc surface electrodes were used which have an electrical contact surface of 1cm² and a centre-to-centre spacing of 2.5cm. The sampling rate was 2000Hz per channel, with a bandwidth of 10-500Hz, a gain of 2000 and a common mode rejection ratio of >115dB at 60Hz (O'Sullivan et al. 2006b). Prior to electrode placement, the skin was prepared to reduce skin impedance. Each electrode site was lightly abraded with fine sandpaper, body hair was shaved if necessary and the skin was cleansed with isopropyl alcohol solution, consistent with recommendations (Hermens et al. 2000). The muscles studied were superficial lumbar multifidus (SLM) (level of L5, parallel to a line connecting the posterior superior iliac spine and L1–L2 interspinous space), iliocostalis lumborum pars thoracis (ICLT) (level of L1, midway between the midline and lateral aspect of the subject’s body) and external oblique (EO) (below the rib cage, along a line connecting the most inferior costal margin and
the contralateral pubic tubercle). These three muscles were selected based on pilot testing and previous research demonstrating that these muscles are most affected by changes in seatpan inclination (O'Sullivan et al. 2012a, O'Sullivan et al. 2012b). The surface electrodes were positioned parallel to the muscle fibre direction of each muscle unilaterally (O'Sullivan et al. 2006b). The side of dominant pain was chosen for the application of electrodes. A common ground electrode was placed at the ulnar styloid. One researcher applied the electrodes for all subjects. Since normalisation to maximal voluntary contraction has been reported as unreliable in LBP patients (Dankaerts et al. 2004), sEMG data were amplitude normalised to two standardised activities to elicit a sub-maximal voluntary isometric contraction (sub-MVIC) (O'Sullivan et al. 2002). The highest generated contraction from three repetitions was taken as sub-MVIC for each specific muscle (Dankaerts et al. 2006a). Each test was recorded for five seconds duration with a one minute rest period between tests to reduce fatigue (O'Sullivan et al. 2002). The middle three seconds were analysed (Soderberg and Knutson 2000).

2.4 Sitting conditions: Forward-inclined seatpan vs. Flat Seatpan

A forward-inclined seatpan (‘Back App’) and a flat seatpan were compared for the purpose of this study (Fig. 1 and 2). The ‘Back App’ was adjusted to allow a hip flexion angle of 55° with subjects placing their feet on the footplate, in line with previous studies (O'Sullivan et al. 2012a, O'Sullivan et al. 2012b, O'Keeffe et al. 2013).

The ‘Back App’ can operate as a stable or dynamic design through adjusting the stability component which is located at the base of the seat. There are three different stability levels which comprise of the ‘green zone’ which is stable, the ‘black zone’ which is slightly unstable, and the ‘red zone’ which features a more unstable training element. The stability level was maintained at the ‘black zone’ for this study which allows a mild degree of motion, in line with previous, similar studies (O'Sullivan et al. 2012a, O'Sullivan et al. 2012b, O'Keeffe et al. 2013).
O'Keeffe et al. 2013). For results relating to this study, the forward-inclined seatpan refers to the ‘Back App’ throughout.

The flat seatpan was height adjustable and had wheels. The seatpan was controlled at a 90° hip and knee angle for each subject ensuring both feet were placed firmly on the floor (Gregory et al. 2006). Goniometry was used to measure both hip and knee angles as this has been reported to have high intra-rater and inter-rater reliability (Ekstrand et al. 1982).

2.5 Backrest

A standard backrest was used for all subjects. The height and distance of the backrest was standardised (Fig. 1 and 2). During the backrest condition, the backrest was secured to a plinth, which was located 22cm behind the subjects’ greater trochanter at the level of posterior superior iliac spine.

