The Effects of Short-Term Isokinetic Resistance Training on Isometric and Concentric Torque of the Forearm Flexors in Females

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ABSTRACT

Traylor DA, Housh TJ, Camic CL, Zuniga JM, Bergstrom HC, Johnson GO, Schmidt RJ, Lewis RW. The Effects of Short-Term Isokinetic Resistance Training on Isometric and Concentric Torque of the Forearm Flexors in Females. JEPonline 2012;12(6):110-116. Although the effects of short-term isokinetic resistance training have been shown to increase peak torque (PT) across the velocity spectrum only in the leg extensors, the minimum number of training sessions needed to increase forearm flexion PT is unknown. This study examined the effects of three concentric isokinetic training sessions on PT for the forearm flexors at 4 velocities (maximal voluntary isometric contraction (MVIC), 60, 180, and 300°·s⁻¹). Ten adult females (mean ± SD age = 21.2 ± 0.8 yrs; body weight = 65 ± 9.4 kg; height = 170.0 ± 6.2 cm) completed two pretests and a posttest that included maximal muscle unilateral isometric and concentric isokinetic forearm flexion of the non-dominant arm at the 4 velocities. During the 4th through 6th visits the subjects performed 5 sets of 10 maximal isokinetic concentric forearm flexion (non-dominant arm) repetitions at 60°·s⁻¹. The results of a 3 x 4 [time (pretest 1, pretest 2, and posttest) x velocity (MVIC, 60, 180, 300°·s⁻¹)] repeated measures ANOVA indicated there was no significant time x velocity interaction (P>0.05) or main effect for time. There were, however, significant decreases in PT at each velocity. The present findings indicated that three sessions of concentric isokinetic training for the forearm flexors were not sufficient to elicit increases in PT across a velocity spectrum (MVIC to 300°·s⁻¹) in females.

Key Words: Peak Torque, Maximal Voluntary Isometric Contraction
INTRODUCTION

Short-term resistance training (2-3 training sessions) has implications for allied health professionals, such as physical therapists, athletic trainers, and occupational therapists who are responsible for developing rehabilitative programs to help patients return to work, practice, and/or competition. In addition, short-term resistance training may provide a cost-effective alternative to surgery or long-term therapy programs (5) and may benefit patients who have limited access to therapy due to their medical coverage. In females, the applications of short-term resistance training in the clinical (rehabilitation) and/or applied (improving strength and performance) settings have been limited to the leg extensors (5). Thus, it is not known how short-term training affects other muscle groups, such as the forearm flexors, or what parameters define effective protocols (such as the number of training sessions, sets, repetitions, and velocities of muscle actions) for various muscles.

Previous studies have shown that muscular strength and performance can be improved in as few as 2 or 3 resistance training sessions (3,5,6,13). However, the authors of these studies have used male-only or combined male and female samples. Only Coburn and colleagues (5) examined the effects of short-term resistance training using a female-only sample. They reported 12 to 40% increases in isokinetic peak torque (PT) of the leg extensors after three training sessions at a slow (30°·s⁻¹) or fast (270°·s⁻¹) velocity.

Previous isokinetic resistance training studies using female subjects that involved 12 to 60 training sessions (7-9) have reported increases in isokinetic PT that were similar to those of the short-term resistance training study by Coburn et al. (5). For example, Garnica (7) found 10 to 18% increases in arm extension PT after 4 weeks of training (12 training sessions) at both 60° or 180°·s⁻¹. Higbie et al. (8) reported an 18% increase in leg extension PT after 10 weeks of training (30 training sessions) at 60°·s⁻¹. Miller et al. (9) examined the effects of reciprocal flexion and extension training at 60°·s⁻¹ and reported a 17% increase in combined forearm flexion and extension PT after 20 weeks of training (60 training sessions). Only Beck et al. (2) have examined the effects of short-term resistance training (2 training sessions) of the forearm flexors in male subjects and reported no training-induced changes in PT for velocities ranging from maximal voluntary isometric contraction (MVIC) to 300°·s⁻¹.

Therefore, the minimum number of training sessions needed to increase forearm flexion PT across the velocity spectrum in males and females is unknown. The purpose of the present study was to examine the effects of 3 concentric isokinetic training sessions of the forearm flexors on PT in females at 4 velocities (MVIC, 60, 180, and 300°·s⁻¹).

