SEX DIFFERENCES IN MAXIMAL ISOMETRIC STRENGTH FOLLOWING HIGH OR LOW LOAD EXERCISE TO FAILURE

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Background & Purpose

- Recently, there has been an ongoing re-evaluation of traditional loading recommendations[1] for resistance exercise. A common point of view is that both high- and low-loads result in comparable chronic increases in hypertrophy and strength, provided that each set is taken to a similar proximity to failure [2], although conflicting data exists in the literature.[3]
- Sex-differences in muscular properties been well established by previous researchers, as women seem to be more resistant to fatigue during submaximal tasks, particularly isometric. This is most likely due to physiological differences, including differences in fiber type distribution and vasodilation during exercise[4], allowing women to generate less contraction-related fatigue when compared to men.
- This general pattern is less clear when contractions are dynamic, e.g. number of repetitions completed when the same relative load is taken to failure. In data collected in a recent narrative review[5], the female and male reps to failure tends to equalize as relative load increases from 40% to 85% 1RM. The differential responses between sexes as a function of relative load implores further investigation.
- Therefore, **the purpose of this study was to determine the interaction of sex differences and relative load on acute reductions of maximal voluntary strength.**

References

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Results

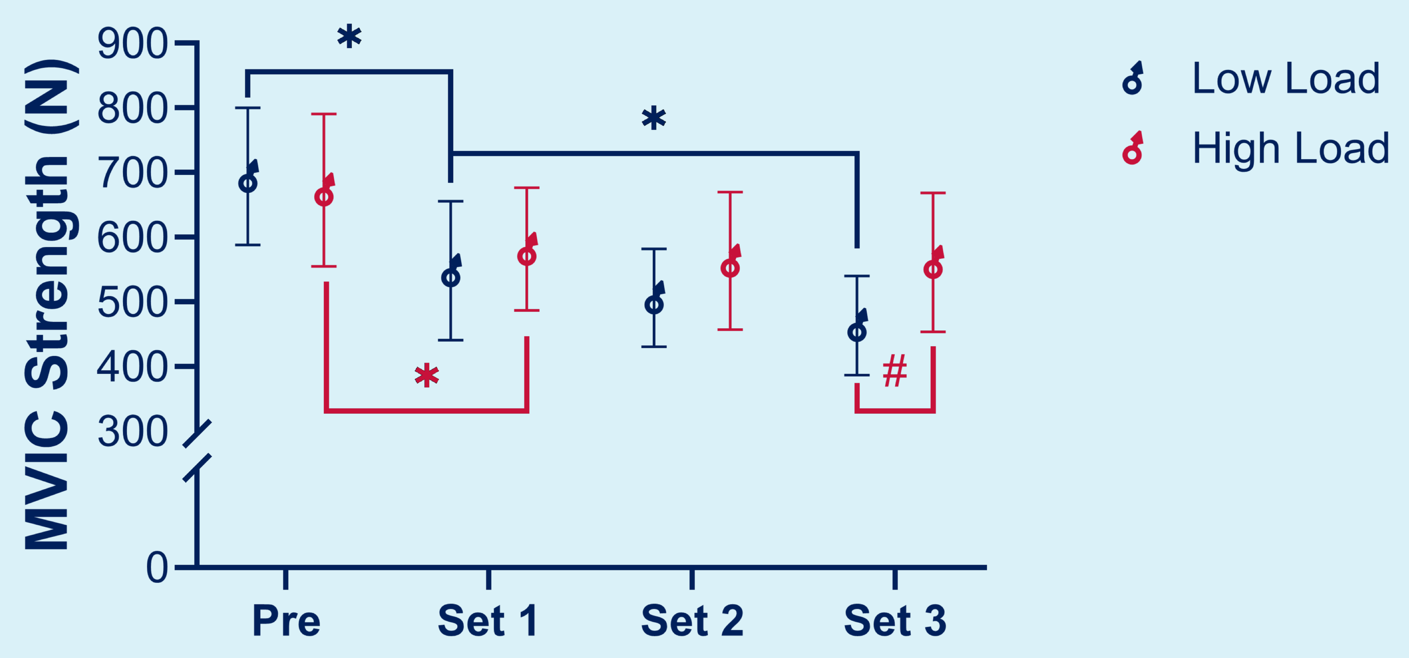

Figure 1. Mean (±95% CIs) for MVIC strength in males during high- and low-load at each timepoint.
*Indicates significant decrease in MVIC strength across timepoints
#Indicates significantly lower MVIC strength during low-load when compared to high-load

