

Increases in Forearm Flexion Peak Torque Following 4 Days of Isokinetic Resistance Training in Women

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ABSTRACT

PURPOSE: The purpose of this study was to examine the effects of 2, 3, and 4 days of maximal, concentric, reciprocal isokinetic forearm flexion (FF) and extension (FE) at 180°·s⁻¹ on FF and FE peak torque (PT) during maximal voluntary isometric contractions (MVIC) and isokinetic muscle actions at 60, 180, and 300°·s⁻¹ in untrained women. **METHODS:** Seven women (mean ± SD: age: 21.6 ± 1.0 yrs; height: 169.3 ± 4.6 cm; body mass: 64.2 ± 6.9 kg) completed 4 days of maximal, concentric, reciprocal isokinetic FF and FE training at 180°·s⁻¹ for 6 sets of 10 repetitions with the non-dominant arm (based on throwing preference). In addition, the subjects completed 4 testing visits (Pre-testing, following 2 days of training [Day 2], following 3 days of training [Day 3], and following 4 days of training [Day 4]) with the non-dominant arm that included 2 FF and 2 FE MVICs at an elbow joint angle of 90°, followed by 3, maximal, concentric, reciprocal isokinetic FF and FE muscle actions at each velocity (60, 180, and 300°·s⁻¹). The highest PT values for the MVICs and isokinetic muscle actions at each velocity were used for analyses. Two separate 4 (Velocity: MVIC, 60, 180, and 300°·s⁻¹) x 4 (Time: Pre-test, Day 2, Day 3, and Day 4) repeated measures ANOVAs were used to examine the training-induced changes in the FF and FE PT values and follow-up pairwise comparisons were used when necessary. Effect sizes were reported as partial eta-squared (η_p^2) and Cohen's *d* for the ANOVAs and pairwise comparisons, respectively. An alpha value of $p \leq 0.05$ was considered statistically significant. **RESULTS:** The results of the repeated measures ANOVA for FF PT indicated that there was no significant 2-way ($p = 0.124$, $\eta_p^2 = 0.216$) interaction, but a significant main effect for Time ($p < 0.001$, $\eta_p^2 = 0.589$) and Velocity ($p < 0.001$, $\eta_p^2 = 0.923$). Follow-up pairwise comparisons for FF PT (collapsed across Velocity), indicated that Day 4 PT (32.0 ± 5.9 Nm) was significantly greater ($p = 0.001$; $d = 0.476$; Bonferroni corrected alpha = 0.0083) than Pre-test PT (29.2 ± 5.9 Nm) and Day 2 PT (28.8 ± 6.1 Nm; $p = 0.003$; $d = 0.533$). For FE PT, results indicated no significant 2-way ($p = 0.314$, $\eta_p^2 = 0.167$) interaction or main effect for Time ($p = 0.477$, $\eta_p^2 = 0.126$), but a significant main effect for Velocity ($p < 0.001$, $\eta_p^2 = 0.924$). **CONCLUSIONS:** These findings indicated that 4 days of maximal, concentric, reciprocal isokinetic FF and FE training at 180°·s⁻¹ was the minimum threshold required to increase FF PT at various velocities in untrained women, but was not sufficient to elicit increases in FE PT. Thus, future studies should continue to examine the minimum days of maximal, concentric, reciprocal isokinetic training at 180°·s⁻¹ required to increase FE PT. **PRACTICAL APPLICATIONS:** Utilizing short-term resistance training programs may be beneficial in clinical and/or athletic settings to increase strength in the upper body for those with limited time or resources. In addition, examining the effects of short-term resistance training may be useful for identifying sex-dependent and/or muscle action-dependent differences in the time course of changes in strength. **ACKNOWLEDGEMENTS:** None.

BACKGROUND

Short-term resistance training (STRT) has been suggested to be applicable to clinical, athletic, and non-athletic populations. It has been suggested that STRT can provide a basis for health professionals to design training or rehabilitation programs for those that have limited medical coverage or are looking for an alternative to surgery, can be used to develop programs for athletes that need to return to play quickly, and can provide recommendations on the minimum number of training sessions needed to observe early phase increases in strength (Coburn et al., 2006; Traylor et al., 2012; Traylor et al., 2013; Traylor et al., 2014).