2.6 Discomfort

Subjects rated discomfort at the end of each sitting condition using the Body Part Discomfort Scale (BPDS) (Corlett and Bishop 1976), as this has been extensively used for seat evaluation (Fenety et al. 2000). This scale involves subjects subjectively rating their discomfort in each of 12 body areas on a six-point verbal numerical rating scale, where 0=“no discomfort” and 5=“extreme discomfort”. LBD was rated using a single LBD score. OBD was also examined as previous studies have demonstrated a reduction in LBD can be associated with increased discomfort in other body regions when sitting on forward-inclined seatpans (Gadge and Innes 2007). OBD consisted of the mean discomfort of the 12 body areas to give a single total body perceived discomfort value (Fenety et al. 2000).
2.7 Procedure

A simulated workstation was devised. As self-selecting workstation set-ups can be linked with poor sitting postures (Gadge and Innes 2007), the height and distance from the workstations was standardised. Subjects were positioned by the same researcher for each sitting condition to enhance consistency. An adjustable plinth was used as a desk in order to ensure subjects’ elbows were at 90° and kept in line with the trunk during the typing task (Kingma and van Dieen 2009). The distance between the subject and the plinth was standardised so that subjects’ greater trochanter was 30cm from the edge of the plinth (O’Keeffe et al. 2013). A laptop was placed 10cm from the edge of the plinth, directly in front of subjects. A paper weight was used to position a standardised document to be typed on the right hand side of the laptop screen.

The set-up and testing protocol were piloted prior to the study to enhance consistency and accuracy. Subjects were instructed to “sit as you normally would” on the flat seatpan (O’Sullivan et al. 2006a), to “maintain your balance” on the forward-inclined seatpan (O’Sullivan et al. 2012b, O’Keeffe et al. 2013), and for both seats to “rest against the backrest” when the backrest was available. Subjects typed for ten minutes in each sitting condition with sEMG data recorded for five seconds every three minutes, similar to previous research (McGill et al. 2006, O’Sullivan et al. 2012b). Subjects were blinded as to when muscle activity was being recorded. Subjects rated their discomfort on the BPDS at the end of the ten minute testing periods. A one minute rest period between sitting conditions was provided to minimise the confounding effects of fatigue (O’Sullivan et al. 2012b).

2.8 Data Analysis

The middle three seconds of raw sEMG data from each five second testing period (O’Sullivan 2006) were analysed using a root-mean-square (RMS) algorithm (using Motion
Lab Systems Analysis software). These RMS sEMG values were normalised to sub-MVIC for the three muscles and the raw data was expressed as % muscle activity. The mean, and variation (SD), from the three time intervals was assessed for all three muscles and was used for statistical analysis. There was little variance between each time interval, corroborating previous studies which demonstrated that time had no significant effect on muscle activity in short sitting tasks (McGill et al. 2006). All raw sEMG files were visually inspected and data from channels with signal interference was removed.

Data were analysed using the Statistical Package for Social Science (SPSS version 20.0). Data were tested for normality using the Shapiro-Wilks test, and homogeneity of variances using Levene’s test. All dependent variables (EO, ICLT, LM, LBD and OBD) were either normally distributed (Shapiro-Wilks, p>0.05), or their plots indicated minimal variation from normality of distribution, allowing for parametric data analysis. A two-way ANOVA (with post-hoc Tukey) was conducted to compare each of the dependent variables (EO, ICLT, LM, LBD and OBD) between two independent variables (presence of backrest and seatpan inclination). Statistical significance was set at p<0.05.

3.0 Results

3.1 Subjects

All 12 subjects completed the protocol. sEMG data was missing for one subject due to signal interference.

3.2 LBD

There was no significant interaction (F (1, 44) =0.000, p=1.000) between the effects of a backrest and seatpan inclination on LBD. Simple main effects analysis showed that LBD did not differ significantly (F (1, 44) =0.076, p=0.785) according to the presence or absence of a
backrest. However, LBD was significantly greater with the forward-inclined seatpan when compared to the flat seatpan (F (1, 44) =19.354, p=0.000) (Fig. 3).

