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Comparison of hamstring quadriceps strength ratios in different combat sports branches

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Background and Study Aim The hamstring and quadriceps muscles can have strength differences because of the sportive activities. It is known that sportive hamstring quadriceps strength imbalance can cause decreasing sportive performance and injuries. Also, each sports branch can have a specific effect on the hamstring quadriceps strength ratio. Therefore, the aim of this study was to examine the effects of different combat sports branches on the hamstring quadriceps ratio.

Material and Methods Wrestlers (N=10), boxers (N=10), wushu athletes (N=10) voluntarily participated in the study (also university students). Subjects were administered standard warm-up and then a strength measurement test was performed. Subjects performed knee extensor (quadriceps) and flexor (hamstring) isokinetic strength test (concentrically) with his dominant leg at 60° angular velocity with by Cybex device (Cybex NORM®. Humac. CA. USA). Peak and average strength were recorded automatically by the device. The SPSS package program was used in the analysis of the data. The isokinetic strength measurements of three groups were analyzed with one-way ANOVA.

Results There were no significant differences between groups' peak isokinetic strength ratio (wrestlers 0.58±0.09 boxers 0.56±0.07 and wushu athletes 0.57±0.12). Also, the average isokinetic strength ratio was not significantly different (wrestlers 0.56±0.08. boxers 0.60±0.08 and wushu athletes 0.53±0.11).

Conclusions According to the results, it can be said that combat sports athletes' hamstring quadriceps ratio can be affected by their sports branches, also by characteristics and training levels.

Keywords: imbalance, hamstring, quadriceps, ratio.

Introduction

Muscle strength is one of the most important components of sports for both the prevention of injuries and high performance. There are several ways to assess muscle strength, balance and joint stabilization. The most useful method for determining muscle balance and strength between dominant/non-dominant and agonist/antagonist is isokinetic dynamometers [1]. For years, isokinetic dynamometers have been used to determine muscle balance and strength, as well as for muscle development and rehabilitation [2]. In addition, determining the isokinetic strength profiles of the athletes in different branches has great importance in terms of providing the continuity of the requirements of the branch and the high-level performance of the athletes [3].

Muscle fatigue is a common problem in athletes. For this reason, it is necessary to evaluate muscle fatigue and its related results. Another important element in exercise and competition is knee joint stabilization. Joint stabilization consists of static and dynamic stabilization. Thanks to the hamstrings and quadriceps, dynamic stabilization is provided in the knee joint [1]. To assess the balance of strength between opposing muscle groups, the strength ratios of these muscle groups are measured. Studies on the hamstring-quadriceps strength ratio can provide accurate results about muscle balance and dynamic stabilization in the knee joint.

To make accurate assessments about muscle balance and dynamic stabilization in the knee joint, it is necessary to determine the H/Q (hamstring/quadriceps) strength ratios. The H/Q ratio is calculated by the ratio of the maximum knee flexor (hamstring) and maximum knee extensor (quadriceps) peak torques at the same angular velocity and concentric contraction. As an example, the functional H/Q ratio for knee extension is calculated by expressing the maximum eccentric hamstring moment relative to the maximum concentric quadriceps moment achieved at a given angular velocity [4]. This ratio is also known as a convenient parameter that shows trends towards injuries [5-8]. In addition, due to the importance of flexor-extensor muscle strength balance, the H/Q ratio is used for rehabilitation in case of knee injury [2, 9].

Except for acute trauma, athletes' injuries mostly occur due to strength imbalance. Because the amount of load on the musculoskeletal system is much higher in sports branches involving high-

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intensity activities compared to endurance sports, the risk of injury increases. Therefore, special attention should be paid to the strength balance of muscle groups when planning training in sports branches where high-intensity activities such as combat sports are dominant [10].

As with many sports branches, combat sports have specific effects in terms of hamstring quadriceps strength ratios. These effects may differ from branch to branch. Therefore, this study aimed to examine the effects of different combat sports branches on the hamstring quadriceps ratio.

Materials and Methods

Participants

Total 30 athletes; wrestlers (n=10 age 20.40±1.57 year, height 178.30±6.75 cm and body weight 77.20±8.71kg), boxers (n=10, age 21.40±2.67 year, height 173.20±7.70 cm and body weight 69.30±9.58 kg), wushu athletes (n=10, age 21.70±2.21year, height 178.00±5.14 cm and body weight 78.50±9.62 kg) voluntarily participated in the study (also university students, at least 5 years experience).

Participants were informed about the risks of the study. All participants provided written informed consent. The study was approved by the local ethics committee (Protocol number 74, 19.10.2020, Ethics Committee of Selcuk University, Faculty of Sports Science, Konya, Turkey).

