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Will Performing Recommended Stretch Break Exercises in the Sitting Position Alter the Spinal Postural Alignment and Body Discomfort?

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Abstract

Objective: The study investigated whether performing recommended stretch break exercises during prolonged sitting altered spinal postural alignment and body discomfort, and whether or not short bouts of reaching tasks in the sitting posture influenced the spinal postural alignment of participants with chronic low back pain differently from that of asymptomatic persons.

Design: This prospective, experimental study was conducted in Health Science Research Laboratory. Fourteen asymptomatic participants with no history of chronic LBP were recruited for Study 1 to perform recommended stretch breaks between prolonged sittings. Study 2 involved 16 participants including 7 with chronic LBP whom performed reaching tasks in sitting. Participant's trunk inclination and thoracic and lumbar curvature angles in the sagittal plane during sitting and their body part discomfort scores recorded at the end of the prolonged sitting period.

Results: There were no significant differences in spinal postural alignment during the prolonged sitting or during the reaching tasks while sitting between the two groups of participants. Stretch break exercises did significantly reduce the discomfort in four regions of the trunk.

Conclusions: The Health Promotion Board's recommended stretch break exercises does reduce body discomfort during prolonged sitting.

Keywords

Chronic low back pain; Stretch break exercises; prolonged sitting

Introduction

The socioeconomic burden of low back pain (LBP) in the USA is estimated to cost society more than $102 billion directly and around $500 billion indirectly [1]. Younger workers in their first year of employment and women (53.9%) are at greater risk of experiencing LBP as they tend to sit for more than half of their working day [2]. When subjects perform repetitive reaching tasks while sitting, the relative risk of experiencing LBP increases by 3.2 times (95% confidence interval {CI} = 1.6-6.4) [3,4].

A critical review of the association between prolonged sitting and LBP found contradictory results. Spinal intra-disc pressures increases in an awkward posture, while repeated flexion and rotation of the spine and lifting objects while sitting also results in a less than optimal lordotic posture [5]. It has also been reported that professional drivers who sit for long periods have a 2.1 times greater risk of experiencing LBP and had the highest hospitalization rate compared to other occupations [6,7]. Performing more than 12 flexion or rotation movements of the trunk per hour also increases the risk of experiencing LBP by 3 times (95%CI=1.4-6.4), even after controlling for confounding factors of age, gender, educational level and duration of employment [2,5,8]. Thus, both prolonged sitting and repeated bending and rotation of the trunk while sitting are aggravating factors that increase the risk of experiencing LBP.

The Singapore National Health Promotion Boards recommends that the performance of regular trunk twisting and bending exercises during prolonged sitting to decrease the static muscle loading on the spinal vertebra, reduce the symptoms of back pain, and improve one's function [9-11]. Graded exercises of twisting, bending and strengthening also increase trunk flexibility and facilitate blood flow to intervertebral disks [5,9]. However, LBP sufferers who perform rotation and flexion tasks while sitting demonstrated less trunk flexion and greater trunk axial rotation, increased co-activation of their trunk muscles, and significant weight bearing asymmetry, especially during lumbar lateral flexion (p=0.037) and axial rotation (p=0.029), compared to asymptomatic participants [12-15]. However, another study reported there were no differences in trunk muscle activities between healthy participants and those with non-specific chronic LBP [16].

What constitutes the ideal sitting posture is also controversial. More than 30% of physiotherapists identified ideal sitting postures as either neutral spine alignment with lumbar lordosis and a relaxed thoracic spine, or extension of the lumbar and thoracic regions with some forward trunk lean [17-19]. These professions' views were significantly influenced by where they had trained [20,21].

The objectives of this two-part experimental study were to determine whether performing stretch break exercises during prolonged sitting alters spinal postural alignment and/or influence bodily discomfort and whether or not the performance of short bouts of reaching tasks while sitting by individuals with chronic LBP alters their spinal kinematics differently from those of asymptomatic individuals.

