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Passive stiffness changes in the lumbar spine and effect of gender during prolonged simulated driving

Diana E. De Carvalho, Jack P. Callaghan*

Department of Kinesiology, Faculty of Applied Health Sciences, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada

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ABSTRACT

Gender differences in lumbar and pelvic posture have been reported previously in prolonged sitting, both in an office chair and automobile seat. To date, it is not known whether these postural exposures during prolonged driving affect the passive lumbar spine flexion stiffness. The purpose of this study was to examine time-varying responses of passive lumbar spine stiffness, lumbar spine and pelvic postures during a 2 h simulated driving trial. Secondary goals investigated the influence of gender on lumbar spine stiffness, discomfort scores and seat pressure profiles. Twenty (10 males, 10 females) subjects were recruited to complete a 2 h simulated driving task. Passive lumbar range of motion was measured on a customized frictionless jig before, halfway through and at the end of 2 h. During driving there was a time-varying difference in the lumbar flexion angles adopted by the gender groups. A significant interaction ($p = 0.0458$) was found for gender and time with women being found to sit significantly different than males in the second hour of driving exhibiting greater maximum lumbar flexion (60.0% ROM (±1.27) than men 50.0% ROM (±1.5). Both men and women demonstrated similar passive stiffness changes characterized by an initial increase in transitional zone stiffness after 1 h (+0.1 Nm/degree for males and +0.3 Nm/degree for females, $p = 0.2372$). Over 2 h of driving there was a non-significant trend of genders to respond differently to the seated exposure. Specifically transitional zone stiffness was found to increase in males (0.86 (SD 0.31) to 0.92 (SD 0.31) Nm/degree) and decrease in females (0.81 (SD0.88) to 0.73 (SD 0.52) Nm/degree) ($p = 0.1178$). Differences in lumbar posture and passive stiffness over 2 h of simulated driving were demonstrated between genders in this study.

Relevance to industry: Gender specific ergonomic interventions should be investigated for the automobile seat. Additionally, the changes in passive stiffness induced by prolonged seated exposures could introduce altered low back kinematics in activities performed after a long car ride. Lifting scenarios such as luggage unloading or parcel delivery are common activities immediately after driving. The altered stiffness of the lumbar spine in these activities could have potential ergonomics and injury related implications for both the general population and professional drivers.

1. Introduction

Internationally, individuals are facing longer periods of time driving both professionally and associated with commuting. A recent population survey reported that Canadians spend an average of 63 min commuting each day (Statistics Canada, 2005 General Social Survey). For professional drivers, such as truck drivers and police officers, driving time per day regularly exceed 8 h. Research from around the world has linked higher prevalence of back pain with these professional populations; especially with bus, taxi and truck drivers (Alperovitch-Najenson et al., 2010; Andrusaitis et al., 2006; Chen et al., 2005; Costa et al., 2001; Krause et al., 2004; Okunribido et al., 2007; Pietri et al., 1992; Gyi and Porter, 1998; Szeto and Lam, 2007). A large cross-sectional survey of British drivers found that participants with increased exposure to driving were six times more likely to lose time from work due to back problems (Porter and Gyi, 2002). Exposure to vibration experienced during driving appears to have a dose–response relationship to low back pain (Bovenzi, 2010, 1996; Tiemessen et al., 2008; Wilder et al., 1996). However, it is not the only identified risk factor associated with low back pain. Rozali et al. (2009) in a cross-sectional study conducted on armoured vehicle drivers in the military has shown that, in addition to vibration exposure, sitting posture also plays a large role. This kyphotic lumbar spine posture adopted in vehicle

* Corresponding author. Tel.: +1 519 888 4567x37080; fax: +1 519 746 6776.
E-mail addresses: ddecarva@uwaterloo.ca (D.E. De Carvalho), callagha@healthy.uwaterloo.ca (J.P. Callaghan).

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