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Differences in the Isokinetic Strength of Thigh Muscles between Track and Field and Taekwondo Athletes

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ABSTRACT. *This research aimed to determine the isokinetic strength differences between two groups of athletes (Taekwondo and track-and-field athletics) and to analyse factors that possibly contribute to the differences. We examined possible differences in peak power output and power ratio between agonist and antagonist thigh muscles of the knee. The sample consisted of 20 respondents: Taekwondo athletes (n=10; age 19±2.4) and track-and-field athletes (n=10; age 18±2.6). For this study, a valid test (CV<5%) of the isokinetic strength output of the knee extensors and flexors, was used at the angular velocity of 60°/s.*

KEYWORDS: *Knee dynamic stabilizers, Flexor and extensor, Training specificity, Evaluation*

1. Introduction

According to the International Association of Athletics Federations (IAAF), the athletics track disciplines are sprint (100 m, 200 m and 400 m), middle and long distances (800 m, 1500 m, 5000 m, 10000 m and 3000 m steeplechase); hurdles (men: 110 m and 400 m; 100 women 100 m and 400 m) and road running (marathon and half-marathon), as well as Relay (4x100 m; 4x400 m); cross country running; mountain running and ultra-running disciplines. Sprint disciplines and sprinting ability is based on lower extremities strength capacity. The long-term training process can initiate different effects in leg strength balance, as well as the unilateral and bilateral strength ratio. Sprinters are faster at 20 m and have more speed at block when their take-off leg is dominant (Vagenas & Hoshizaki, 1986). Asymmetry of dynamic leg strength is key factor for successful start (Vagenas & Hoshizaki, 1986; Exell, Irwin, Gittoes, & Kerwin, 2017). Most of the strength asymmetry is registered in the ankle and upper leg muscles (Exell et al., 2017); however, there is no correlation between leg strength asymmetry and running velocity.

Taekwondo is different from other martial arts in that its basic goal, which is symbolic destruction of the opponent, is achieved by simulated or strictly controlled blows of the arms and legs. Generally, punches account for 89.09% of the movements, leg kicks 8.36%, while cleaning and throwing with pointing account for

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2.55%. The dynamics of movement in Taekwondo are particularly emphasized, while static situations most often occur when maintaining postures. Also, in Taekwondo, reaction time is a key element, because high performance is based on explosive techniques, while Taekwondo performance relies more on muscle strength at lower versus higher loads.

This research aimed to determine the isokinetic strength differences between two groups of athletes (Taekwondo and track-and-field athletics) and to analyse factors that possibly contribute to those differences.

2. Methods

Inclusion criteria featured male athletes 16-21 years of age. For this study, a valid test (CV<5%) of the isokinetic strength output of the knee extensor's and flexor's, was used at the angular velocity of 60°/s. Age and morphological characteristics (height and body mass) of the first tested group of athletes (Taekwondo): n=10, 19±2.4, 184±7 cm, 77.8±11.5 kg; and second tested group of athletes (track-and-field athletics): n=10, 18±2.6, 182±5.4 cm, 76.1±4.5 kg.

Isokinetic variables (Biodex System): Peak torque dominant leg Extensor (Nm), Peak torque non-dominant leg Extensor (Nm), Peak torque dominant leg Flexor (Nm), Peak torque nondominant leg Flexor (Nm), Total work dominant Extensor (J), Total work non-dominant Extensor (J), Total work dominant Flexor (J), Total work non-dominant Flexor (J), Unilateral ratio dominant leg, Unilateral ratio non-dominant leg.

At-test for independent samples was used to determine the differences. Statistical significance was set at the conventional 95%.

All subjects were completely healthy, with no recorded knee joint injuries, and at their iscretion participated in the study and isokinetic testing procedure. All tested athletes id this isokinetic testing from 2012 to 2017. The measurement protocol involved a standard arm-up procedure after which the subject performed five maximal voluntary contractions t an angular velocity of 60°/s. An 80° range of motion was set for each subject. The rotation of the knee joint is aligned with the axis of rotation of the isokinetic dynamometer. he gravity correction was performed at an angle of 30° with respect to the vertically ositioned isokinetic dynamometer. Each subject was in a specific position: sitting on an sokinetic chair.

3. Results

The Taekwondo athletes achieved better results with their dominant leg in all variables, except for the Peak torque Extensor variable which indicates a better result achieved with the non-dominant leg (Table 1). The skewness values indicate that all variables have a positive sign, of which seven results have slightly more pronounced asymmetry values. This means that most of the results are poorly grouped; that is, there are one or several extremely high values in Taekwondo

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athletes. The total work non-dominant Flexor and Unilateral ratio dominant leg variables are closest to ideal symmetry. The values of kurtosis indicate that most of the results in Taekwondo athletes have a mesokurtic distribution, and the closest to the ideal distribution is variables Peak Torque dominant leg Extensor and Total work dominant Extensor.