Methods

Fourteen asymptomatic participants with no history of chronic LBP (7 females, 7 males), mean age of 20.6 years (range 18-24), mean weight of 55 kg (range 42-64), mean height of 1.66 m (range 1.59-1.80) were recruited for Study 1. They were assigned to an experimental group or a control group using Random Allocation Software. Study 2 involved 16 participants (9 females, 7 males), including 5 females and 2 males with chronic LBP, mean age of 21.6 years (range 18-27), mean weight of 56.3 kg (range 43-65), mean height of 1.65 m (range

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1.57-1.78) recruited from an institution of higher learning through an e-mail invitation. The National Institute of Neurological Disorders and Stroke defines chronic LBP at the spine as pain that persists for 12 weeks or longer after an initial injury or after treatment.

During a face-to-face discussion, all the recruited participants were made aware of the two experimental protocols and their informed consent was obtained. This study was approved by the Research and Project Committee of the School of Health Sciences, Nanyang Polytechnic (SHS/2007/02/PT).

Kinematic data of the participants' spinal alignments were collected using the Qualysis™ Motion Analysis System (Qualysis Medical AB, Gothenburg, Sweden Motion Analysis) with 3 ProReflex™ motion capture units. Reflective markers were placed on the participants' seventh spinous vertebral process (M1), the apex of kyphosis (M3), the apex of lordosis (M6), and the lower edge of the sacrum (M8). Markers were also placed between M1 and M3 (M2), between M3 and M6 (M4 & M5), and midway between the 2 posterior superior iliac spines (M7); markers on the left and right acromion (Al and Ar) identified the shoulder girdle position. Two additional markers were bilaterally placed on the upper arms to monitor arm movements during the studies. Trunk inclination (α1), thoracic curvature angle between M1, M3 and M6 (α7), and the lumbar curvature angles between M3, M6 and M8 (α8) in the sagittal plane were calculated. This kinematic spinal model was adopted from the studies of Frigo et al and Pauline et al [22,23].

The participants sat on an unsupported back-less stool (to allow viewing of the reflective body markers on the trunk) with their thighs horizontal and lower limbs vertical. There was a free space of 4 cm between the front edge of the stool and the popliteal fossa of the participants. The participants' feet were positioned apart and their arms were placed on their thighs.

The Borg CR-10 Body Part Discomfort (BPD) scale was used to assess participants' levels of discomfort at various truncal body parts after the prolonged sitting session. BPD is a well-accepted assessment tool and requires no prior training to administer [24]. If the participants had no discomfort, they were scored 0 and when they experienced extreme discomfort, they were scored 10. Before commencing the study, participants were required to lie supine for 10 minutes to cancel out prior loading on the spine. Then, they were assigned either to the control group or the experimental in Study 1. If a participant had a history of chronic LBP for more than 12 weeks, he or she was assigned to the Chronic LBP group in Study 2 (Figure 1).

Study 1 investigated the effects of performing stretch breaks exercises during prolonged sitting. Participants in the control group sat continuously for 2 hours and watched a movie while those in the experimental group performed 6 stretch break exercises in the sitting position as recommended by the Singapore Health Promotion Board during the 10-minute break between the first and second hour of prolonged sitting (Appendix 1) [10]. Kinematic data of participants' trunk inclination (α1), thoracic curvature angle (α7), and lumbar curvature angle (α8) in the sagittal plane were collected at 5-minute intervals during the 2 hours sitting period. At the end of the sitting period, the participants verbally reported their BPD scores.

Study 2 investigated the effects of performing short bouts of reaching tasks on the spinal kinematics of individuals with chronic LBP and compared them with those of asymptomatic participants. On the instruction "Go", participants reached and picked up a 1 kg dumb-bell placed on the floor at 3 different positions (left, right and centre) using the hand nearest to the dumb-bell or the dominant hand if the object was at the centre. Each reaching task was performed 3 times.

The dumb-bells were placed at 90 degrees to the sagittal plane on the left and right sides and at 50% of the subject's arm length (acromion to tip of middle finger). The dumb-bell at the front was placed at 100% of the participant's arm length. Participants rested their unused hand on their lap between performances of the reaching tasks.

Statistical Package for the Social Sciences for Windows version 22 (Statistical Package for the Social Science (SPSS) for Windows (version 22) was used to analyse the kinematic data of trunk inclination (α1), thoracic curvature angle (α7), and lumbar curvature angle (α8) in the sagittal plane and the BPD data of the participants. Significance was accepted for values of $p<0.05$.