3.3 OBD

There was no significant interaction (F (1, 44) =0.477, p=0.493) between the effects of a backrest and seatpan inclination on OBD. Simple main effects analysis showed that OBD did not differ significantly (F (1, 44) =0.068, p=0.795) according to the presence or absence of a backrest but did differ significantly depending on seatpan inclination, with OBD significantly greater on the forward-inclined seatpan (F (1, 44) =6.24, p=0.016) (Fig. 4).

3.4 Trunk Muscle Activation

There was no significant interaction between the effects of a backrest and seatpan inclination for mean activation of any of the three muscles analysed (p>0.05). Additionally, simple main effects analysis showed no significant difference (p>0.05) in mean trunk muscle activity according to the presence or absence of a backrest, or depending on seatpan inclination. There was also no significant difference in the variation of trunk muscle activity between the any of the sitting conditions (p>0.05).

4.0 Discussion

4.1 Sitting Discomfort

The findings of this study demonstrate that in a subgroup of people with extension-related LBP, consistent with an active extension pain disorder (Dankaerts et al. 2006b), LBD and OBD were significantly increased on a forward-inclined seatpan in comparison to a flat seatpan. The most likely explanation for an increase in LBD in this study, based on previous research using the same forward-inclined seatpan, is an increase in lumbar lordosis
(O’Sullivan et al. 2012b). Although that study was conducted among pain-free subjects, it is in line with other research which has demonstrated that similar forward-inclined seatpans can increase lumbar lordosis (Gale et al. 1989, Gadge and Innes 2007, Koskelo et al. 2007).

The importance of investigating subgroups of LBP patients has been previously highlighted (Dankaerts et al. 2006b). Therefore, this current study deliberately consisted of subjects with extension-related LBP. Previous research demonstrates that this subgroup tend to sit in a hyperextended posture which is correlated with their symptoms (Dankaerts et al. 2009). Therefore, as extension is an aggravating factor for this particular subgroup of LBP patients, a forward-inclined seatpan which encourages lumbar lordosis is likely to be the primary reason for an increase in LBD. The directional nature of the disorder resulted in an increase in LBD, as hypothesised. In contrast to this, it was recently found that LBD was reduced on the same forward-inclined seatpan (O’Keeffe et al. 2013). However that study examined those with flexion-related LBP. Therefore, matching the forward-inclined seatpan according to the flexion-pattern of their LBP most likely reduced LBD as a result of the directional nature of the disorder (O’Keeffe et al. 2013). This highlights the importance of matching ergonomics interventions to the clinical presentation of individual patients rather than generic prescription, as it is evident that different subgroups can respond with either significantly increased or reduced LBD, based on their individual LBP disorder.

A number of studies have previously investigated the effect of forward-inclined seatpans on sitting discomfort. However contrasting results have been obtained with both decreased (Bridger 1988, Gadge and Innes 2007) and increased (Bendix et al. 1988, Bishu et al. 1991) LBD reported with a forward-inclined seatpan. However, most studies investigating seatpan inclination included pain-free populations, and those that did include LBP patients did not consider their individual clinical presentation.
The increase in OBD in this study corroborates the results of a previous study which demonstrated that forward-inclined seatpans increased discomfort levels in other body areas, such as the hips and buttocks (Gadge and Innes 2007). It is also somewhat consistent with the lack of a decrease in OBD in the recent study using the same forward-inclined chair among people with flexion-related LBP (O'Keeffe et al. 2013). Another possible reason for the differences in OBD between sitting conditions was foot position. The forward-inclined seatpan required subjects to distribute more weight through the front of their feet, with increased ankle plantar flexion. While research is limited on the effect of foot position, it has been shown to affect lower leg muscle activation which could contribute to lower leg discomfort (Carlsoo 1961). Therefore, this may have led to an increase in OBD observed on the forward-inclined seatpan, although since foot position does not significantly increase trunk muscle activation (Carlsoo 1961) it most likely had no effect on LBD.

