Unresisted and resisted sprint kinetics and kinematics are essentially similar when compared at the same velocity

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Summary

This study examined differences in sprint kinematics and kinetics when unresisted and resisted at slow, medium, and fast relative velocities [60%, 40% and 20% decrease in maximal running velocity (V_{DEC}), respectively]. Fourteen males performed sprints with individual resistive loads applied using a motorized resistance. Kinematics and kinetics were assessed via infrared cameras and force platforms. Significant differences were observed only for: contact time at 40% and 60% V_{DEC}, vertical impulse across all V_{DEC} levels, ankle range of motion and hip angle at toe-off at 60% V_{DEC}. Overall, there were few clear differences between resistive conditions, with those observed seemingly mostly due to velocity changes induced by resistance, rather than the resistance itself.

Introduction

Many researchers have remarked on clear differences between unresisted and resisted sprinting [1]. The observation that these changes appear to scale with load has driven criticism of higher resistances due to fears of decreased longitudinal performance and increased injury risk. Nonetheless, a recent detailed investigation which controlled running velocity reported only minor biomechanical differences between resisted loads for ground reaction forces and spatiotemporal variables [2]. Velocity strongly influences mechanics, justifying comparisons at matched velocities [3]. This study compared kinetic and kinematic variables between unresisted and resisted sprinting under low, medium, and high %V_{DEC} conditions, across velocity-matched steps.

Methods

Fourteen physically active male subjects (age 27.7 ± 8.7 years and body mass of 75.5 ± 10.7 kg) provided written informed consent to participate in the study (IORG0007394; IRBN322016/CHUSTE). First, individual load-velocity relationships were compiled, from which resistive conditions were set: unresisted and resisted conditions at 20, 40, and 60% V_{DEC}, controlled via motorized resistance (1080 Sprint). Next, athletes performed maximal sprints under these resistive conditions, with kinetic and kinematic variables assessed using 12 infrared cameras (200 Hz), 6 force platforms (2000 Hz). Individual starting positions were set using distance-velocity relationships, to ensure data were collected at the same velocity across conditions. A one-way repeated-measures ANOVA was used to compare load-conditions: each resisted load versus unresisted.

Results and Discussion

Among the 7 kinetic and 12 kinematic variables considered and compared (Figure 1) with discrete variable, few statistically significant differences were found. Contact time was 8.8% and 16.8% longer under resisted conditions at 40 and 60% V_{DEC}, respectively, and vertical impulse was 8.3%, 9.1% and 14.1% greater at 20, 40, and 60% V_{DEC}, respectively ($p<0.013$).

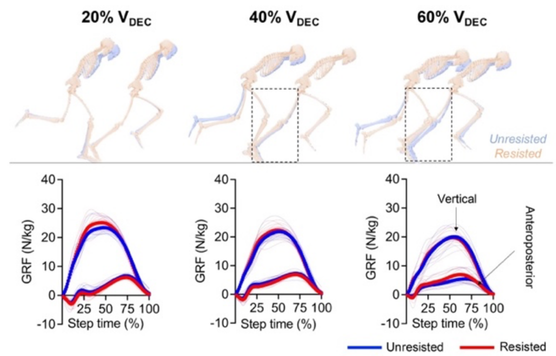

Figure 1: Kinematic (mean angles) and kinetic (mean and individual ground reaction force traces) comparison between unresisted and resisted under 20, 40 and 60% V_{DEC}.

Finally, the ankle range of motion was 5.8° greater at 60% V_{DEC}, and hip angle at toe-off were 3.3° and 8.3° greater at 40 and 60% V_{DEC}, respectively ($p<0.033$).

Conclusions

When compared for steps at the same running velocity, sprint kinetics and kinematics were mostly not different between unresisted and resisted conditions. The differences that were observed tended to be quite small, notably when compared to the magnitudes reported in the previous literature. Accordingly, the acute changes in mechanics induced by resisted sprinting load discussed in many previous studies appear mediated mostly by changes in running velocity, rather than directly due to load. This suggests a broad applicability of loading parameters for targeting velocity-specific sprint adaptations, while balancing retaining a common-sense approach to training load selection.

References

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