# COMPARISON OF MALE AND FEMALE PEAK TORQUE USING A VARIABLE NUMBER OF REPETITIONS DURING A KNEE JOINT ISOKINETIC TEST

**Barbara L. Warren, Sarah Moody and Deanna Malikie**

**University of Puget Sound, Tacoma, Washington, USA**

The purpose of this study was to assess peak torque in males and females using a variable number of repetitions at five different isokinetic velocities. Sixty subjects, males and females, athletes and non athletes were tested on four separate occasions. Each testing session the subject executed a set number of repetitions, either 4, 6, 8, or 10, at velocities of 60, 120, 180, 240 and 300 $^{o}\cdot s^{-1}$ with a 60 second rest period between each velocity set. The order of repetitions was randomly assigned. A 2 X 2 X 4 X 5 repeated measures ANOVA was used to analyze the data with $\alpha < .05$. The independent variables were gender, athlete, repetitions, and velocity with peak torque as the dependent variable. The following were found to be significant: interaction between gender and velocity; athlete and velocity; velocity; gender; athlete/non athlete; but no significant differences in number of repetitions were found. Therefore, peak torque was demonstrated equally regardless of the number of repetitions. However, by carefully reviewing the data for females it was evident that the women athletes did not reach peak torque at any of the five velocities when they executed four repetitions. In the female non athletes only at the higher velocities did they reach peak torque with four repetitions. It was concluded that females may need more repetitions to achieve peak torque than their male counterparts and that this should be taken into account when they are being tested for strength.

**KEY WORDS:** isokinetic, peak torque

**INTRODUCTION:** Considerable research has been conducted using isokinetic machines to assess strength, power and work of particular muscle groups. This has been accomplished using a variety of protocols including various rest periods (Longwell & Warren, 2008; Parcell, Sawyer, Tricoli, & Chinevere, 2002; Warren, 2007), velocities (Cotte & Ferret, 2003; Dauty, Dupre, Potiron-Josee, & Dubois, 2007; Ozcaldiran, 2008; Parcell et. al, 2002), and number of repetitions (Cotte & Ferret, 2003; Magalhaes, Oliveira, Ascensao & Soares, 2004; Pincivero & Campy, 2004). Rest periods between velocity sets have varied from 15 sec to 300 sec with some findings indicating that 60 sec is adequate (Longwell & Warren, 2008; Parcell et al., 2002). The number of velocities at which to test and the order varies from two to eight velocities with most tests being conducted with an ascending order although some have been randomly ordered (Arnold & Perrin, 1995; Dauty et al, 2007; Longwell & Warren, 2008; Magalhaes et al., 2004; Parcell et al., 2002). Many investigators who have assessed strength have used anywhere from three to five repetitions at more than one velocity, although others have used as many as 30 repetitions. Brown & Weir (2001) stated that no more than five repetitions are necessary when assessing strength. However, it has not been clear if these findings are similar in male and females subjects. The purpose of this study was to assess peak torque in males and females using a variable number of repetitions at five different isokinetic velocities. The desired outcome would be to recommend to future researchers a set number of repetitions to be used during isokinetic testing when assessing strength in both male and female populations.

**METHODS: Data Collection:** Thirty male and 30 female (15 athletes and 15 non athletes of each gender) apparently healthy, college aged students were recruited for this study. The athletes were those who were members of a university athletic team, while the non athletes were students who were not members of a university athletic team. Subjects were excluded if they had a previous knee injury. The study was approved by the University IRB and all subjects signed informed consent. The mean age, height, and weight of the males respectively were 20.87 ± 1.25 yrs, 179.92 ± 49.7 cm, and 81.33 ± 14.04 kg., while the means for the females were 20 ± 1 years, 170.2 ± 5.58 cm, and 70.63 ± 12.90 kg.

A Cybex NORM isokinetic machine was used for all testing. For the present study gravity correction was integrated in all tests and the Cybex NORM was calibrated prior to collection of any data.

Subjects reported to the lab on five or six separate occasions, depending on their familiarity with the isokinetic machine. One or two were familiarization sessions and four were experimental testing sessions, all of which included a required five minute warm up on a bicycle ergometer at a self selected pace. The warmup on the isokinetic machine included four submaximal knee extensions at 60, 120, 180, 240 and 300 $^{o}\cdot s^{-1}$ with a 60 second rest period between each velocity. All isokinetic tests used a 90$^{o}$ range of motion.

