P02-5 ID46

EFFECT OF SKILL LEVEL ON KNEE FLEXOR AND EXTENSOR STRENGTH IN MALE JUDO

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Judo has a high requirement of the physical strength of lower limb. In this paper, the centripetal knee force of national master athletes and first-grade athletes of male Judoka was measured using the ISOMED2000 Isokinetic system. Try to discuss the differences between different grades of judoka in the area of the physical strength of lower limb. Judo-related specific knee strength indices, such as peak torque in relation to body weight, flexor torque in relation to the extensor torque and average power of knee, were compared between the two groups by statistic analysis. The results showed that the first-grade athletes did not significantly differ from the national master athletes in terms of relative power of the knee flexors, but significant difference existed in the absolute power and explosive strength of the knee extensors between the two levels of athletes.

KEY WORDS: Judo, knee joint, isokinetic centripetal test, comparative analysis.

INTRODUCTION: Compared with other sports events, Judo requires much higher lower limb strength, especially event-related specific strength of the knee joint, which is a significant factor in the competitive ability of an athlete. There are the questions that should be clear to train the physical quality. What are the differences between different grades of judoka in the area of the physical strength of lower limb? Which aspects of the lower grades should take accentuation training? According to the literature, for now, the research of this aspect has not been discussed (Yu Di,2006). The isokinetic centripetal strength test of the knee joint shows high accuracy and repeatability(Abe T,1992; Yang T.2007). This study used the isokinetic test system to evaluate the isokinetic centripetal strength of two levels of male Judo athletes, namely, national master athletes (top rank athletes in China) and first-grade athletes (second top rank athletes in China). The purpose of this study was to provide scientific evidence for the power training of Judo athletes.

METHODS: Eight male national master Judo athletes (height: 167.5 cm ± 6.2 cm, weight: 72 kg ± 11.6 kg) and nine male first-grade Judo athletes (height: 165.3 cm ± 5.4 cm, weight: 71 kg ± 12.3 kg) volunteered to participate in this study.
The ISOMED2000 Isokinetic system (D&R Company, Germany) was used to measure the isokinetic centripetal strength of extensor and flexor of the knee joints of the participants. The subjects were instructed to do warm-up exercises before the measurement, which consisted of knee flexion and extension for 10 min. According to the specifications of ISOMED2000, the subjects were positioned on the system, such that the power head center of the system was pointed to the center of the knee. During the measurement, the subjects initially performed knee flexion and extension 10 times to familiarize themselves with the system. Afterward, the subjects were asked to perform the maximum knee flexion and extension 5 times at an angular velocity of 60°/s and then 5 times at an angular velocity of 240°/s, respectively. Generally, the angular velocity of 60°/s is considered low speed for knee flexion and extension, which reflects the relative power of the muscle. The angular velocity of 240°/s is considered high speed for knee flexion and extension, which reflects the explosive strength of the muscle.
Five specific strength indices were calculated: 1) peak torque of the knee flexor in relation to body weight (PT/BW), 2) peak torque of the knee extensor in relation to body weight (PT/BW), 3) flexor torque in relation to the extensor torque (F/E), 4) average power of the flexor and extensor, and 5) average power of the extensor. Each index was compared between the two

groups of athletes. Excel 2003 and SPSS 16.0 software were used for the calculation and statistical analysis of data. T-test was performed to compare the two groups. The statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION: Comparative analysis of PT/BW: The results listed in Table 1 showed that when the angular velocity reached 60°/s, the PT/BW of the flexors of the national master athletes (1.73 N·m/kg ± 0.38 N·m/kg) did not exhibit a significant difference from that of the first-grade athletes ($p > 0.05$). Thus, evident difference did not exist between the first-grade athletes and the national master athletes in the relative power of flexors. However, the first-grade athletes (2.36 N·m/kg ± 0.57 N·m/kg) and the national master athletes (2.80 N·m/kg ± 0.43 N·m/kg) showed a significant difference ($p < 0.05$) in the knee extensors. This result indicated a remarkable distinction between the first-grade athletes and the national master athletes in terms of the relative power of their knee extensors. When the angular velocity reached 240°/s, the two groups of athletes showed differences in the PT/BW of the knee flexors ($p < 0.01$) and extensors ($p < 0.05$). This result indicated that significant difference in the explosive strength of the flexors and extensors existed between the two groups. The national master athletes had higher explosive strength than the first-grade athletes in both flexors and extensors of the knee.