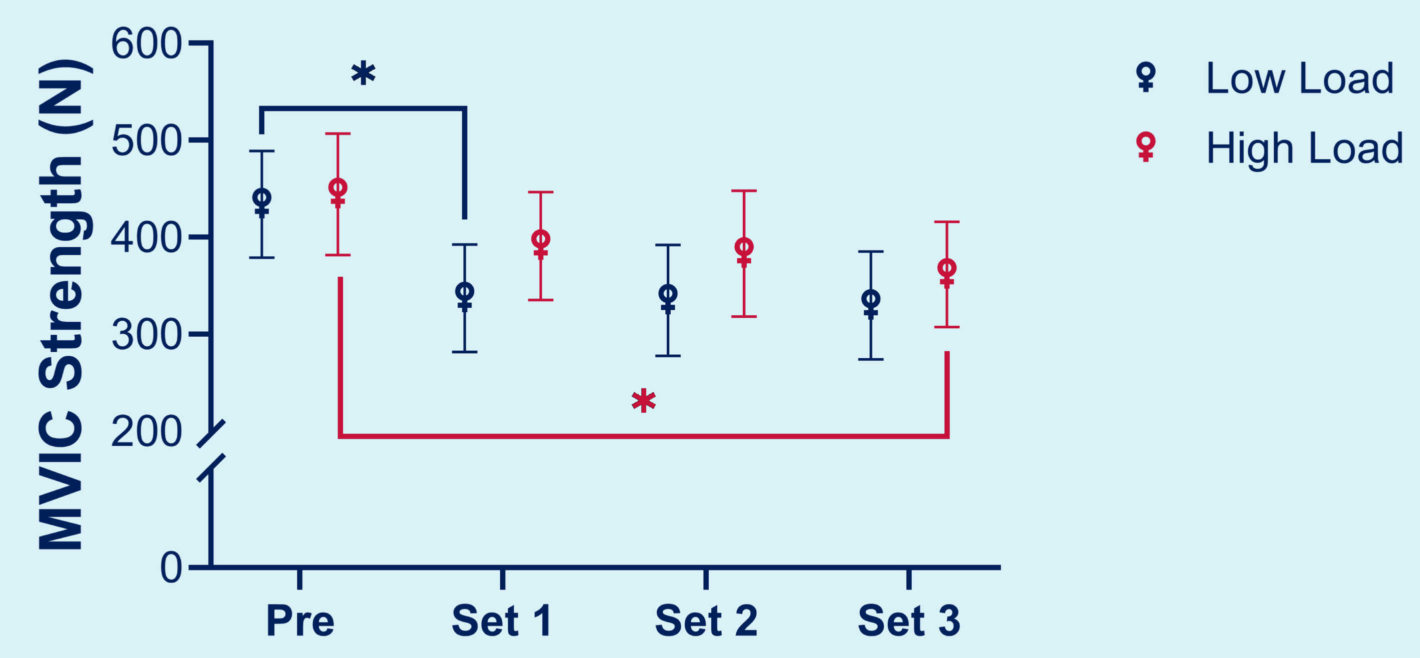

Figure 2. Mean (±95% CIs) for MVIC strength in females during high- and low-load at each timepoint.
*Indicates significant decrease in MVIC strength across timepoints

There was a significant sex × condition × time interaction for MVIC strength (p=0.029). Post-hoc analysis revealed that during LL in males, MVIC strength significantly declined from Pre (694.2 ± 158.2 N) to Post Set 1 (548.4 ± 160.2 N; p< 0.001), before further declining at Post Set 3 (463.7 ± 114.3; p = 0.001). In HL, males MVIC strength significantly declined from Pre (673.1 ± 175.7 N) to Post Set 1 (581.7 ± 141.7 N; p = 0.007) but did not decline any further during the exercise bout (p = 0.410-0.999). Consequently, MVIC strength was significantly greater at Post Set 3 during HL (561.2 ± 159.7) when compared to LL (p< 0.001). In females during LL, MVIC strength significantly declined from Pre (434.1 ± 91.0 N) to Post Set 1 (337.2 ± 91.7 N; p = 0.020) but did not decline any further throughout the exercise bout (p = 0.999). Conversely, during HL, females MVIC strength did not significantly decline from Pre (444.3 ± 103.4 N) until Post Set 3 (361.6 ± 90.0 N; p = 0.002). There were no differences in MVIC strength between HL and LL at the same time points in females (p = 0.078-0.670). Finally, males exhibited greater MVIC strength than females in both conditions and at all time points (p< 0.001-0.003).

Methods

Twenty-five resistance-trained, college-aged volunteers (11M/14F; age (mean ± SD): 22 ± 4 yrs.) with no recent history of lower extremity injury volunteered to participate in this randomized, cross-over study, completing 80% (HL) or 30% (LL) of their 1 repetition maximum unilateral leg extension to volitional failure. Each visit was separated by 24 hours (±1 hr.) and the leg utilized and load utilized was randomized and counterbalanced across visits. All visits begun with the establishment of a unilateral 1RM on a plate-loaded leg extension. Following a brief period of rest and several submaximal warm-ups, maximum voluntary isometric contraction (MVIC) strength was measured via a load cell attached to the base of the leg extension machine. After 5-min. rest period, subjects completed 3 sets of unilateral leg extension to volitional failure with their assigned load. Immediately after every failure set, MVIC strength was assessed followed by 2 minutes of rest. A time (Pre/Post Set 1/Post Set 2/Post Set 3) × condition (30%/80%) × sex (M/F) repeated measures ANOVA with Bonferroni post-hoc comparisons was run using SPSS. Alpha was set a-priori at 0.05.

Conclusions

The present data indicate that the LL protocol elicited greater fatigue across both sexes when compared to HL. Importantly, there were sex-related differences in time-course of changes in MVIC strength across loading conditions. Overall, our data underscore the existence of sex-related differences in fatigability of the lower body.

Practical Applications

The present data suggest that biological sex should be considered when writing load prescriptions for resistance training, particularly in the lower body musculature. Based on our data, women exhibit greater fatigue resistance, particularly during the later sets of low-load exercise. Finally, our data indicate that females may need additional sets of high-load exercise to achieve similar levels of fatigue to males.