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Carry-over effects of backpack carriage on trunk posture and repositioning ability

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ABSTRACT

Immediate effects of backpack carriage on spinal curvature and motor control in adults have been reported. However, there is a scarcity of evidence whether the effects would persist or not after the carrying load is removed. This study aimed to investigate the carry-over effects of backpack carriage on trunk posture and repositioning ability. Thirteen healthy adults were recruited and instructed to walk on a treadmill for 30 min with backpack (10% body weight) followed by 30-min unloaded walking. Participant's trunk posture and repositioning ability were measured at different time points. During backpack carriage, reduction in lumbar lordosis and posterior pelvic tilt with significant increased cervical lordosis, thoracic kyphosis and trunk forward lean were observed. There was also a significant increase in repositioning errors in all spinal curvatures and trunk forward lean. After removal of the carrying load, there was a tendency for restoration of trunk posture and repositioning ability. However, the cervical lordosis and the repositioning error of all spinal curvatures could not be fully returned to the levels of the preload condition (all $p < 0.05$). The persistent changes in both spinal curvature and repositioning ability revealed an increased risk of spinal injury even after the backpack was removed, and the effects on the neck and back pain warrant future study.

Relevance to Industry: The effects of backpack carriage (10% body weight for 30 min) on the spine could not be fully restored after 30-min unloaded walking. The persistent changes in both spinal curvature and repositioning ability revealed an increased risk of spinal injury even after the backpack was removed. Proper postural reminder might be given to backpack users to alleviate the adverse effects induced after prolonged backpack carriage.

1. Introduction

Backpack carriage is common among adults, schoolchildren and adolescents for daily transferring of personal belongings, laptops, books and stationeries to and from offices or schools. As the load of backpack is directly applied to the spine via the shoulder straps and external loading has been demonstrated to be associated with spinal disorders (Korovessis et al., 2005; Leboeuf-Yde and Kyvik, 1998; Negrini and Carabalona, 2002; Sheir-Neiss et al., 2003; Troussier et al., 1994; Viry et al., 1999), there is a growing concern on the effects of load carriage on the spine.

It has been demonstrated that load carriage could adversely affect a number of physiological parameters, such as gait (Birrell and Haslam, 2009, 2010; LaFiandra et al., 2003; Smith et al., 2006), energy consumption (Foissac et al., 2009; Lloyd and Cooke, 2000; Stuempfle et al., 2004), trunk muscle activity (Motmans et al., 2006; Piscione and Gamet, 2006), stance stability (Heller et al., 2009; Zultowski and Aruin, 2008) and cardiopulmonary function (Legg and Cruz, 2004). Head and trunk postures (Attwells et al., 2006; Devroey et al., 2007; Fiolkowski et al., 2006) and spinal feedforward postural control (Li and Aruin, 2009) were also found to be significantly affected by backpack carriage. It was shown that carrying a backpack significantly increased head and trunk forward lean with extended neck and decreased spinal postural control ability. The results revealed that the trunk posture and motor control were immediately and significantly affected by the carrying load. The time effect of backpack carriage on the spine was examined by Orloff and Rapp (2004). The head and trunk postures as well as spinal curvature (thoracic to lumbar spine) were measured at 3 min (rested condition) and 21 min (mild fatigue condition) in 25 female adults when they walked with a 9 kg backpack at a constant speed (1.79 m/s). Although there was no significant change in both head and trunk postures, they found that the thoracic to lumbar region cubic curve significantly increased after 21 min of loaded walking. The change in spinal curvature demonstrated that backpack carriage would lead to increased spinal deformation, particularly at the upper thoracic

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