Table 1
Data sheet of PT/BW of the knee flexors and extensors（ $\bar{x} \pm SD$ ）

	60°/s		240°/s	
	PT/BW of the flexors[Nm/kg]	PT/BW of the extensors[Nm/kg]	PT/BW of the flexors[Nm/kg]	PT/BW of the extensors[Nm/kg]
The national master athletes	1.73±0.38	2.80±0.43*	1.31±0.28**	2.36±0.57*
The first-grade athletes	1.79±0.33	1.84±0.38*	1.22±0.40**	1.57±0.33*

Note: "**" means $p<0.01$, "*" means $p<0.05$, no label means $p>0.05$.

Comparative analysis of F/E: The results of F/E of male Judo athletes are presented in Table 2.The index of F/E reflects the athletic ability to coordinate the contraction of the whole muscle or the muscle group. This characteristic has an important role in preventing injury and facilitating joint stability. Based on documented data, when the angular velocity reaches 60°/s, F/E is from 60% to 69%; when the angular velocity reaches 240°/s, F/E is from 80% to 89%. In this study, the F/E of the national master athletes fell under the 60% to 69% criteria at low speed, whereas the F/E of the first-grade athletes was outside the range. No significant difference existed between the two groups of athletes. As the angular velocity reached 240°/s, the findings in the two groups of athletes showed some differences from the normal data provided in the literature(Lu D.M.,2004). This result could be attributed to the specific skills and techniques used in Judo. Moreover, the differences between the national master athletes and the first-grade athletes were large.

Table 2
Data Sheet of F/E ($\bar{x} \pm SD$)

F/E	60°/s	240°/s
The national master athletes	0.66±0.13	0.74±0.13**
The first-grade athletes	0.74±0.28	0.70±0.21**

Note: "**" means $p<0.01$.

Comparative analysis of the average power: The results of the average power of the flexor and extensor of male Judo athletes are presented in Table 3.The average power is calculated as the work done by the muscle or the muscle group in a unit of time, which reflects the work efficiency of the muscle or the muscle group. The literature shows that the average power of the muscle within a certain range increases as the movement speed increases. However, when the speed of the muscular movement reaches a critical value, the average power decreases(Abernethy PJ，1996). In this study, the test results corresponded with the documented data(Yang T.,2007). However, when the angular velocity reached 240°/s, the average power did not reach the critical value. Significant difference did not exist in the average power when the flexors of the first-grade athletes were under low-speed condition. By contrast, when the flexors were under high-speed condition, a significant difference existed in the average power. The national master athletes and the first-grade athletes demonstrated significant difference when the extensors were under low-speed or high-speed conditions.

Table 3
Data sheet of average power of the flexor and extensor ($\bar{x} \pm SD$)

	60°/s		240°/s	
	average power of the flexor[w]	average power of the extensor [w]	average power of the flexor[w]	average power of the extensor [w]
The national master athletes	81.4±26.6	118.0±31.4**	122.1±29.9*	170.1±45.2**
The first-grade athletes	77.3±22.9*	113.0±41.4**	107.3±48.7**	158.8±61.3**

Note: "**" means p<0.01.

CONCLUSION: The first-grade athletes did not exhibit a remarkable difference in the absolute power of the knee joint flexors compared with the national master athletes, but showed a remarkable difference in the explosive strength. This finding suggests that attention should be directed on the explosive strength training of first-grade Judo athletes in the future. The absolute and explosive strength of the knee joint extensor of the first-grade athletes was evidently weaker than those of the national master athletes.

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