METHODS

Subjects
Ten adult females (mean ± SD age = 21.2 ± 0.8 yrs; body weight = 65 ± 9.4 kg; height = 170.0 ± 6.2 cm) volunteered for this study. The subjects had not participated in a resistance training program for the previous 3 months. The study was approved by the University Institutional Review Board for Human Subjects, and all participants completed a health history questionnaire and signed a written informed consent document prior to testing.

Procedures
The subjects visited the laboratory on 7 occasions, with 48 to 72 hrs between visits (Figure 1). During the 1st visit, the subjects signed written informed consent and were oriented to the testing procedures. During the 2nd (pretest 1) and 3rd (pretest 2) visits, the subjects completed pretesting which included maximal unilateral isometric and concentric isokinetic forearm flexion (non-dominant
arm) muscle actions at MVIC, 60, 180, and 300°·s⁻¹. These pretests served as the within subjects control phase of the study. During the 4th through the 6th visits, the subjects performed 5 sets of 10 maximal isokinetic concentric forearm flexion (non-dominant arm) repetitions at 60°·s⁻¹. The final visit (visit 7) involved the same testing procedure as pretests 1 and 2 and served as the posttest.

**Isokinetic and Isometric Peak Torque Determinations**
Isokinetic and isometric testing occurred during laboratory visits 2 (pretest 1), 3 (pretest 2), and 7 (posttest). It involved the determination of unilateral isometric and concentric isokinetic PT of the non-dominant (based on throwing preference) forearm flexors on a calibrated Cybex 6000 dynamometer (CYBEX Division of LUMEX, Inc., Ronkonkoma, NY). For all muscle actions, the subjects were in a supine position and used a neutral handgrip in accordance with the Cybex 6000 instruction manual (Cybex 6000 owner’s manual). Prior to the strength testing, the subjects performed a warm up of five submaximal isometric muscle actions of the forearm flexors. The subjects were instructed to provide an effort corresponding to approximately 50% of their maximum effort during the warm up.

Each isometric muscle action was 6 sec in duration and was performed at a joint angle of 115° between the arm and forearm. After the warm up trials and 2 min of rest, the subjects performed two maximal isometric forearm flexion muscle actions. Each 6-sec isometric muscle action was separated by 2 min of rest, and the highest PT was selected as the MVIC value. After the isometric strength testing and 2 min of rest, the subjects were tested for maximum concentric isokinetic PT of the forearm flexors at randomly ordered velocities of 60, 180, and 300°·s⁻¹. The testing at each velocity began with the forearm fully extended and consisted of three muscle actions. The highest of the three maximal muscle actions was selected as the isokinetic PT value at each velocity. The reliability for the PT measures were determined from pretest 1 versus pretest 2 and resulted in strong intraclass correlations (R = 0.99) at each velocity (14). Furthermore, there were no significant (P > 0.05) differences between pretest 1 and pretest 2 for any of the velocities. The standard error of measurement (SEM) values ranged from 0.42 to 0.64 Nm.

**Isokinetic Training**
In addition to the strength testing, the subjects performed three separate concentric isokinetic training sessions. Forty-eight to 72 hrs of rest were allowed between all testing and training sessions. Each training session began with a warm up of 10 submaximal muscle actions of the forearm flexors at approximately 50% of maximum effort followed by a 2-min rest period. The subjects then performed 5 sets of 10 maximal concentric isokinetic muscle actions of the non-dominant forearm flexors at a velocity of 60°·s⁻¹. The subjects were verbally encouraged to provide a maximal effort during each
muscle action. A passive return to full extension followed each maximal forearm flexion muscle action with a 2-min rest between sets.

Statistical Analyses
A 3 x 4 [time (pretest 1, pretest 2, and posttest) x velocity (MVIC, 60, 180, and 300°·s⁻¹)] repeated measures ANOVA was used to analyze the torque data. Paired t-tests were used for the follow up analyses. An alpha level of P=0.05 was considered statistically significant for all comparisons. Based on results of the isokinetic PT and performance measures from previous short-term resistance training studies (1,3), a priori power analyses indicated that a sample size of n = 10, yielded power values of greater than 0.90.

