Plantar flexor isometric torque is related to performances of, and plantar flexor kinetics during, sprinting and jumping

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Summary

The relationship of isometric strength with athletic performance (e.g. sprinting and jumping) has long been debated. Thus, how isometric plantar flexion (PF) strength relates to PF kinetics during these tasks and overall task performance is unknown. The current study found that PF isometric strength was significantly correlated to PF kinetics during sprinting and jumping and overall performance in these tasks.

Introduction

Isometric strength tests are commonly used to measure plantar flexion (PF) strength, which is often considered a key performance indicator in athletic populations due to the role of PF in running and jumping. However, the importance of isometric PF strength to PF kinetics during sprinting and jumping as well as to the performance of those tasks is still largely unknown. Although some studies have investigated the relationship of isometric PF strength with sprinting or jumping, the strength measures were typically done at highly flexed knee joint angles with questionable functional relevance [1,2]. Therefore how joint specific isometric strength (i.e. peak torque) at extended knee joint angles relates to joint kinetics during sprinting and jumping as well as overall task performance would further elucidate the importance of maximal PF strength to sprinting and jumping. The current study assessed the relationship between isometric PF strength (measured with two dynamometers) with PF kinetics during jumping and sprinting as well as overall performance in these tasks.

Methods

Thirty-eight participants, (n = 38) took part in this ethically approved study. Participants completed maximal isometric PF tests in both a novel, seated and established, standing isometric dynamometers (IMD) during two identical (1 familiarisation and 1 measurement) sessions prior to completing countermovement jumps (CMJ), drop jumps (DJ), and 22-m sprints (SP). Force plates (Kistler Instrumental AG, Winterthur, Switzerland) assessed ground reaction forces and motion was captured via an eighteen-camera system (Vicon Motion Systems Ltd, UK) were used with modelling software (Visual3D, C-motion Inc, Maryland, USA) to calculate joint kinematics and kinetics for all isometric and dynamic tasks via inverse kinematics and inverse dynamics.

Results

The current study found that isometric PF strength assessed with a standing IMD had significant and positive correlations to all measures of PF kinetics during sprinting and jumping (r=0.391-0.594) as well as overall performance of these tasks (r=0.359-0.460;Table 1). Isometric strength assessed with a seated IMD was also significantly correlated to some measures of PF kinetics during CMJ and DJ, as well as sprint performance.

Table 1: *Pearson's correlations between isometric PF strength and PF kinetics and overall task performance..*

		Correlations with isometric peak moment (Nm)	
Task	Measure	Standing IMD	Seated IMD
CMJ	Jumpheight (m)	0.460 *	0.217
	Peak Moment (Nm)	0.550 **	0.475 *
	Peak positive power (W)	0.508 *	0.224
	Positive work (J)	0.474 **	0.277
DJ	RSI	0.386 *	0.149
	Peak Moment (Nm)	0.433 *	0.550 **
	Peak positive power (W)	0.456 *	0.400 *
	Positive work (J)	0.391 *	0.470 *
SP	Speed (m/s)	0.359 *	0.339 *
	Peak Moment (Nm)	0.594 **	0.291
	Peak positive power (W)	0.540 **	0.209
	Positive work (J)	0.471 *	0.198

*CMJ: countermovement jump, DJ: drop jump, SP: sprints, IMD: isometric dynamometer, RSI: Reactive strength index. *p<0.05, **p<0.001*

Discussion

The results of this study suggest that despite the extensive neuromechanical differences (e.g. joint angle, angular velocity, posture, balance and co-ordination) between restrained isometric strength measurements and athletic tasks such as sprinting and jumping isometric PF strength is not only related to overall sprinting and jumping performance but also PF kinetics during these tasks. It also highlights the importance of testing isometrically in positions (i.e. less knee flexion) that more reflect the position of the intended task (i.e. sprinting and jumping) to avoid any neuromuscular deficits and improve functional relevance of the test.

Conclusion

Plantar flexion strength measures seem to provide useful information about the capability for PF kinetics during sprinting and jumping as well as the performance of these tasks. Further studies may look to understand how specific PF kinetics (power, work etc.) contribute to task performance and how this may differ across tasks.

References

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