During the familiarization sessions, subjects were fitted on the isokinetic system and settings were recorded to ensure the same positioning for all four experimental tests. After the warmup protocol, the subjects performed four maximal contractions at isokinetic velocities of 60, 180, and 300$^{o}\cdot s^{-1}$ with a 3-min rest between sets.

When experimental testing began, subjects were requested to abstain from maximal exercise bouts 24 hours prior to each session. During experimental testing at velocities of 60, 120, 180, 240 and 300 $^{o}\cdot s^{-1}$., subjects performed sets of maximal contractions of either four, six, eight or ten randomly assigned repetitions. Rest periods between velocity sets were standardized at 60 seconds Subjects were instructed to contract maximally during knee extension, while flexion velocity was set at 300 $^{o}\cdot s^{-1}$, which offered very little resistance.

Subjects were given both visual and verbal feedback during the tests. Each velocity tested was considered a set and the peak torque value for each velocity set was used for comparison.

**Data Analysis:** A 2 X 2 X 4 X5 repeated measures ANOVA was used to analyze the data with alpha < .05. The independent variables were gender, athlete, number of repetitions and velocity sets respectively, while the dependent variable was peak torque. For a two-tailed alpha=.05, power=.8, an effect size was calculated to be .7.

**RESULTS:** Analysis of the data revealed significant interactions between velocity and gender: (means and standard deviations are reported in ascending order of velocities) males 238.7±55.9, 189.7±46.2, 155.1±37.6, 131.8±30.9, 114.0±25.6 and females 151.2±37.8, 120.9±28.6, 98.7±23.1, 83.3±19.6, 71.0±16.5 (Figure 1); and between velocity and athlete: athletes 214.8±66.9, 168.7±55.1, 138.5±44.5, 118.1±36.9, 100.9±30.9, and non athletes 175.0±56.0, 142.0±44.1, 115.3±35.9, 97.0±30.57, 83.9±27.4 (Figure 2). As expected there was a significant difference in peak torque at different velocities (Figures 3-6), a significant difference in peak torque between genders, and a significant difference between whether one was an athlete or non athlete. However, there were no significant differences in peak torque at each velocity when using a different number of repetitions.

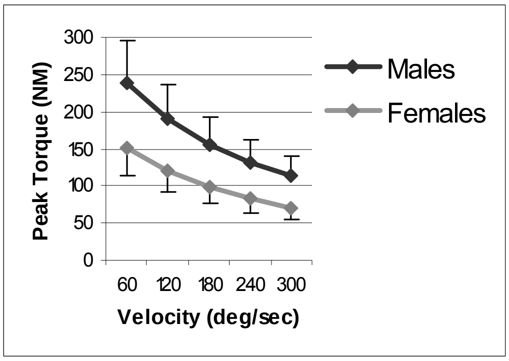



Figure 1: Peak Torque by Gender

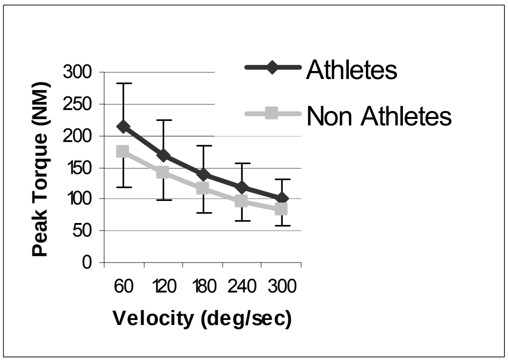
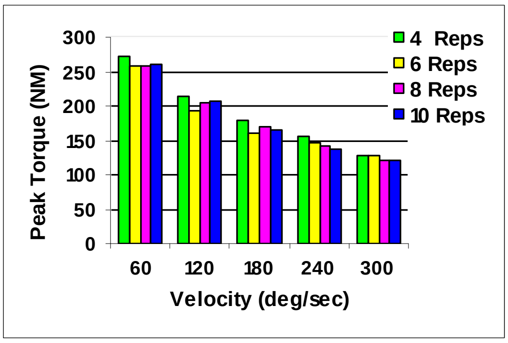