RESULTS
Table 1 shows the mean (± SD) values for pretest 1, pretest 2, and posttest for PT values at MVIC, 60, 180, and 300°·s⁻¹ as well as the marginal means for time (collapsed across velocity) and velocity (collapsed across time). The results of the 3 x 4 ANOVA indicated that there was no significant time x velocity interaction or main effect for time. There was, however, a main effect for velocity. The follow-up t-tests for the marginal means for velocity (collapsed across time) indicated that there were significant decreases in PT at each velocity.

DISCUSSION
The results of this study indicated that in females three concentric, isokinetic training sessions had no effect on PT of the forearm flexors at MVIC, 60, 180, or 300°·s⁻¹. A number of previous concentric isokinetic training studies of 4 to 20 weeks in duration, however, have reported increases in PT in females for leg (8), forearm (9,10,12), and arm flexion (7) and extension movements. For example, Higbie et al. (8) reported an 18% increase in leg extension PT at 60°·s⁻¹ after 10 weeks of training (3 sets of 10 maximal leg extensions at 60°·s⁻¹, performed 3 days per week). Nickols-Richardson et al. (12) and Miller et al. (10) reported 13 to 29% increases in forearm and leg flexion and extension PT at 60°·s⁻¹ following 20 weeks of training (1 to 5 sets of 6 maximal, reciprocal leg flexion and extension repetitions at 60°·s⁻¹, performed 3 days per week). Miller et al. (9) found a 17% increase in combined forearm flexion and extension PT at 60°·s⁻¹ after 20 weeks of training (1 to 5 sets of 6 maximal, reciprocal flexion and extension repetitions at 60°·s⁻¹, performed 3 days per week). Garnica (7) reported 10 to 18% increases in arm extension PT at 60 and 180°·s⁻¹ after 4 weeks of training (4 sets of 5 maximal reciprocal arm flexion and extension repetitions, performed 3 days per week) for slow-velocity (60°·s⁻¹) and fast velocity (180°·s⁻¹) training groups. Only Coburn et al. (5), however, have previously examined the effects of short-term concentric, isokinetic training on PT in females. The subjects of Coburn et al. (5) performed three leg extension training sessions (4 sets of 10 maximal...
repetitions) at 30 or 270°·s⁻¹. The results indicated 12 to 40% increases in leg extension PT for slow (30°·s⁻¹) and fast (270°·s⁻¹) velocity training groups. The magnitude of the increases in leg extension PT reported by Coburn et al. (5) after only three training sessions (12-40%) were similar to the 19 to 29% increases reported in previous isokinetic, leg extension training studies that involved 60 training sessions (10,12). These studies (5,10,12) suggest that a substantial proportion of the training-induced increase in leg extension PT occurs within the first week of an isokinetic training program. The early phases of training-induced increases in strength are typically attributed to neural adaptations (4,11) including increased agonist activation (1) and/or decreased antagonistic coactivation. Thus, the results of the present study suggested that three isokinetic training sessions for the forearm flexors were not sufficient to induce significant neural adaptations that would lead to increases in PT.

The results of the present study, in conjunction with those of Coburn et al. (5), suggest that, in females, the effects of short-term training were specific to the muscle groups involved. That is, three training sessions involving 120 maximal muscle actions increased leg extension PT by 12 to 40% (5), while, in the present study, three sessions involving 150 maximal muscle actions had no effect on forearm flexion PT. For the forearm flexors, only Beck et al. (2) have previously examined the effects of short-term training on concentric, isokinetic PT. The male subjects of Beck et al. (2) trained for two sessions of 6 sets of 10 maximal, concentric, isokinetic forearm flexion and extension muscle actions at 180°·s⁻¹. The results indicate that there were no training-induced increases in forearm flexion or extension PT. Thus, the current findings and those of Beck et al. (2) indicated that two or three training sessions involving 120 to 150 maximal muscle actions had no effect on forearm flexion PT across a velocity spectrum in either gender.

CONCLUSIONS
The results from this study suggested that, for females, there were no increases in isokinetic forearm flexion PT after three isokinetic training sessions. These findings were not consistent with a previous study (5) that found increases in leg extension PT after 3 days of training. Beck et al. (2), however, reported that for males there were no training-induced increases in PT for the forearm flexors and extensors after two training sessions. Thus, to significantly increase isokinetic PT of the forearm flexors in males may require more than two training sessions and females more than three. The results of the present study potentially have implications for the number of visits that are required for rehabilitation after injury and/or surgery, therefore, future investigations should examine the minimum number of training sessions needed to increase forearm flexion PT at various velocities for males and females.

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