Results

Study 1: Stretch break exercises during prolonged sitting

The control and experimental groups' baseline trunk inclinations (α1), thoracic curvature angles of kyphosis (α7) and lumbar curvature angles (α8) in the sagittal plane were not significantly different. After 2 hours of prolonged sitting, the participants who performed stretch break exercises showed no significant difference in their trunk inclination (α1), thoracic curvature angle (α7) or angle of lordosis (α8) in the sagittal plane from those of the control participants (Table 1).

There were significant differences in the average BPD scores reported for the neck, upper back, mid and low back, and the buttocks between the participants who performed stretch break exercise after 1 hour of prolonged sitting (experimental group) and those of the participants who sat continuously for 2 hours (Table 2).

Study 2: Effects of performing short bouts of reaching tasks on the spinal kinematics of the individuals with chronic LBP and those of the asymptomatic persons.

The baseline values of thoracic curvature angle (α7) and lumbar curvature angle (α8) of asymptomatic participants were not significantly different from those of the individuals with chronic LBP. There were also no significant differences between the asymptomatic participants and chronic LBP participants' thoracic curvature angle (α7) and lumbar curvature angle (α8) after they reached and picked up dumbbell placed at the front, and at the left and right sides (Table 3).

Discussion

This study contributes new knowledge to previous literature regarding strategies to minimise discomfort during prolonged sitting. Performing stretch break exercises recommended by the Singapore Health Promotion Board during prolonged sitting did not significantly change trunk inclination, thoracic curvature or lumbar curvature angles. Callaghan and McGill [25] reported there were no significant changes in the thoracolumbar curvatures of the spine during continuous sitting. A possible explanation is that the load sharing ability of slow twitch spinal muscles responds to spinal loading without changing postural alignment during prolonged

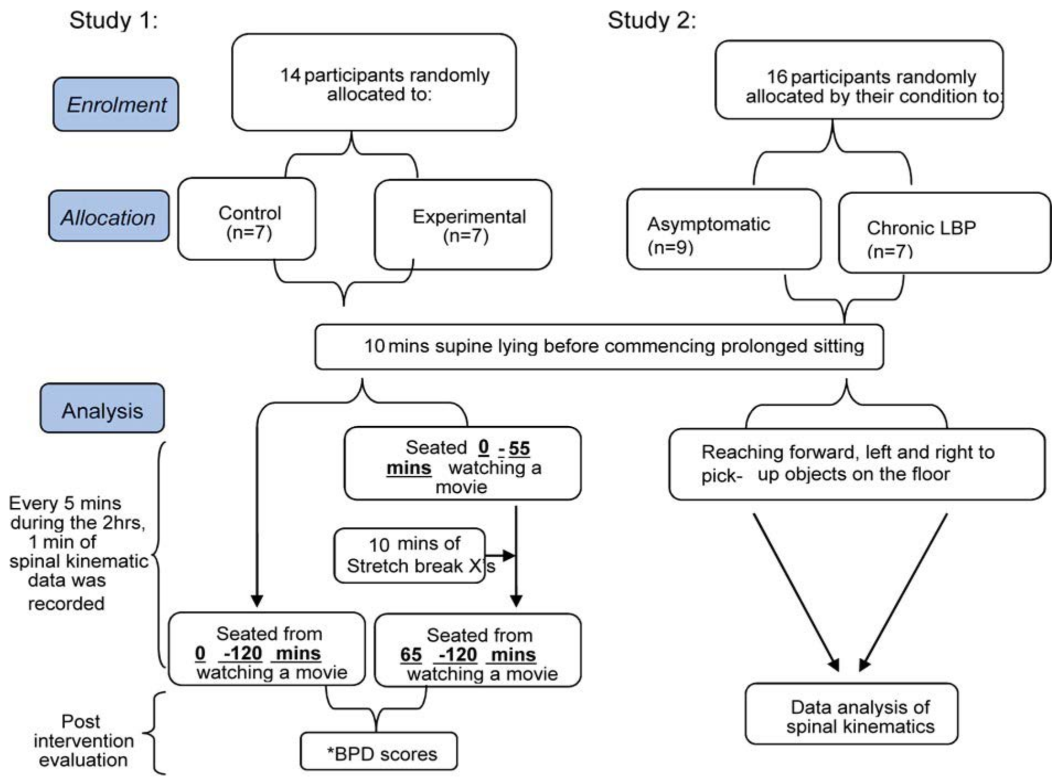

Figure 1: Experimental flow of this two-part study. *BPD: Body Part Discomfort.