Previous studies have examined the effects of STRT during isokinetic and dynamic constant external resistance muscle actions on strength (Coburn et al., 2006; Traylor et al., 2012; Traylor et al., 2013; Traylor et al., 2014; Beck et al., 2007; Byrd et al., 2018; Byrd & Bergstrom, 2018; Costa et al., 2016; Costa et al., 2022 Brown & Whitehurst, 2003; Cramer et al., 2007). The minimum number of days required to increase upper body strength in untrained women, however, is unknown. Thus, the purpose of this study was to examine the effects of 2, 3, and 4 days of maximal, concentric, reciprocal isokinetic FE and FF training at 180°·s⁻¹ PT during MVICs and isokinetic muscle actions at 60, 180, and 300°·s⁻¹ in untrained women.

METHODS

Subjects: Seven women (mean ± SD: age: 21.6 ± 1.0 yrs; height: 169.3 ± 4.6 cm; body mass: 64.2 ± 6.9 kg) volunteered to participate in this study. All subjects reported participating in resistance training less than 2 days per week for the previous 3 months. Subjects were free of upper body pathologies that would affect performance. All testing and training was performed with the non-dominant arm (based on throwing preference) on a Biodex System 4 Pro according to guidelines (Figure 1). **Time Course of Procedures:** Subjects visited the laboratory on 7 separate occasions with 48 hours between each visit. The time course of the testing and training visits are as follows: Pre-testing, Training Visit #1, Training Visit #2, Testing (Day 2) and Training Visit #3, Testing (Day 3) and Training Visit #4, and Post-Testing (Day 4). **Testing Procedures:** Subjects performed a standardized warm up that included 5 submaximal (50-75% max effort) isometric FE and FF muscle actions followed by 5 submaximal (50-75% max effort), concentric, reciprocal isokinetic FE and FF muscle actions at 60, 180, and 300°·s⁻¹. Subjects then performed 2, 3 sec MVICs at an elbow joint angle of 90° for FE and FF followed by 3 maximal, concentric, reciprocal isokinetic FE and FF muscle actions at 60, 180, and 300°·s⁻¹ (in random order). **Training Procedures:** Subjects performed a standardized warm up that included 5 submaximal (50-75% max effort) isometric FE and FF muscle actions followed by 5 submaximal (50-75% max effort), concentric, reciprocal isokinetic FE and FF muscle actions at 60, 180, and 300°·s⁻¹. The subjects then performed 6 sets of 10 maximal, reciprocal, concentric, isokinetic forearm extension and forearm flexion repetitions at 180°·s⁻¹, with 2 minutes of rest between sets. **Analysis:** Changes in PT were assessed using separate 4 (Velocity: MVIC, 60, 180, and 300°·s⁻¹) x 4 (Time: Pre-test, Day2, Day3, and Day4) repeated measures ANOVAs for FE and FF. Effect sizes were reported as partial eta-squared and follow-up pairwise comparisons were used when necessary. An alpha value of $p \leq 0.05$ was considered statistically significant.

RESULTS

The results of the repeated measures ANOVA for FF PT indicated that there was no significant 2-way ($p = 0.124$, $\eta_p^2 = 0.216$) interaction, but a significant main effect for Time ($p < 0.001$, $\eta_p^2 = 0.589$) and Velocity ($p < 0.001$, $\eta_p^2 = 0.923$). Follow-up pairwise comparisons for FF PT (collapsed across Velocity), indicated that Day 4 PT (32.0 ± 5.9 Nm) was significantly greater ($p = 0.001$; $d = 0.476$; Bonferroni corrected alpha = 0.0083) than Pre-test PT (29.2 ± 5.9 Nm) and Day 2 PT (28.8 ± 6.1 Nm; $p = 0.003$; $d = 0.533$).

For FE PT, results of the repeated measures ANOVA indicated no significant 2-way ($p = 0.314$, $\eta_p^2 = 0.167$) interaction or main effect for Time ($p = 0.477$, $\eta_p^2 = 0.126$), but a significant main effect for Velocity ($p < 0.001$, $\eta_p^2 = 0.924$).

CONCLUSION

Four days of maximal, concentric, reciprocal isokinetic FF and FE training at 180°·s⁻¹ was the minimum threshold required to observe early phase increases in FF PT during MVICs and at various isokinetic velocities in untrained women, but was not sufficient to elicit increases in FE PT. This would suggest that increases in PT following isokinetic training at 180°·s⁻¹ may be movement-specific. Thus, future studies should continue to examine the minimum days of maximal, concentric, reciprocal FE and FF isokinetic training at 180°·s⁻¹ required to increase FE PT in women.