Contrary to the hypothesis, the addition of a backrest to both of the seatpans did not significantly reduce LBD or OBD. Previous research has demonstrated very slight reductions in sitting discomfort when using a backrest (Lander et al. 1987, Gregory et al. 2006, Kingma and van Dieen 2009). However, these other studies were all among pain-free subjects, providing limited evidence for backrests having any effect on sitting discomfort in LBP patients.

4.2 Trunk Muscle Activation

In contrast to our hypothesis, there was no significant difference in trunk muscle activity for any of the sitting conditions in this study. Previous research indicated that trunk muscle activity may be reduced among pain-free subjects with a backrest (Gregory et al. 2006, Kingma and van Dieen 2009). However, very little research has been conducted on the effect of a backrest on muscle activation among people with LBP, and that which had used LBP
subjects had contained several confounding factors (Cram and Vinitzky 1995). There is also considerable inconsistency in research examining the effect of inclined seatpans on trunk muscle activation, with both increased (Lander et al. 1987, Cram and Vinitzky 1995) and decreased (Koskelo et al. 2007) muscle activation reported. However, one recent study (O'Sullivan et al. 2012b) investigating the effect of the same forward-inclined seatpan used in the current study among pain-free subjects demonstrated reduced paraspinal muscle activity.

There are a number of likely explanations as to why muscle activity was not altered between sitting conditions in the current study. As highlighted, most previous studies have been done using pain-free populations. A meta-analysis (Geisser et al. 2005) identified higher muscle activity levels during static postures in LBP subjects when compared to pain-free subjects, and a reduced ability to relax the paraspinal muscles. These altered levels of trunk muscle activation among LBP patients are linked to sitting posture, with the highest levels of paraspinal muscle activation among those with extension-related LBP who actively posture their spine in extension (Dankaerts et al. 2009). Therefore, this group may be less able to relax into anterior pelvic tilt and lumbar lordosis on a forward inclined seatpan than painfree subjects (O'Sullivan et al. 2012b). Similarly, this group may be less able to relax their lordosis and use a backrest in the manner that painfree participants can. Another possible reason for no change in muscle activation in the current study is the greater levels of functional disability. Subjects with more disabling LBP, such as those included in this study, are reported to have altered patterns of muscle activity during sitting when compared to control subjects and those with non-disabling LBP (DeGood et al. 1994). Therefore, this may explain why trunk muscle activation was reduced amongst pain-free subjects on the forward-inclined seatpan (O'Sullivan et al. 2012b) and not in this group. Finally, the dynamic component of the forward-inclined seatpan is another factor which must be considered in this study. This may increase spinal movement in sitting (O'Sullivan et al. 2006a, Kingma and
van Dieen 2009), yet most research suggests dynamic sitting has a negligible effect on LBD (O'Sullivan et al. 2012c), spinal posture (O'Sullivan et al. 2006a) and trunk muscle activation (O'Sullivan et al. 2013b). Therefore, the dynamic element is unlikely to have contributed to the results obtained in this study.

4.3 Implications for Clinical Practice and Research:

The results of this study may have important implications for the management of people with LBP and research in this area. It has been reported that seating modifications are ineffective in the management of musculoskeletal disorders (Driessen et al. 2010). Despite the fact that sitting discomfort actually increased in this study, there are many aspects worth noting towards the role of seating modifications.

