ISOKINETIC SPECIFIC TENSION OF QUADRICEPS IN SPRINTERS, DISTANCE RUNNERS AND NORMAL YOUNG ADULTS

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The purpose of this study was to determine whether isokinetic specific tension differences existed between athletes of different sports. Nine sprinters, eight distance runners and nineteen young adults were recruited as subjects in this study. A Cybex dynamometer was employed to measure the isokinetic peak torque of knee extension at 60°/sec, 120°/sec, 180°/sec, 240°/sec and 300°/sec. The cross sectional area of quadriceps was measured using the anthropometic equation of Housh et al. (1995). There was no significant difference between isokinetic specific tension of quadriceps in sprinters, distance runners and normal young adults.

KEYWORDS: specific tension, cross sectional area, isokinetic peak torque, sprinters, distance runners

INTRODUCTION: Muscular strength is one of the major factors influencing the performance of sports activity. The success in many sports is closely related to the athlete's ability to develop muscular strength.

Specific tension is a measurement of force per unit of muscle cross sectional area. Multiplying by muscle cross sectional area, specific tension can estimate the magnitude of the muscle force vector, which is a difficult quantity to measure in humans. According to Enoka (1994), the value of specific tension, measured isometrically, is about 30 N cm^{-2}.

In previous studies, isometric strength was commonly used to measure the specific tension of the athletes. However, as most sport movements are dynamic rather than static, the isometric method is not the most appropriate method to determine the muscle characteristic of athletes. Therefore, dynamic muscle strength testing, such as isokinetic measurement, should be used in specific tension measurement. The purpose of this study was to determine the isokinetic specific tension of athletes involved in different sports.

METHODS: Subjects: Thirty-six male university students: 9 sprinters, 8 distance runners and 19 normal young adults were recruited as subjects in this study. The sprinters (stature 1.72 $\pm$ 0.06 m, body mass 62.6 $\pm$ 4.8 kg) were athletics team members, who trained to compete in races of up to 400 metres in track and field events. The distance runners (stature 1.72 $\pm$ 0.02 m, body mass 61.49 $\pm$ 5.8 kg) were also athletics team members, who trained for 5000 metres. The 19 normal young adults (stature 1.70 $\pm$ 0.05 m, body mass 61.2 $\pm$ 10.4 kg) were healthy young men and were not currently involved in any type of exercise exceeding 30 minutes per day and 2 days per week. The normal young adults were used to obtain a norm values of the testing variables.

Determination of Isokinetic Peak Torque: A Cybex dynamometer was employed to measure the isokinetic peak torque of knee extension at 60°/sec, 120°/sec, 180°/sec, 240°/sec and 300°/sec. Only the dominant leg was investigated in this study. At each testing velocity the subjects were required to perform five knee extensions with maximal effort. The sequence of the five testing velocities was from the lowest, 60°/sec to the highest, 300°/sec.

Determination of Quadriceps Cross Sectional Area: The cross sectional area of quadriceps was measured by the anthropometric equation which was reported by Housh et al. (1995):

Quadriceps cross sectional area = (2.52 x midthigh circumference in cm) - (1.25 x anterior thigh skinfold in mm) - 45.13, r = 0.86 and SEE = 5.2 cm^2

The midthigh circumference and anterior thigh skinfold of dominant leg were measured using the standardized procedures described by Housh et al. (1995).
A one-way ANOVA with Scheffe post hoc comparison, using a level of significance at $p < 0.05$, was used for comparison of testing variables between subject groups.

RESULTS AND DISCUSSION: Table 1 shows the cross sectional area of quadriceps, isokinetic peak torque, and specific tension at each testing velocity.

Table 1 Mean and Standard Deviation of Quadriceps Cross Sectional Area, Isokinetic Peak Torque and Isokinetic Specific Tension for Sprinters, Distance Runners and Normal Young Adults

Variables	Sprinters (n = 9)	Distance Runners (n=8)	Normal Young Adults (n=19)
Quadriceps cross sectional area, cm^2	72.15 ± 4.27 **	65.95 ± 2.27	60.25 ± 7.31
Isokinetic peak torque at, Nm			
60°/sec	**192.78 ± 28.93 ****	**195.38 ± 36.74***	**146.58 ± 36.48**
120°/sec	**160.11 ± 30.42 ****	**158.16 ± 38.20***	**118.79 ± 29.87**
180°/sec	**140.22 ± 30.85 ****	**137.38 ± 27.14***	**98.37 ± 30.43**
240°/sec	**121.11 ± 32.87 ****	**109.50 ± 29.23**	**83.58 ± 26.11**
300°/sec	**104.78 ± 29.28 ****	**93.86 ± 25.47**	**74.47 ± 24.57**
Isokinetic specific tension, Nm cm^{-2}			
60°/sec	**2.67 ± 0.39**	**2.95 ± 0.42**	**2.44 ± 0.54**
120°/sec	**2.22 ± 0.43**	**2.38 ± 0.44**	**1.98 ± 0.48**
180°/sec	**1.94 ± 0.41 ****	**2.07 ± 0.26***	**1.64 ± 0.49**
240°/sec	**1.68 ± 0.45**	**1.66 ± 0.39**	**1.39 ± 0.42**
300°/sec	1.45 ± 0.40	1.42 ± 0.33	1.25 ± 0.42

