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Gender-based differences in postural responses to seated exposures

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Abstract

Background. Individuals may respond differently to various chair designs and the factors that influence these sitting behaviours are not well understood. There is very little information in the scientific literature regarding the observation and documentation of gender differences in seated postures. In particular, anecdotal observations of potential gender-specific sitting behaviours led us to test the influence of gender on the postural responses to different seated conditions.

Methods. Sixteen healthy university students (8 males and 8 females) were tested on four different chair configurations. Upper body kinematics (spine angles and centre of mass) and seat pressure profiles (centre of pressure, peak pressure) were obtained during each testing session.

Findings. Regardless of the chair used or the task performed, average lumbar and trunk angles were significantly more flexed for males than for females ($P = 0.047$ and $P = 0.0026$, respectively). Males exhibited average lumbar spine and trunk angles of 65.4° (SD 16.2°) and 29.8° (SD 28.3°), respectively, while female lumbar spine and trunk angles were 49.6° (SD 23.1°) and −3.3° (SD 20.4°), respectively. The pelvis was posteriorly rotated for males (7.6° (SD 8.2°)) and anteriorly rotated for females (−5.5° (SD 9.3°)) ($P = 0.0008$). Significant gender * chair interactions of the location of the individual on the chair seat were most marked for the pivoting chair with a back rest. Females positioned their centre of mass and hip joints anterior to the chair pivot point while males' centre of mass ($P = 0.0003$) and hip joints ($P = 0.0039$) were located posterior to the pivot point. Females also sat with their centre of mass closer to the seat pan centre of pressure than males when a back rest was present ($P = 0.0012$).

Interpretation. Males and females may be exposed to different loading patterns during prolonged sitting and may experience different pain generating pathways. Therefore, gender-dependent treatment modalities and/or coaching should be implemented when considering methods of reducing the risk of injury or aggravation of an existing injury.

Keywords: Gender differences; Male; Female; Prolonged sitting; Low back pain; Lumbar; Spine; Posture; Seat pressure; Centre of pressure; Centre of mass

1. Introduction

An extensive amount of research has attempted to determine the "optimal" seating position for the human spine that would reduce the risk of developing low back pain. Thus, different chair designs have emerged with the goal of allowing the individual to assume an optimal seated posture while maintaining comfort and functionality of the chair. However, individuals may respond differently to different chair designs and the factors that influence these sitting behaviours are not well understood. In particular, anecdotal observations of potential gender-specific sitting behaviours have driven us to examine if males and females exhibit different responses from exposure to various seated conditions.

The evidence in the scientific literature is controversial for the benefits of dynamic office chairs. Bendix

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and colleagues have shown in a series of experiments that pivoting chairs do not significantly change trunk kinematics (Bendix, 1984; Jensen and Bendix, 1992), however neither study examined any potential gender differences in the response to the various chairs tested. When examining three chairs, one with a fixed seat and back rest and two dynamic chairs, van Dieen et al. (2001) found that there was an increased gain in stature over the 3 h period for the two dynamic chairs when compared to the fixed chair. They attributed this stature gain to the recovery of disc height because of more effective support from a spring-loaded back rest of the dynamic chair which would subsequently reduce spinal compression. Data from males and females were not analyzed separately, nor was there any extensive reporting of other postural variables such as trunk or spinal angles. Investigating which factors determine lumbar spine posture in sitting, Bridger et al. (1992) noted that when moving from a standing to a sitting posture, males have a greater loss of lumbar lordosis than females. Although their study examined a substantial number of both male and female participants ($n = 25$ for each gender), they did not extensively compare nor emphasize any gender differences observed in seated postures. In a study conducted in our own laboratory examining the difference between sitting on a stability ball and on an exercise chair, females exhibited a similar response to that reported by Bridger et al. (1992) with less lumbar flexion than males when sitting on both the chair and the ball (Gregory et al., in press). Females also tended to be more static sitters than males, maintaining a narrow range of lumbar spine postures for prolonged periods of time (Gregory et al., in press). Furthermore, the passive tissues of the trunk in males and females have been found to respond differently over time when exposed to 2 h of prolonged sitting (Beach et al., 2005). For males, the lumped passive structures in the spine (e.g., spinal ligaments, and intervertebral discs) became stiffer during the 2 h period. Females showed changes in passive stiffness; however these changes were not consistent across female participants. Nevertheless, there is evidence that males and females respond differently while sitting. To our knowledge, gender differences have not been taken into account when examining different configurations of office chairs, such as the presence of a pivoting seat pan and/or a backrest.

The primary purpose of this project was to test the influence of gender on the postural responses to different office chair configurations. Particular focus was placed on the relative location of a chair's pivot point and an individual's selected seating position with measurements of the participant's centre of mass, spine postures and pelvic position. A secondary purpose included determining if and/or how males and females respond to different computer-based tasks while seated.

2. Methods

A total of 16 participants, 8 males (mean age = 24.8 years (SD 1.5); mean height = 1.81 m (SD 0.06); mean mass = 84.6 kg (SD 11.2)) and 8 females (mean age = 23.4 years (SD 2.1); mean height = 1.71 m (SD 0.08); mean mass = 66.5 kg (SD 12.9)), were recruited from a university population. This population was deemed to be relevant to this study as university students tend to spend a large amount of time performing seated work. All participants were free of low back pain for 12 months prior to the testing period. The study protocol received approval from the University Office of Research and subjects gave informed consent before testing began.

Participants were required to attend four testing sessions that occurred on different days, at the same time of day for each individual. Each testing session involved 45 min of seated computer work. Four different office chair configurations were randomly tested and included: (1) a fixed seat pan with no back rest, (2) a pivoting seat pan with no back rest, (3) a pivoting seat pan with a back rest and (4) a freely pivoting spring-post stool (seen in Fig. 2B). The chairs were adjusted at the start of the first session such that the initial seated position for each participant allowed the knees to be at 90° when the feet were in full contact with the floor. The desk was adjusted so that the elbows were at 90° with relaxed shoulders when the participant was typing on the keyboard. The heights of the chair and desk were measured and reproduced in each of the test sessions for the participant. Participants were tested at approximately the same time of day for each session they attended. They did not receive any specific instructions regarding their activities prior to arrival for testing. However, upon arrival each participant was subject to approximately 30 min of upright standing and moderate forward flexion during the set-up period. It is thought that this is sufficient time to equalize any effects of prior loading for relative comparisons within participants, as has been demonstrated in stadiometry studies (Althoff et al., 1992; Leivseth and Drerup, 1997).

During each testing session, participants performed three 15-min intervals of simulated office work consisting of a mousing task (various computer games that used the mouse to move objects around), a typing task (transcription of a type-written document) and task involving a combination of the two (a quiz requiring Internet searches) (Fig. 1). The tasks were standardized between participants and presented in a random order to ensure that any observed differences were not attributable to the order of task performed. Participants were asked to stand up and move around after each 15-min interval in order to assess the repeatability of repositioning the body on the chair. Prior to the 45-min sitting period, an upright standing trial was collected for baseline