Effect of footwear on lower extremity net joint moments and barbell kinematics in weightlifting: a case study

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Introduction

Performance in Olympic weightlifting is measured by an athlete's ability to lift maximally during both the snatch and the clean and jerk. Evidence suggests that weightlifting performance is strongly associated with optimal timings in peak lower extremity net joint moments (NJM) at specific phases of the lifts (*Kipp et al.* 2012). In addition, internal NJM at the ankle and knee greatly contribute to barbell velocity and acceleration (*Kipp et al.* 2022). However, due to the technical skill required to perform the snatch and the clean and jerk, research on weightlifting typically recruits experienced weightlifters who would wear weightlifting shoes (WLS). Weightlifting shoes provide favorable compensatory movements that aid in performance. For example, the heel lift feature of a WLS encourages an upright trunk and shank posture and allows for a greater squat depth. Yet it is common for athletes in the weightlifting community to choose footwear without the traditional heel lift feature for training and competition.

Purpose of the study

The purpose of this case study was to examine the effect of a traditional WLS, and another popular WLS without a heel lift, on lower extremity NJM and barbell velocity and acceleration during the snatch and clean exercise.

Methods

One male weightlifter with two years' experience in competing at national level weightlifting championships participated in this case study (age: 27 years; mass: 84 kg; height: 171 cm). Ethical approval was granted by the University Research Ethics Committee. Data was collected at 80% 1 rep max for the snatch and clean exercise. The footwear used within this study were: Adidas Adipower Weightlifting Shoes (WLS) and Nike Metcon 4 Premium training shoe (MC). A 17-camera motion capture system (VICON, Oxford, UK) collected marker coordinate data at 200Hz. Simultaneously, two AMTI-OR6 force platforms (Advanced Mechanical Technology, Inc., MA, USA) collected kinetic data at 1000Hz. Kinematic and kinetic data were filtered using a fourth-order, low-pass Butterworth filter with cut-off frequencies of 6Hz and 25Hz, respectively (Kipp *et al.* 2012). Three trials were collected, and data was normalized for time (0-100%) from when the barbell left contact with the ground to when the GRF fell below 10 N.

Results

While magnitude differences in knee (Figure A) and ankle (B) NJM were evident between the footwear conditions and lift techniques, bar velocity (C) and acceleration (D) waveform profiles were nearly identical across time for each lift technique, irrespective of the footwear condition.

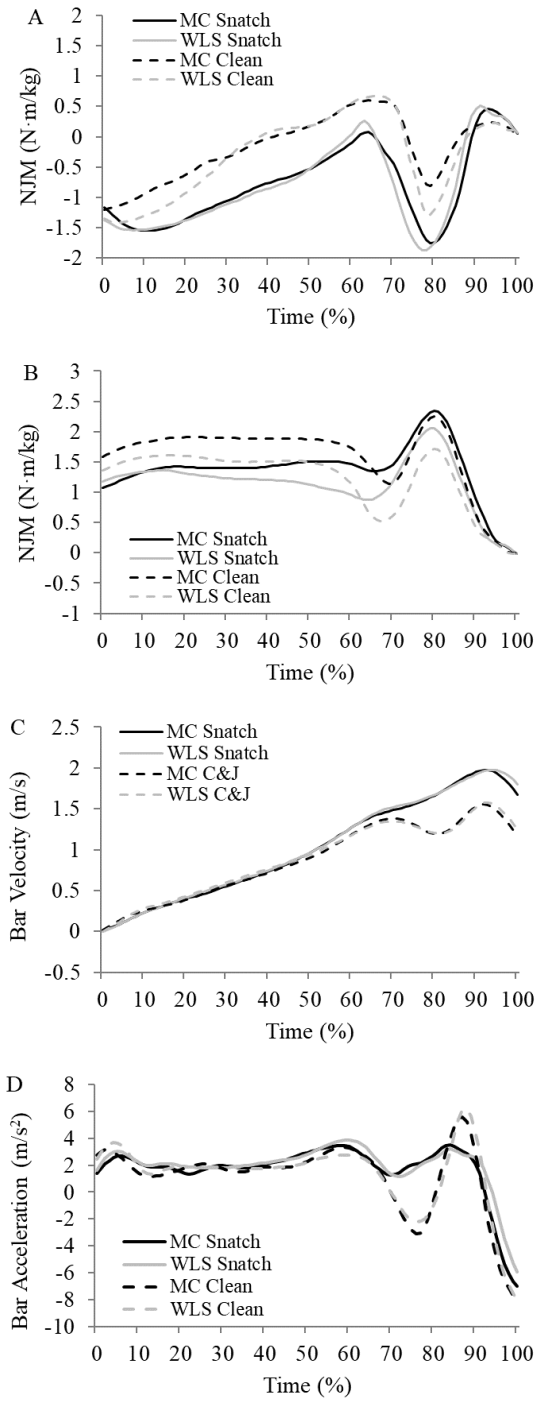

Figure 1. Mean knee (A) and ankle (B) net joint moments, and barbell velocity (C) and acceleration (D) waveforms during the snatch and clean exercise for the Metcon (MC) and Weightlifting Shoe (WLS) conditions.

Discussion and conclusion

For an experienced weightlifter, introducing a new footwear without a heel raise feature did not impact on weightlifting performance. Indeed, bar velocity and acceleration waveform profiles were nearly identical across time for each lifting technique. However, magnitude differences in NJM at the knee and ankle were occasionally evident across time between the footwear conditions and lifting techniques. Since data was collected at 80% 1 rep max for the snatch and clean exercise, the higher load associated with the clean exercise in comparison to the snatch may explain the differences in NJM magnitudes. Differences in NJM magnitude may also relate to the technical requirements of each lift, since greater extension of the thigh segment at the start of the clean can be explained by the higher position of the hips, which is caused by a narrow grip of the bar. Overall observations suggest the participant was able to complete successful lifts due to optimal timings in peak lower extremity NJM at the knee and ankle at specific phases of the lifts (*Kipp et al.* 2022).

References

Kipp, K., Redden, J., Sabick, M.B., & Harris, C. (2012). Weightlifting performance is related to kinematic and kinetics patterns of the hip and knee joints. *Journal of Strength and Conditioning Research*, 26(7), 1838-44.

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