** Sprinters > Normal young adults for $p < 0.05$
* Distance runners > Normal young adults for $p < 0.05$

Cross Sectional Area of Quadriceps: The quadriceps cross sectional area of sprinters was greater than that of distance runners and normal young adults, while only the difference between sprinters and normal young adults was statistically significant for $p < 0.05$ (Table 1). The latter finding is consistent with those of Maughan et al. (1983). Muscle cross sectional area is determined by both size and number of muscle fibres. Since, on the average, sprinters tend to have greater percentage of type II fibres which have a greater cross sectional area than type I, the sprinters have a greater quadriceps cross sectional area than distance runners (Fox et al., 1989).
As sprinting is a power activity and distance running is an endurance activity, power training is one of the most important components in the training program of sprinters. In addition, the increase in cross sectional area of type II fibres due to strength training is greater than that of type I (Hickson et al., 1994). The difference in the muscle fibre cross sectional area might be due to the muscle hypertrophy after strength training in sprinters.
Isokinetic Peak Torque: In the present study, there were significant differences in peak torque between sprinters and normal young adults at all testing velocities, $p < 0.05$ (Table 1). However, significant differences in peak torque between distance runners and normal young adults could only be found in the slower testing velocities: 60°/sec, 120°/sec and 180°/sec. This result can be attributed to type II fibres which predominate in sprinters and type I fibres which predominate in distance runners. Type II fibres can contract with a greater rate of shortening and tension than type I. Therefore, the sprinters would be expected to generate greater peak torque than other subject groups at high testing velocity.
Furthermore, previous studies have shown that muscle strength is positively correlated with

muscle cross sectional area. Thus, the quadriceps cross sectional area could also explain the difference in isokinetic peak torque between subject groups.

Isokinetic Specific Tension: This study has showed that there were significant differences in absolute muscle strength among subject groups (Table 1 and Figure 1). However, from this result, we could not determine whether the significant differences were due to the differences in quadriceps cross sectional area or other sports specific variables, such as muscle fibres composition or training mode. In order to eliminate the effect of cross sectional area on muscle strength, isokinetic specific tension was measured. The present study demonstrated no significant difference between subject groups in all testing velocities, except 180°/sec (Table 1).

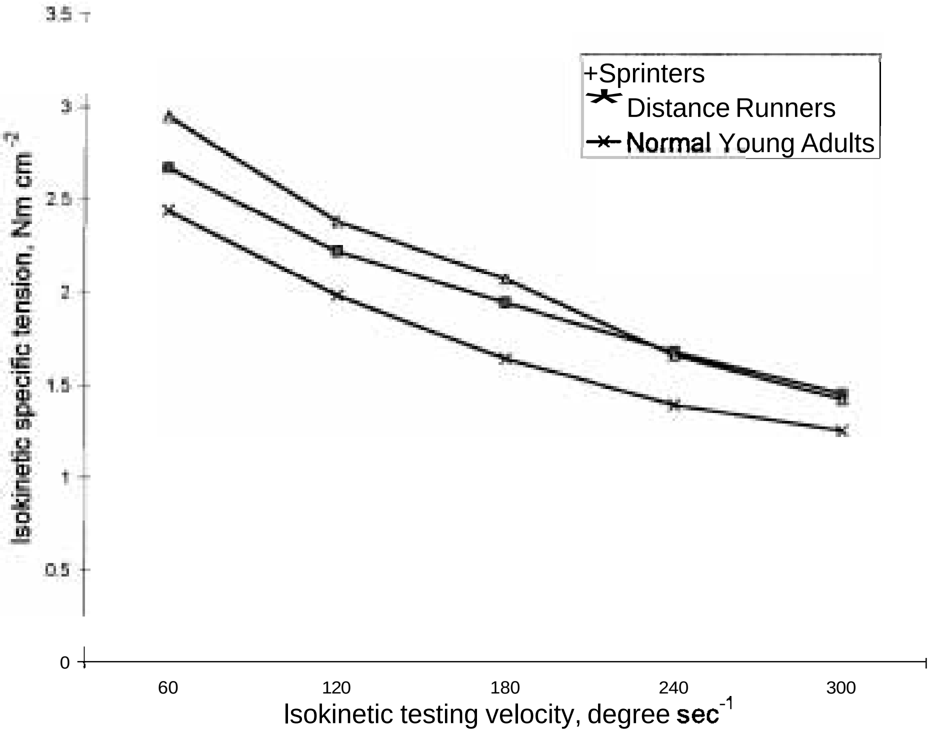

Figure 1 - Isokinetic specific tension for knee extensor of sprinters, distance runners and normal young adults.

'Theoretically, type I fibres have high aerobic and low anaerobic capacity, while type II fibres demonstrated the reverse characteristics. Therefore, the difference in isokinetic specific tension between sprinters and normal young adults should be greater at high testing velocities: 240°/sec and 300°/sec. However, this study did not support this hypothesis. The results showed that there was no significant difference in isokinetic specific tension between subject groups at high testing velocities. It is possible that the maximal output in isokinetic contraction requires maximal or near maximal recruitment of both type I and type II fibres, i.e. independent of angular velocity (Perrin, 1993).

Moreover, quadriceps is a pennate muscle, which fibre pennation angles are greater in hypertrophied than in normal muscles. The increase in fibre pennation angles may reduce the force transfer to the tendon because of a change in the orientation of fibres to the tendon angle of pull (Bruce et al., 1997). Therefore, even thought there is a greater isokinetic specific tension in sprinters and distance runners, the larger quadriceps cross sectional area will also reduce isokinetic peak torque. As a result, the difference between quadriceps specific tension could not be observed between subject groups.

CONCLUSION: The result of this study indicated no significant difference in isokinetic specific tension between subject groups. Therefore, when the equation:

$$\text{Torque} = \text{specific tension} \times \text{cross sectional area}$$

was used to predict the magnitude of peak muscle torque vector in sprinters and distance runners, the specific tension of them can be assumed to be equal.

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