THE EFFECT OF NUMBERS OF REPETITIONS ON PEAK TORQUE IN ROWER ANS NON-ATHLETE FEMALES WHEN USING ISOKINETIS TESTING

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Isokinetic training has been used as a successful means for testing and increasing muscle strength. The purpose of this study was to investigate the effect that different numbers of repetitions have on fatigue and force generation in females and specifically between athletes and non-athletes. Thirty college-aged females (15 rowers, 15 non-athletes) were tested using an isokinetic machine to measure peak torque. Each subject was tested 5-6 times on the isokinetic machine. This included 1-2 familiarization tests and four experimental testing sessions during which subjects performed randomly assigned maximal knee extensions of either four, six, eight, or ten repetitions, through a 90 degree range of motion, at 60, 120, 180, 240, and 300deg/s. Rest periods between velocities were kept constant at 60 sec. Using SPSS 14.0 data were analyzed using a 2 X 4 X 5 repeated measures ANOVA with alpha < .05. Group, repetitions, and velocity served as the independent variables and peak torque as the dependent variable. Peak torque in rowers was also compared to the time taken to complete a 2000m distance on a rowing ergometer. No significant difference was found between the various repetitions at different velocities. A significant difference was found between peak torques at the different velocities ($F=1221.37$, $p<.05$). A significant difference was also found between athletes and non-athletes at the different velocities ($F=24.272$, $p<.05$). A correlation of -0.82 was found between peak torque and 2000m time for rowers. The number of repetitions does not appear to effect peak torque production. Athletes appear to produce more torque at all velocities compared to non-athletes. There is a linear relationship between knee extensor peak torque and performance on a rowing ergometer.

KEY WORDS: isokinetics, CYBEX, knee extension, rowing.

INTRODUCTION: Isokinetic training has been used as a successful means for measuring and tracking the progress of peak torque development in muscle strength (Dauty & Rochcongar, 2001) and to identify asymmetry in leg strength (Dauty et al., 2007). Because isokinetic training controls velocity during movement it can be used for safe and effective rehabilitation, its original purpose. Hamstring/quadriceps ratios have been studied using isokinetic machines in regards to ACL injuries and rehabilitation (Hewett et al., 2008). Research has been conducted testing varying velocities (Arnold & Perrin, 1995) and strength gain has been observed across these velocities (Akima et al., 1999). Isokinetic testing, however, does not have a set protocol and standardization needs to be established.

While there are other muscles involved in a rowing stroke, the quadriceps muscles of the leg have a direct impact on the performance power of the leg drive (Tachibana et al., 2007). Rowers have shown greater strength in knee extensors than non-rowers (Parkin et al., 2001); however it is uncertain as to whether peak knee torque has a relationship to rowing performance. Little research has compared the effect on peak torque when using a variable number of repetitions and velocities, nor have many comparisons been made between athletic and non-athletic populations. The purpose of this study was to investigate the effect that different numbers of repetitions have on peak torque generation of the knee extensors in females, specifically between athletes and non-athletes. A secondary purpose was to compare knee extensor strength in rowers to rowing performance.

METHODS: Data Collection: Thirty apparently healthy college-aged females were recruited from the student population at the University of Puget Sound in Tacoma, WA. The 15 athletes were members of the women's varsity crew team and the other 15 subjects were university athletes.The mean age, height, and mass of the subjects respectively were 20±1 years, 1.70±.006m, and 70.63±12.90kg. Subjects with previous knee injuries were excluded from this study. The study was approved by the Internal Review Board and all subjects signed a form of informed consent. Testing was conducted on a Cybex NORM Isokinetic Machine. Subjects completed one-two familiarization sessions and four experimental sessions. Each test included a five minute warm-up on a cycle ergometer at a self-selected resistance and pace and a warm-up on the Cybex machine. This involved four submaximal knee extensions at 60, 120, 180, 240, and 300°/s with 60s rest periods between each velocity. All isokinetic testing occurred through a 90deg range of motion and held knee flexion constant at 300deg/s. Familiarization sessions involved either four or six maximal knee extensions at 60, 180, and 300°/s with a three minute rest period between velocity sets. The four experimental tests incorporated randomly assigned maximal knee extensions of either four, six, eight, or ten repetitions with ascending ordered velocities of 60, 120, 180, 240, and 300°/s. Flexion speed was held constant at 300deg/s and rest periods between velocity sets were 60s. Both visual and verbal feedback was provided throughout the tests. Subjects were asked to abstain from maximal exercise bouts within 24 hours prior to testing and all subjects had a minimum 24-hour rest period between data collection sessions.