Table 1: Average spinal posture changes between the control group which sat for 2 hours and the experimental group which performed stretch break exercises at the mid-point of the 2-hour sitting period.

Sagittal plane	Control group Average change in angles (°) (SD)	Experimental group Average change in angles (°) (SD)
Trunk Inclination (α1)	−1.46 (5.23)	−3.24 (5.49)
Thoracic curvature angle (α7)	2.07 (3.25)	−2.24 (6.54)
Lumbar curvature angle (α8)	−0.40 (4.56)	−0.18 (3.44)

SD: standard deviation

Table 2: Average ratings of regional body part discomfort (BPD) scores of the control group which sat for 2 hours without a break, and the experimental group which performed stretch break exercises at the mid-point of the 2-hour sitting period.

Body location	Control group (SD)	Experimental group (SD)
Neck	4.29 (1.70)	1.00 (1.29) *
Upper back	3.71 (1.25)	1.43 (0.98) *
Mid & low back	5.14 (1.77)	1.43 (1.51) *
Buttocks	4.86 (2.41)	1.57 (1.62) *

SD: standard deviation, *p<0.05

sitting [26]. Furthermore, the performance of dynamic stretching exercises in walking, standing or reaching tasks has been reported to nourish the nucleus pulposus and the intervertebral discs, reduce spinal shrinkage, transfer forces to the surrounding musculoskeletal structure and result in delays to the onset of fatigue [27-29]. Although lumbar spine stiffness and discomfort at the neck, upper back, low back, and hip/thighs significantly increased after 1 hour of prolonged sitting, the biomechanical compressive tolerance at the intervertebral discs suggested by NIOSH was well below the limit of 3400 N [6,22,26].

Performing reaching tasks during sitting also did not alter the postural alignment of individuals with chronic LBP. Dankaerts et al. [27] also found there were no abnormal postures among individuals with non-specific chronic LBP during sitting. Mork and Westgard [26] also reported that seated female computer workers with LBP who performed occasional reaching task during work did not demonstrate abnormal postural alignment or show increases in surface electromyography activities. A possible explanation frequent performance of reaching activities creates a micro massaging effect on spinal muscles which modulates the symptoms of LBP.

The results of this study support the hypothesis that performing stretch break exercises or frequent reaching tasks while sitting does not influence spinal postural alignment or symptoms of LBP. It validates the hypothesis that performing the stretch break exercises recommended by the Singapore Health Promotion Board during prolonged static sitting reduces body discomfort.

Certain limitations are inherent to this study. This study did not follow up participants to evaluate the carry-over effects of the interventions between the sessions of prolonged sitting. The use of a back-less chair did not allow participants to lean backwards to relax if they experienced fatigue, and seat type is known to influence spinal kinematics [30]. Future research should study the changes in spinal muscle recruitment patterns and their links with body discomfort during sitting.

Despite these limitation, these findings scientifically validate the benefits of performing the Singapore Health Promotion Board's recommended stretch break exercises during prolonged sitting. These stretch break exercises minimise body discomfort during prolonged sitting activities and may reduce the likelihood of experiencing low back pain.

Table 3: Average changes in thoracic curvature angle (α7) and lumbar curvature angle (α8) of asymptomatic and chronic LBP participants as they performed short bouts of reaching tasks while sitting.

	Average change in angles (°) (SD)	
Reaching task	Asymptomatic	Chronic LBP
a) Forward flexion Thoracic curvature angle (α7)	152.7 (6.2)	154.5 (5.3)
Lumbar curvature angle (α8)	153.4 (8.3)	153.5 (6.0)
b) Left side flexion Thoracic curvature angle (α7)	159.5 (11.6)	151.6 (4.4)
Lumbar curvature angle (α8)	154.0 (7.4)	155.9 (5.5)
c) Right side flexion Thoracic curvature angle (α7)	148.0 (5.8)	150.6 (6.0)
Lumbar curvature angle (α8)	155.9 (4.0)	156.2 (4.6)

SD: standard deviation

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