Research Desing

5 min standardized warm-up protocol was performed on a cycle ergometer at a rate of 60–70 rpm before isokinetic strength testing. After warming up, measurements of the knee isokinetic flexor (hamstring) and extensor (quadriceps) muscle strengths of the participants' dominant legs were taken with the concentric contraction protocol. The isokinetic strength measurements were taken using a cybex device (Cybex NORM®. Humac. CA. USA) at 60 ° sec^{-1} angular velocity. Peak and average isokinetic strength measurements were recorded automatically by the device.

Isokinetic Strength Measurement

The isokinetic strength measurements of the knee were performed by an isokinetic dynamometer (Cybex NORM®, Humac, CA, USA) in the kinatropometry laboratory of Selcuk University. Participants were seated in the correct position in the test seat. The participants' holders and the middle sections of the thighs were stabilized to the seat by the tapes. In addition, they were allowed to brace for support by holding the handles on the right and left sides of the seat during the test. The participants were instructed to complete a ROM from 90° to 10°. The point of the beginning was 90° of flexion, then moving into extension.

Each participant was given a familiarization at 60° sec^{-1} for five repetitions [11]. When the familiarization was done, each participant had a 2-min rest. After the rest period, each participant was asked to perform five repetitions as hard and fast as possible he could at a speed of 60° sec^{-1}. Participants were verbally encouraged. The isokinetic strength data were automatically recorded by the device as peak strength in newton meters and average strength in watts.

Statistical Analysis

The data were presented as mean and standard deviation. The Shapiro-Wilk test is used to check a data set for normality to make parametric tests applicable. Skewness and kurtosis values were checked for datasets that were not normally distributed, and those within ±2 were accepted to be normally distributed. One-way ANOVA used for data analysis in comparing multiple parameters. All statistical tests were performed using the software package SPSS version 24.0 (SPSS Inc., Chicago, IL, USA). An alpha value of <0.05 was considered to be statistically significant.

Results

Table 1 shows that there is no statistical difference between the groups in terms of age, height and body weight.

When the isokinetic strength outputs were examined, it was found that the isokinetic strength parameters of groups were not statistically different (see Table 2).

In table 3. when the relative isokinetic strength outputs were examined, it was found that there were no statistically difference between groups relative isokinetic strength parameters.

The peak strength ratios and the average strength ratios of the groups did not differ statistically (see Table 4).

Table 1. Comparison of demographic characteristics of groups.

Variables	Box	Wrestling	Wushu	P
	Mean±SD	Mean±SD	Mean±SD	
Age (year)	21.40±2.67	20.40±1.57	21.70±2.21	0.39
Height (cm)	173.20±7.70	178.30±6.75	178.00±5.14	0.17
Body Weight (kg)	69.30±9.58	77.20±8.71	78.50±9.62	0.64

*Statistically significant differences (P< 0.05).

Table 2. Comparison of isokinetic strength of groups

Variables	Groups	Mean	Std. Deviation	95% Confidence Interval		F	P
				Lower	Upper		
Peak Extension (Torque)	Box	221.50	48.87	186.54	256.46	1.793	0.18
	Wrestling	241.00	21.79	225.41	256.59		
	Wushu	250.60	28.56	230.17	271.03		
Peak Flexion (Torque)	Box	124.90	28.16	104.76	145.04	1.059	0.36
	Wrestling	141.10	31.41	118.63	163.57		
	Wushu	142.40	30.22	120.78	164.02		
Average Extension (Watt)	Box	155.30	30.32	133.60	177.00	2.230	0.12
	Wrestling	168.30	18.84	154.82	181.78		
	Wushu	175.80	13.13	166.41	185.19		
Average Flexion (Watt)	Box	93.10	20.60	78.36	107.84	0.011	0.98
	Wrestling	94.30	12.89	85.08	103.52		
	Wushu	93.70	20.30	79.18	108.22		

*Statistically significant differences (P<0.05).

Table 3. Comparison of relative isokinetic strength of groups

Variables	Groups	Mean	Std. Deviation	95% Confidence Interval		F	P
				Lower	Upper		
Peak Extension (Torque)	Box	3.18	.49	2.83	3.54	0.130	0.87
	Wrestling	3.14	.29	2.92	3.35		
	Wushu	3.25	.66	2.78	3.72		
Peak Flexion (Torque)	Box	1.79	.24	.07	1.61	0.40	0.96
	Wrestling	1.82	.33	.10	1.58		
	Wushu	1.83	.47	.14	1.50		
Average Extension (Watt)	Box	2.24	.32	2.01	2.47	0.198	0.82
	Wrestling	2.18	.19	2.04	2.32		
	Wushu	2.27	.36	2.01	2.53		
Average Flexion (Watt)	Box	1.33	.18	1.20	1.47	0.942	0.40
	Wrestling	1.22	.15	1.11	1.34		
	Wushu	1.20	.30	.99	1.42		

*Statistically significant differences (P<0.05).