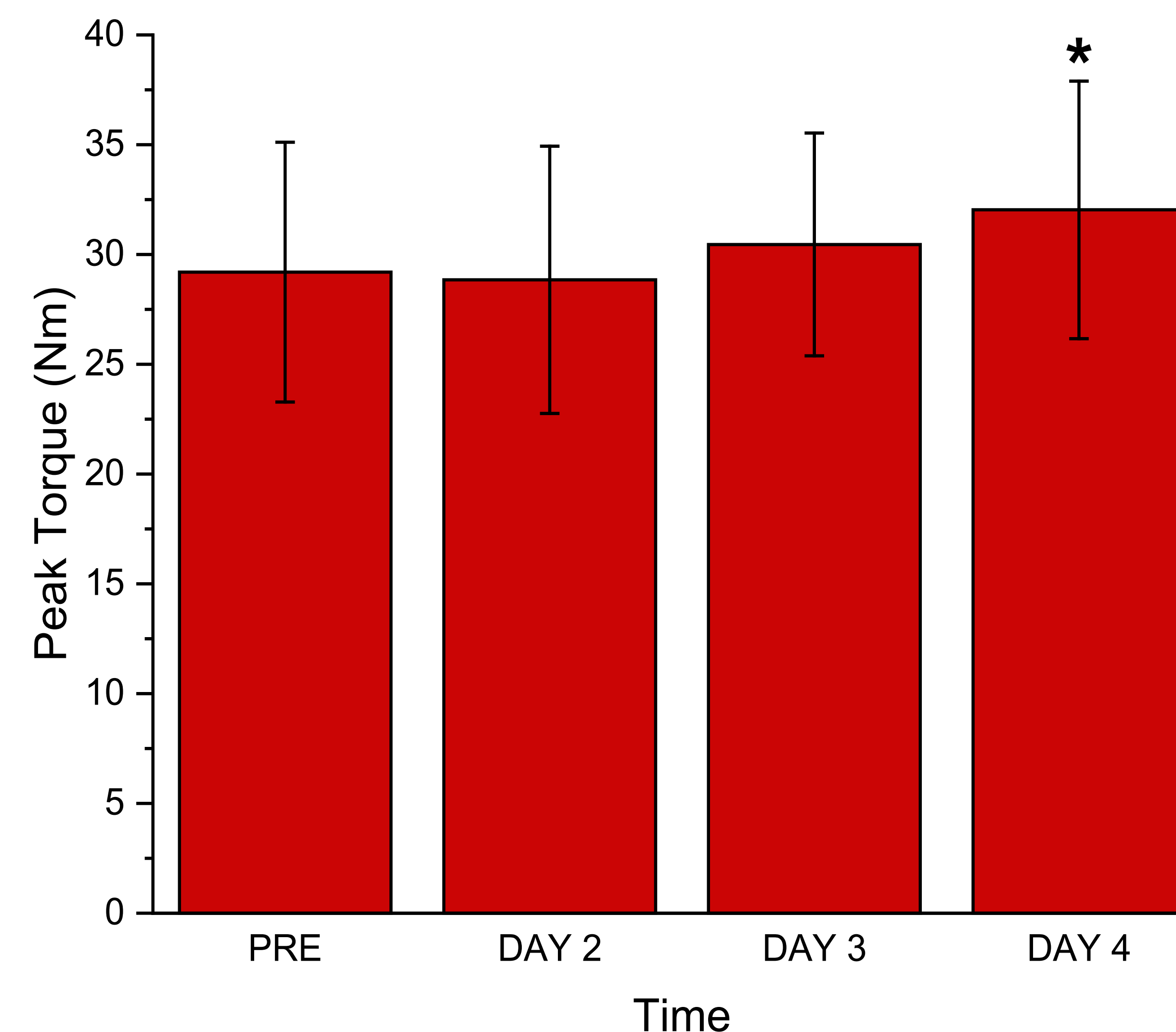


Figure 2. Forearm flexion peak torque (collapsed across Velocity) for Pre-test, Day 2, Day 3, and Day 4.

* Significantly greater ($p < 0.05$) than Pre-test and Day 2.

PRACTICAL APPLICATIONS

Four days of maximal, concentric, reciprocal isokinetic FF and FE training at 180°·s⁻¹ was the minimum threshold required to observe early phase increases in FF PT during MVICs and at various isokinetic velocities in untrained women, but was not sufficient to elicit increases in FE PT. This would suggest that increases in PT following isokinetic training at 180°·s⁻¹ may be movement-specific. Thus, future studies should continue to examine the minimum days of maximal, concentric, reciprocal FE and FF isokinetic training at 180°·s⁻¹ required to increase FE PT in women.



Figure 1. Example of testing and training position.

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