Table 1 Descriptive Isokinetic Parameters of Taekwondo Athletes

Variables	Minimum	Maximum	Mean ± SD	Skewness	Kurtosis
Peak torque dominant leg Extensor	202.1	289.3	230.91±28.88	0.93	0.16
Peak torque non-dominant leg Extensor	199.6	309.9	236.10±35.34	0.9	0.62
Peak torque dominant leg flexor	114.5	180.1	138.13±21.44	1.03	0.4
Peak torque non dominant leg flexor	99.4	180.6	129.15±24.56	0.86	0.97
Total work dominant Extensor	793.7	1362.1	995.33±187.18	0.93	0.12
Total work non dominant Extensor	763.1	1231.9	968.35±143.95	0.6	-0.32
Total work dominant Flexor	491.1	878.5	637.17±139.69	0.97	-0.36
Total work non-dominant Flexor	437.4	734.6	582.55±97.72	0.13	-0.94
Unilateral ratio dominant leg	55.4	64.9	59.71±3.79	0.18	-1.91
Unilateral ratio non-dominant leg	48.9	63.9	54.58±4.91	0.46	-0.37

Track-and-field athletes also achieved better results with their dominant leg (Table 2). The only exception is the variable Total work dominant Flexor, in which a nearly identical result was recorded with dominant and non-dominant leg. Regardless of the positive or negative sign, skewness values in dicate that all but one result is within the allowed distribution. An exception is the extreme negative asymmetry of results in the Peak torque dominant leg Extensor variable in track-and field athletes. This suggests grouping better results than the arithmetic mean, that is, the presence of one or several extremely lower values. Peak torque non-dominant leg Extensor and Unilateral ratio non-dominant leg are close to ideal symmetry of 0.

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Table 2 Descriptive Isokinetic Parameters of Track-and-Field Athletes

Variables	Minimum	Maximum	Mean ± SD	Skewness	Kurtosis
Peak torque dominant leg Extensor	197.1	330.6	283.91±35.80	-1.59	3.95
Peak torque non-dominant leg Extensor	211.7	343.8	280.45±41.62	0.05	-0.92
Peak torque dominant leg flexor	113.6	169.7	148.07±19.03	-0.52	-0.91
Peak torque non dominant leg flexor	112.3	166.5	143.68±19.57	-0.31	-1.1
Total work dominant Extensor	892.9	1354.3	1142.37±139.69	-0.21	-0.45
Total work non dominant Extensor	936.5	1347	1092.06±127.56	0.87	0.18
Total work dominant Flexor	533.5	744.4	652.48±74.02	-0.6	-0.87
Total work non-dominant Flexor	521.8	830.1	652.65±102.74	0.34	-1
Unilateral ratio dominant leg	45.3	60.4	52.43±5.56	0.18	-1.47
Unilateral ratio non-dominant leg	40.6	64.4	52.01±7.88	0.07	-0.75

Comparing the result of arithmetic means between two tested groups of athletes, it is evident that the variable Peak torque dominant leg Extensor in Taekwondo athletes has a lower value by 53 Nm compared to the value measured in track and-field athletes, or by 44.4 Nm in the variable Peak torque non-dominant leg Extensor. The peak torque dominant leg Flexor is slightly higher for track-and-field athletes by 9.9 Nm or 14.5 Nm for Peak torque non-dominant leg Flexor. The total work of dominant and non-dominant legs in extensors is higher in track-and-field athletes than in Taekwondo athletes (147 Nm and 123.7 Nm). The total work of the dominant and non-dominant legs in flexors measured in track-and-field athletes is also higher than measured values of Taekwondo athletes (15.3 Nm and 70.1 Nm).

Statistically significant differences between the two test ed groups of athletes are evident in the following variables (Table 3): Peak torque dominant leg Extensor ($p=0.002$), Peak torque non-dominant leg Extensor ($p=0.019$) and Unilateral ratio dominant leg ($p=.003$). A negative sign of the t-test in the variables Peak torque dominant leg Extensor and Peak torque non-dominant leg Extensor indicates a better power output values of the track-and-field athletes.

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Table 3 statistical table of variances

Variables	t	Df	Sig.
Peak torque dominant leg Extensor	-3.644	18	.002*
Peak torque non-dominant leg Extensor	-2.569	18	.019*
Peak torque dominant leg flexor	-1.096	18	0.287
Peak torque non-dominant leg flexor	-1.463	18	0.161
Total work dominant Extensor	-1.991	18	0.062
Total work non-dominant Extensor	-2.034	18	0.057
Total work dominant Flexor	-0.306	18	0.763
Total work non-dominant Flexor	-1.563	18	0.135
Unilateral ratio dominant leg	3.423	18	.003*
Unilateral ratio non-dominant leg	0.875	18	0.393
Legend: * $p<0.05$			

4. Conclusion

The results obtained with the isokinetic protocol in the treated groups of Taekwondo and track and field athletes are within the optimal values. Track and field athlete's better test-results are probably the result of the specificity of the structure of their motor movement and greater muscular work in training and competition. In track and field athlete's training, the mechanical work of the lower extremities is particularly pronounced, which involves performing high-speed and explosive movements, as well as very high engagement of the muscles of the upper leg (m. quadriceps femoris, m. biceps femoris, m. semitendinosus and m. semimembranosus). The results of this study indicate the presence of a low tendency for muscular asymmetry on both legs in track-and-field athletes.

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