Table 4. Comparison of peak and average strength ratios of groups

Variables	Groups	Mean	Std. Deviation	95% Confidence Interval		F	P
				Lower	Upper		
Peak Rate (Torque)	Box	.56	.07	.51	.61	.057	0.94
	Wrestling	.58	.09	.51	.65		
	Wushu	.57	.12	.48	.66		
Average Rate (Watt)	Box	.60	.08	.54	.66	1.096	0.34
	Wrestling	.56	.08	.50	.62		
	Wushu	.53	.11	.45	.62		

*Statistically significant differences (P<0.05).

Discussion

Muscle strength is one of the most important indicators of success in sports performance and prevention of injury. Some methods are used to evaluate muscle strength. One of them is isokinetic strength assessment [3, 9]. The H/Q ratio is frequently evaluated to examine functional ability, knee joint stability, and muscle balance between the hamstrings and quadriceps at various angular velocities. It is also a widely used variable to evaluate function in both athletes and patients with various knee injuries and pathologies [12]. The H/Q ratio shows different specific effects from branch to branch. Therefore, it was examined the isokinetic strength values of athletes participating in combat sports branches as well as effects of different combat sports branches on the hamstring quadriceps ratio in this study. The results demonstrate that hamstring quadriceps ratio of combat sports athletes can be affected by their sports branches, also by characteristics and training levels.

It is known that it is important to evaluate the isokinetic knee strength values and H/Q ratios of athletes in many sports branches. In the literature, there are many studies comparing isokinetic knee strength values and the H/Q strength ratios of athletes in different sports branches. Some of these were performed with the dominant leg, while others were performed with both legs. In addition, the measurements were performed at different angular velocities. In the study of Andrade et al. [13] on soccer players, handball players and judo players, peak extension torque values at 60°·s-1 angular velocity were found to be higher in judokas, while peak flexion torque values were found to be similar. Magalhaes et al. [3] also reported that the peak extension torque values higher in soccer players than volleyball players, while the peak flexion torque values were similar. Cheung et al. [12] stated that the peak flexion torque values in soccer players were statistically higher than in volleyball players and basketball players, but the peak extension torque values were similar. In contrast, no statistically significant differences were found between sports branches in terms of isokinetic strength values at 60°·s-1 angular velocity in our study. Maly et al. [14] indicated that no statistically significant differences were found between soccer and floorball players in terms of isokinetic strength values. These results are similar to the our study. The finding of no differences in the isokinetic strength values in different sports may be associated with training adaptations and levels.

There are limited studies comparing the H/Q strength ratios of combat sports branches. However, when we examine the branches one by one, Tatlici et al. [15] reported that while H/Q strength ratios were 0.58 in the dominant leg before 8- week wrestling-specific training, it decreased to 0.52 after wrestling-specific training. Zhou et al. [16] on the other hand, stated that the strength ratio of boxers was 0.61 in the results of their study. Jung et al. [17] stated that the H/Q strength ratio of taekwondo athletes was 62.8 in their right legs and 59.4 in their left legs.

Andrade et al, [13] reported that the H/Q ratios of handball players and soccer players at an angular velocity of 60°·s-1 were similar, while the ratios of judokas were lower than other two sports branches. Magalhaes et al. [3] also reported that the H/Q ratios of soccer players were statistically higher than volleyball players. Cheung et al. (2012) stated that the H:Q ratio was statistically higher in soccer players at an angular velocity of 60°·s-1 than in volleyball and basketball players. In addition, Maly et al. [14] stated that soccer players have higher H/Q ratio values than floorball players at an angular velocity of 60°·s-1. These findings can be explained by the enhanced knee flexors specific load adaptation required by soccer. In contrast, Rosene et al. [9] reported that no statistically significant differences were found between soccer, volleyball and softball players in terms of H/Q ratio values. Similarly, Zakas et al. [18] stated that there were no statistical differences in terms of H/Q ratios between soccer players and basketball players playing in different leagues. In our study, no statistical differences were found between the H/Q strength ratios of athletes at an angular velocity of 60°·s-1 in different combat sports such as boxing, wrestling and wushu. Thus, it can be said that various combat sports have specific effects in terms of H/Q strength ratio.

Conclusions

According to the results, there were no significant differences between groups in terms of isokinetic strength parameters including peak and average values. Also, peak and average isokinetic strength ratios of groups did not differ statistically. Therefore, it can be said that combat sports athletes' hamstring quadriceps ratio can be affected by their sports branches, also by characteristics and training levels.

Conflicts of interest

The authors declare no conflicts of interest.

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