Subjects in this study were specifically selected as they subjectively reported pain with extension-related postures such as walking/standing. This was purposely conducted so that subjects who were sensitive to lumbar extension were matched to a seating device that increased lumbar extension. A particular subgroup of LBP subjects were selected, rather than prescribing it to all people with LBP. Although this approach is clinically relevant, the consideration of matching interventions to subgroups of LBP patients is not frequently investigated (Fersum et al. 2010). This is important as the response of LBP patients to seating modifications may vary according to their individual clinical presentation (Dankaerts et al. 2006b). This has been highlighted in the current study, with an increase in LBD, which is in direct contrast to previous results (O'Keeffe et al. 2013) which found reduced LBD among those with flexion-related LBP. Although lordotic sitting appears to be considered as optimal for the lumbar spine (O'Sullivan et al. 2012d, O'Sullivan et al. 2013a), this study provides evidence that seating modifications may need to vary between subgroups of LBP populations to prevent the “washout” effect (Dankaerts et al. 2009).
Additionally, subjects in this study had at least moderately disabling LBP, with high levels of fear avoidance and functional disability. As such, there was likely to be a greater degree of central nervous system sensitisation involved in their pain (Smart et al. 2010). Therefore, they may be less likely to benefit from an ergonomics intervention in isolation, although their pain did demonstrate at least some mechanical pain behaviour. Research indicates chronic LBP requires a biopsychosocial approach (O'Sullivan 2005). Therefore it would be expected that a physical ergonomics intervention alone would be insufficient for the management of the majority of LBP patients (Driessen et al. 2010), such as those included in this study, as it does not reflect LBP patients at ‘high risk’ of chronicity (Hill et al. 2011) or severe disability. However, there may be a role for an ergonomics intervention, as part of a comprehensive biopsychosocial approach (Fersum et al. 2012), and this should be further investigated.

4.4 Limitations:

This study investigated a small sample of a particular subgroup of people with LBP, and therefore results may not transfer across to other LBP populations. The task was of short duration as subjects only typed for ten minutes in each sitting condition. However, pilot testing revealed that ten minutes of testing was sufficient in this subgroup of LBP patients, with high levels of pain and disability, to observe increases in LBD and OBD. Ideally these ergonomics studies should be investigated over a much longer time period and in typical occupational settings, as the standardised nature of the office task in this study does not reflect the true office environment.

The evaluation of additional outcome measures such as spinal kinematics could have enhanced results of the likely mechanism of effect. Yet, based on previous research, facilitation of lumbar lordosis was the likely cause of effect for increased LBD (O'Sullivan et al. 2012b). There were a limited number of muscles analysed, with only three muscles...
investigated in this study. However, these were selected based on previous research (O'Sullivan et al. 2012a, O'Sullivan et al. 2012b) demonstrating that they are most affected by changes in seatpan inclination. Furthermore, the assessor was not blinded.

5.0 Conclusion

In a specific subgroup of people with extension-related LBP, there was a significant increase in LBD and OBD while sitting on a forward-inclined seatpan when compared to a flat seatpan. The lack of investigations into subgroups of people with LBP may explain the inability to detect effective ergonomics interventions, as their clinical presentation has not been taken into account. Therefore, future research should target interventions to the clinical presentations of subgroups of LBP patients. LBP is a complex multidimensional disorder and future studies should investigate seating modifications as part of a biopsychosocial management plan.

6.0 References


Dankaerts, W., O'Sullivan, P., Burnett, A. & Straker, L., 2006b. Differences in sitting postures are associated with nonspecific chronic low back pain disorders when patients are subclassified. *Spine, 31* (6), 698-704.


Table 1: Mean (±SD) subject demographics

<table>
<thead>
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<td>Stress</td>
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Figure 1: Layout of the simulated workstation, with subject sitting on the forward-inclined seatpan, with backrest (left) and without backrest (right).
Figure 2: Layout of the simulated workstation, with subject sitting on the flat seatpan with backrest (left) and without backrest (right).
Figure 3: Change in the mean (±SD) of LBD for all sitting conditions. Negative values indicate that discomfort reduced in that sitting condition.

[LBD=low back discomfort]
Figure 4: Change in the mean (±SD) of OBD for all sitting conditions. Negative values indicate that discomfort reduced in that sitting condition. [OBD=overall body discomfort]