Data Analysis: Using SPSS 14.0 data were analyzed using a 2X4X5 repeated measures ANOVA with alpha < .05. Differences in peak torque across velocities between athletes and non-athletes were determined. A Pearson Correlation and linear regression were also computed to compare peak torque at 60°/sec to times recorded to complete a 2000m piece on a rowing ergometer for the 15 athletes.

RESULTS: There were no significant differences in peak torque when varying the number of repetitions. A significant difference in peak torque was found between the different velocities (F=1221.37, p<.05) (Fig.1).

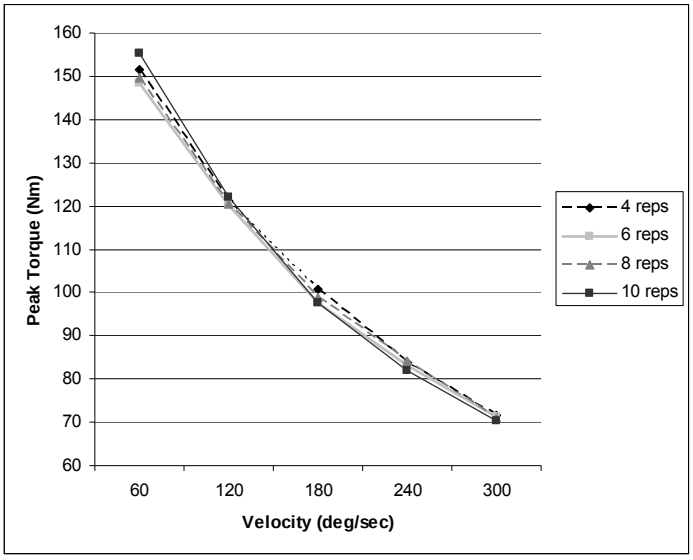

Figure 1: Peak torque versus velocities at various repetitions.

There was also a significant difference in peak torque found between athletes and non-athletes at the different velocities (F=24.27, p<.05) (Fig. 2).

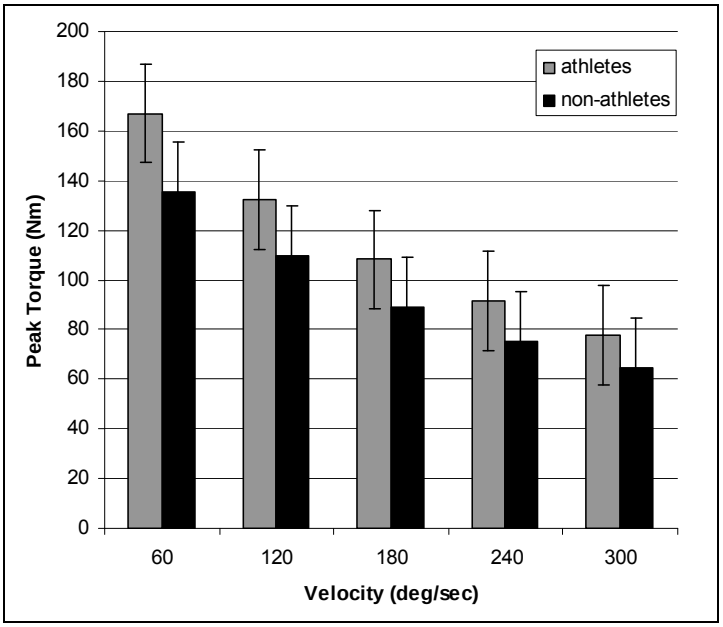

Figure 2: Differences in peak torques between athletes and non-athletes across five different velocities. All velocities were significant.

