Exploring lumbar spine posture and movement in sitting: laboratory and real-world measures

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Summary

Wearable sensors enable evaluation of spine alignment and movement outside the laboratory. This study evaluated spine alignment during sitting in the laboratory and real-world. Results reveal the variability of natural spine alignment and show that some features can be estimated from measures in the laboratory during a challenging unstable sitting task.

Introduction

Sitting is linked to health problems, including low back pain. Laboratory measurements of spine alignment provide insight into how one sits, but it remains unclear how these measures relate to spine alignment in the real-world. Development of wearable sensor technologies have enabled measurement of spine alignment and movement in the real-world to begin exploration of natural sitting behaviours. This study aimed to; (i) evaluate variation in natural sitting behaviour in the real-world, (ii) compare laboratory and real-world measures of spine alignment in sitting, and (iii) compare laboratory measures with real-world sedentary/active behaviour.

Methods

A cross-sectional study was conducted with measures in "laboratory" and "real-world" settings among 25 adults with no history of low back pain. Wearable motion sensors recorded posture and angular motion of the lumbar spine and hip. ActivePal sensors (PAL Technologies Ltd, Glasgow, UK) were attached to the lateral thigh to automate the classification of periods of sitting, and dorsaVi sensors (dorsaVi Ltd, Melbourne, Australia) were placed at the T12/L1 and L5/S1 spinal levels and lateral thigh to quantify lumbar spine and hip angles. In the laboratory session participants adopted sitting postures in response to the instruction to "sit normally" in an upright position, during a completion of a questionnaire while they were unaware that their posture was being measured, and while sitting on an unstable surface [1]. After the laboratory session, participants wore the sensors for 2 days while undertaking their normal activity in the real world.

We explored spine posture during periods of sitting in the real world using Gaussian mixture models of spine alignment to define participant-specific modes and overall probability distributions of real-world sitting posture. These data were used to explore the individual patterns of variation in spine alignment and for comparison with laboratory measures of sitting spine alignment. We also compared laboratory measures with periods of sedentary/activity behaviours in the real-world.

Results and Discussion

In the laboratory, the mean lumbar flexion angle was more flexed during questionnaire sitting (30.0°) than upright sitting (19.8°). The angle in unstable sitting was intermediate (27.1°).

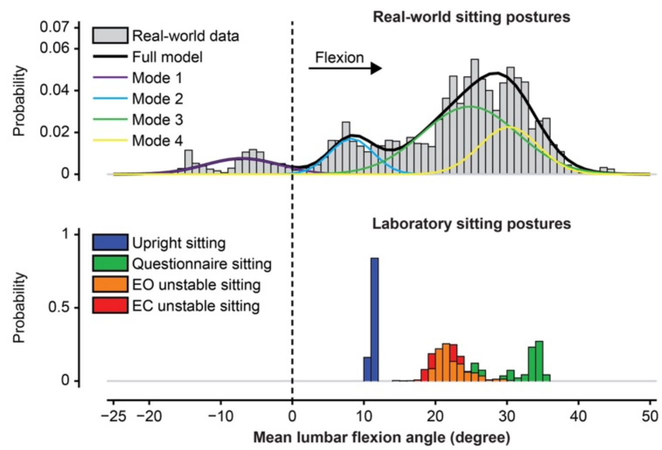

Figure 1: Example of the Gaussian Mixture Model (GMM) in one participant for estimating modes of sitting postures that are frequently adopted over 48h in the real-world.

Spine alignment in sitting in the real world could be explained by 4 Modes in the Gaussian Mixture Model, with substantial variation between participants. Spine alignment in unstable sitting was correlated with the overall mean posture (r=0.49-0.54) and first most frequent mode (r=0.47) in the real-world. Upright laboratory sitting posture was correlated with the second most frequent mode of real-world postures (r=0.54). Sitting less (r=0.45) and walking more (r=0.41) in the real-world were related to better overall balance performance and lumbar spine coordination in unstable sitting.

Conclusions

Findings reveal that spine alignment in the unstable sitting laboratory task had the strongest association with sitting in the real-world, but did not replicate the diversity of spine alignments adopted in real-world sitting. Wearable sensors provide a viable method to study postures and movements in the real-world.

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References

[1] Alshehri MA, et al. (2024) *PLoS One*. 19:e0296968.