Alteration in spine curvature when pushing carts of different weight

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Summary

Pushing carts is associated with a considerable risk of back disorders. While the effect of cart pushing on trunk position has been intensively investigated, little is known about how the curvature of the spine changes when different loads are pushed. This study evaluates the effect of load magnitude on spinal curvature during the sustained phase of pushing a cart. Spinal curvature in the sagittal, frontal and transverse plane of 30 healthy subjects was determined by Video-Rastersterography. Subjects had to walk with two different constant gait velocities while pushing a cart of different loads (0N, 80N or 160N). Independent of gait velocity or gait phase, the thoracic spine flattens, and the curvature extremes of kyphosis and lordosis converge as the pushed load increases. These findings underscore the importance of considering alternated spine curvature when estimating the risk posed to the spine by pushing activities.

Introduction

Manual pushing of loads takes up a large part in many occupational scenarios and is associated with a considerable risk of musculoskeletal disorders. Many studies investigated trunk posture demonstrating higher trunk flexion with higher pushed load and higher pushing velocity. However, although there is some evidence that the resulting spinal strain depends on spinal curvature, little is known about how the curvature of the spine changes when different loads are pushed. The purpose of this study was therefore to evaluate the effect of load magnitude on spinal curvature during the sustained phase of pushing a cart with different gait velocities.

Methods

The study was conducted as an explorative, cross-sectional study assessing the spinal curvature of 30 healthy participants. Participants were walking on a treadmill with constant gait velocity (neither 3 km/h or 5 km/h) while pushing three different loads (no load, 80 N and 160 N).

Video-Rastersterography (DIERS Formetric 4Dmotion) was used to measure spinal curvature, trunk and pelvic position dynamically. Trunk inclination and pelvic tilt were calculated to characterize the upper body position in the sagittal plane, while spine curvature has been determined in the sagittal, frontal and transverse plane by 6 parameters.

Results and Discussion

No significant effect of the gait phase on the relationship between pushed load and value of any of the parameters was identified. Forward trunk inclination and posterior pelvic tilt increased significantly with increasing pushed weight ($p<0.01$). No effect of the pushed load on the spine curvature in the frontal or transverse plane could be demonstrated. However, the Kyphotic angle and Lordosis apex decreases significantly when higher weights are pushed while Kyphosis apex increases. No effect on the Lordotic angle has been observed.

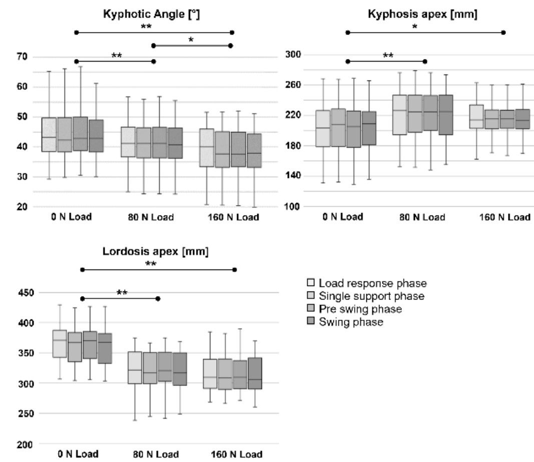

Figure 1: Spinal curvature in the sagittal plane while pushing a cart with 5 km/h. (** $p < 0,01$; * $p < 0.05$).

The decrease in thoracic kyphosis and the fact that no effect on lumbar lordosis was observed indicate that the thoracic spine straightens most, when loads are pushed. In addition, a larger kyphosis apex means that the extremum of the thoracic spine curvature shifts to the caudal region, while a reduced lordosis apex means that the extremum of the lumbar spine curvature shifts from caudal to cranial. Pushing activities therefore cause the extremes of the thoracic and lumbar spine curvature to get closer, which results in a higher spinal curvature in the region between the lumbar and thoracic spine.

Conclusions

This study provides valuable insights into the spinal curvature while pushing a cart. As the pushed load increases, the thoracic spine flattens, and the curvature extremes of kyphosis and lordosis converge. This effect is independent of gait velocity and gait phase. Since, up to now, the approximation of the strain on the spine during pushing tasks is based exclusively on biomechanical modelling, our findings underscore the importance of considering alternated spine curvature in the models in order to get realistic estimations about the strain and risk posed to the spine by pushing activities.

Acknowledgments

This work was supported by the Federal Ministry of Education and Research (BMBF); Grant number: 16SV844