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Sex-Based Comparisons of Absolute and Normalized Isometric and Isokinetic Leg Extension Strength and Power

Morgan Wood[1], James Hood[2], Marissa Bello[3], JohnEric Smith[1], and Zachary Gillen[1]
[1]Mississippi State University, Mississippi State, MS; [2]Naval Air Station Meridian, Meridian, MS; [3]University of Alabama at Birmingham, Birmingham, AL

BACKGROUND

Sex-related differences in strength and power have been attributed to differences in muscle size, muscle type, and neural recruitment patterns. A larger quantity of fast oxidative or fast glycolytic muscle fibers can result in an increased power output. When isometric peak torque and MVIC peak torque become normalized to muscle size and MVIC peak torque, the differences in male and female strength and power become comparable.

PURPOSE

The purpose of this study was to compare absolute and normalized isometric and isokinetic leg extension strength and power between recreationally trained adult males and females.

METHODS

Twenty-eight college-aged males and females participated in this study (n=14 males, mean±95% confidence interval, age=23±2yrs; n=14 females, age=24±1yrs). Panoramic ultrasound images quantified quadriceps femoris muscle cross-sectional area (CSA). Participants then completed maximal voluntary isometric contractions (MVICs) of the leg extensors, followed by maximal voluntary isokinetic leg extension muscle actions at angular velocities of 60, 120, 180, 240, and 300°·sec^{-1}. Peak torque (PT) was taken during MVICs and each isokinetic muscle action, while mean power (MP) was taken during each isokinetic muscle action. Sex-related comparisons of absolute MVIC PT and MVIC PT normalized to CSA were performed. Additionally, sex- and velocity-related comparisons of absolute isokinetic PT and MP, isokinetic PT and MP normalized to CSA, and isokinetic PT and MP normalized to MVIC PT were performed.

CONCLUSION

Although the males were stronger than the females for absolute and normalized isokinetic strength and power, the nature of the power-velocity relationship changed with normalization for females. Specifically, when normalized, isokinetic MP increased to a higher angular velocity compared to absolute MP (180 vs. 120°·sec^{-1}) for the females. Thus, it appears that power output at higher angular velocities may be at least partially dependent on muscle size and muscle strength, particularly for females. Additionally, other factors outside of CSA and maximal strength may influence sex-specific differences in muscle strength and power.

Isometric and isokinetic peak torque and mean power were measured via isometric and isokinetic knee extensions (60, 120, 180, 240, 300°·sec^{-1}). Quadriceps femoris cross-sectional area (CSA) was assessed via ultrasonography.

Peak torque and mean power were presented in absolute terms and normalized to CSA and MVIC peak torque.

Males were had greater CSA, absolute torque and power, and normalized torque than females.

Males tended to have greater normalized power than females, but normalization changed the nature of the power-velocity relationship for females.

Power output at higher velocities may be partially dependent on muscle size, particularly for females.

PRACTICAL APPLICATION

Females may benefit from prioritizing strength and hypertrophy training when the goal is to increase power output across the velocity spectrum. Future studies should consider examining holistically the underlying physiological factors affecting muscle strength and power differences between males and females.

RESULTS

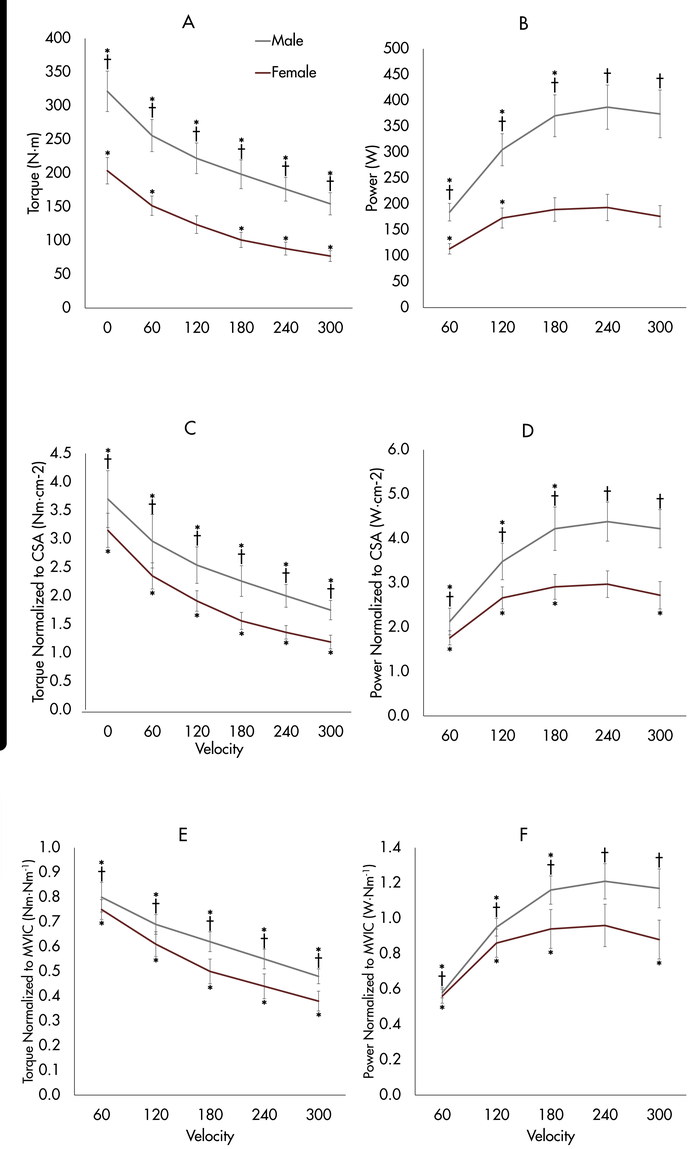

Figure 1. A) absolute peak torque, B) absolute mean power, C) peak torque normalized to CSA, D) mean power normalized to CSA, E) peak torque normalized to MVIC peak torque, F) mean power normalized to MVIC peak torque. *Significant difference in output across velocity. †Significant difference between sexes.