Figure 2: Peak Torque by Athlete



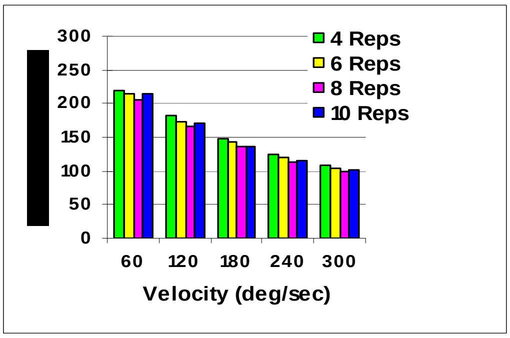
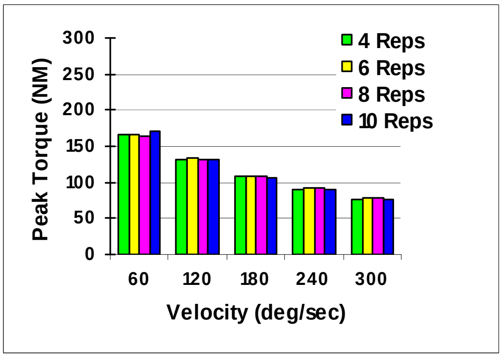




**Figure 3: Male Athlete Peak Torque**

**Figure 4: Male Non Athlete Peak Torque**



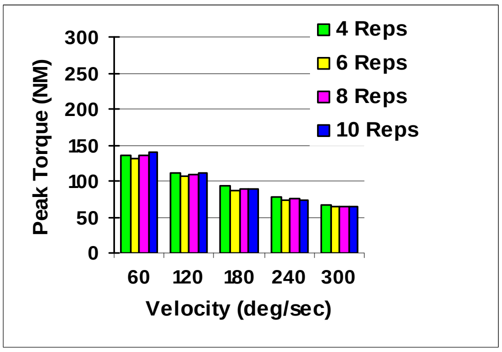




**Figure 5: Female Athlete Peak Torque**

**Figure 6: Female Non Athlete Peak Torque**

**DISCUSSION:** The primary focus of this study was evaluating whether the number of repetitions executed during isokinetic testing would affect the amount of peak torque each subject could produce. Brown and Weir (2001) indicated that if strength was being measured there was no reason to use more than five repetitions. In fact, the majority of studies assessing strength as well as other variables using an isokinetic machine ask the subjects to execute between three and five repetitions (Aasa, Jaric, Barnekow-Gergkvist, Johansson, 2003; Arnold & Perrin, 1995; Cotte & Ferret, 2003; Longwell & Warren, 2008; Magalhaes et al., 2004; Ozcaldiran, 2008; Parcell et al., 2002; Warren, 2007). This study attempted to include a large number of subjects, athletes and non athletes as well as both genders. What was found about the male subjects is consistent with the findings of many of the studies cited above. Essentially, males can produce peak torque when executing four repetitions (Figures 3, 4). However, the female athletes' peak torque scores were not as high at any of the five velocities when using only four repetitions (Figure 5). They needed six or eight repetitions to achieve their peak torque. The female non athletes were unable to achieve peak torque with four repetitions at the lower velocities of 60 or 120 $^{o}\cdot s^{-1}$, while at the higher velocities they could produce peak torque with four repetitions (Figure 6). Although the peak torques between repetitions for women were not significant differences, it seems important to note they had difficulty producing peak torque with fewer repetitions. This observation would seem to be important for clinicians, trainers, and researchers who are assessing peak torque in the following situations: prior to a season, bilateral comparisons, evaluation of clients who are completing rehabilitation, or isokinetic testing for research purposes.

**CONCLUSIONS:** It was concluded that regardless of if one is an athlete; males seem able to produce peak torque with four repetitions, while females need at least six or eight repetitions to demonstrate peak torque. This is applicable for both clinicians and researchers who are using peak torque as an indicator of successful rehabilitation or performance, as women would not have achieved peak torque in most cases if only four repetitions are used for evaluation.

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