Pearson's Correlation revealed a -0.82 correlation (α=0.01) between peak torque at 60°/sec and the time taken to complete a 2000m distance on a rowing ergometer for the athletes (Fig. 3).

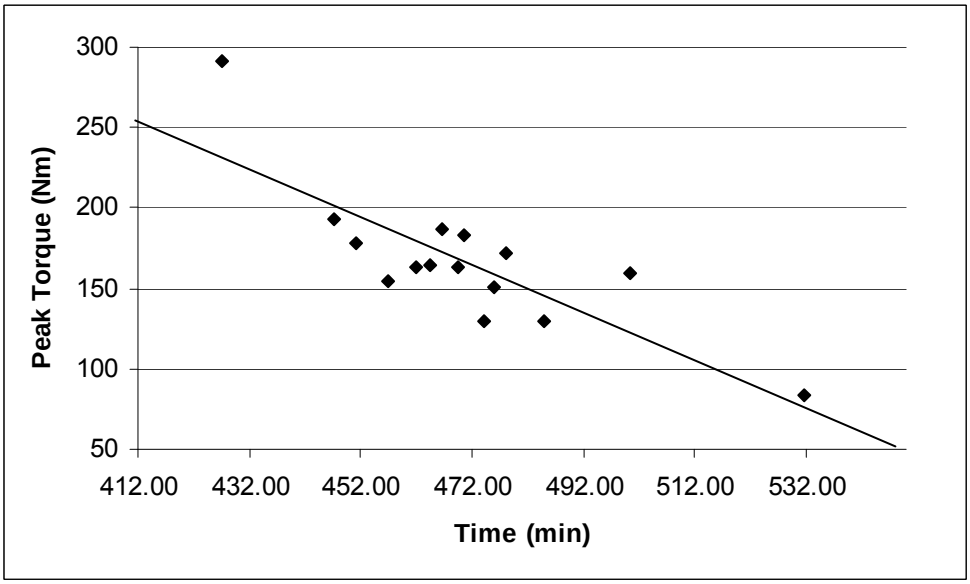

Figure 3: Peak torque at 60°/sec (4 reps) for the 15 rowers compared to the time taken to complete 2000m on a rowing ergometer.

DISCUSSION: The results confirm an inverse relationship between peak torque and velocity, which supports findings in previous studies (Gerodimos et al., 2003; Koutedakis et al., 1998). Similar to past research, athletes produced more torque at all velocities compared to non-athletes (Koutedakis et al., 1998). In addition, the number of repetitions does not appear to effect peak torque production; therefore four repetitions may be adequate when measuring peak torque. There was also an inverse relationship between the peak torque produced at 60°/sec and the time it took the rowers to complete a 2000m distance on a rowing ergometer. This suggests that there is a relationship between quadriceps strength and rowing power performance as reported by Tachibana et al. (2007). As rowers begin a

rowing strength they push primarily with the quadriceps muscles. Moreover, this study supports the findings of Parkin et al. (2001), who reported that male rowers exhibited greater knee extensor strength than non-rowers. Although it was not tested, verbal and visual encouragement seemed to impact the effort of the subjects. O'Sullivan & O'Sullivan (2008) found there was a significant difference between conditions with and without verbal and visual feedback. Maximal effort also seemed to be impacted by the competitive nature of the subjects. As rowing is an endurance sport, it is unclear whether the trends found in this study would hold true for non-endurance athletes.

CONCLUSION: The number of repetitions does not seem to effect peak torque production in athletic and non-athletic female populations and therefore four repetitions may be adequate when measuring peak torque. Rowing performance power does appear to be influenced by the strength of the knee extensors.

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Acknowledgement

This research was funded by a research grant from the University of Puget Sound.