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Differences of Explosive Strength in Judokas Medallists and Not Medallists

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ABSTRACT

This study aim to analyze the explosive lower body strength in medalists judokas and not medalists. A sample of 63 world-class judokas (athletes with medals in World Cups, Grand Slam, World Championships and Olympic Games - Top-Elite, n=30; and national team athletes who had participated in international competitions and hadn't obtained medals - Elite, n=33) were performed a squat jump (SJ) and countermovement jump (CMJ), according to the procedures reported by Monteiro et al. (2011). The results showed that while the peak of strength is similar between this studied judokas groups, the Top-Elite are the ones more optimized with increased recruitment of motor units and increased activation of the same units. It can be concluded that the nervous factors in highly trained judo athletes may be decisive for the podium. In other words, sports success (in judo) is related to the greater speed of execution.

KEYWORDS judo, squat jump without, countermovement jump, explosive strength.

Introduction

Judo is an Olympic sport where to perform lower body actions require a certain explosive strength determined as much for the movement of athletes by tatami as for the execution of technical entries, as for opposition to the opponent's actions.

According to Stone et al. (2003) and Schmidtbleicher et al. (1992), the most critical aspects of sports performance happen in a very short time period (250 ms), therefore athletes develop capabilities to produce greater amounts of force within this time, would reach to get a faster acceleration and higher speed. So it is understood that the possibility of applying more force in the shortest time possible when perform a particular act (either in arms or legs), is an attribute that can determine a success event at any time of a judo combat. However, the inability to evaluate quantitatively the explosive strength of lower limb with several specific combat judo movements, becomes necessary to use a test, although non-specific, to determine the motor pattern of manifestation on the strength in the lower limbs (Mansilla-Fernández, 2000; Fernández et al., 2008).

It is clear that manifestation of the explosive force in the lower limbs (e.g., without countermovement jump) result: (1) combining the contractile capacity, understood as the concentric action of the agonist muscles without the use of muscle stretch-shortening cycle - SSC (Gollhofer et al., 1987); and (2) the synchronization ability of the contraction of the fibers. However, it's currently accepted that the participation of the SSC increases the mechanical efficiency of the movements, that using followed eccentric muscle actions (immediately) by explosive concentric actions. This justifies the utility of expression elastic-explosive evaluation with recourse to countermovement jump (CMJ). The objective of this work is to analyze the levels of explosive lower body strength through the SJ and CMJ to observe differences between Top-Elite judokas and Elite judokas.

The study hypothesis is that the global elite judokas, whether not-medalists or medalists, not differ in the different forms of manifestation of the lower limb strength, that are reflected in purely concentric explosive action and in which are reflected the elastic-explosive eccentric-concentric actions. By other words, enunciated hypothesis establishes that the difference between a medalist judoka in World Cups, Grand Slam, World Championships and Olympic Games and non-medalist judokas in these competitions, are based on other variables that are not in any case related to the conditional aspect, and yes more linked to character technical-tactical elements and aspects of information processes.

Method

Participants

The study design was cross-sectional. Sixty-three judokas, from Portugal, Spain, Brazil, Tunisia and France judo national teams, participated voluntarily in this study and signed the permission form. The judokas have been distributed for two performance categories (independent variable): Top-Elite (n = 30; athletes with medals in World Cups, Grand Slam, World Championships and Olympic Games); and Elite (n = 33; national team athletes who had participated in international competitions and that they had not obtained medals). The two groups of judokas not present age differences (Top-Elite: 23.5±3.2 years; Elite: 22.6±2.9 years), Stature (Top-Elite: 1.77±0.06 m; Elite: 1.76±0.07 m) and body mass (Top-Elite: 79.17±15.08 kg; Elite: 73.27±9.09 kg).

Procedures and Tools

Data from athletes were collected on April 2010 (at lab, at the Strength Room from the High Performance Center of Lisbon and the Elite Center of Tunisia).

Study procedures and tools are reported elsewhere (Monteiro et al., 2011). Briefly, were considered two anthropometric measures (stature and body mass) and twelve relating variables to different indicators of vertical jumps (i.e., dependent variables). Therefore, in jump without countermovement (SJ) were registered: (1) jump height (cm); (2) Peak velocity (Vmáx; mŸs-1); (3) peak relative power (Pmáx; WŸkg-1); (4) Peak relative strength (Fmáx; NŸkg-1); (5) Production rate relative strength (TPF; NŸs-1Ÿkg-1). In the countermovement jump (CMJ; Figura 1) were registered: (1) jump height (cm);

(2) Peak velocity (Vmáx; mŸs-1); (3) Peak eccentric relative power (Pmáx Eccentric ;WŸkg-1); (4) Peak eccentric relative strength (Fmáx Eccentric; NŸkg-1); (5) Peak concentric relative power (Pmáx Concentric; WŸkg-1); (6) Peak concentric relative strength (Fmáx Concentric; NŸkg-1); and (7) Production rate relative strength (TPF; NŸs-1Ÿkg-1). Considering the height of the jumps SJ and CMJ elasticity index of each of the participants was calculated [Elasticity Index (%) = (CMJ-SJ) * 100/SJ].

Statistical analysis

The significance of the difference of the average values of the age, morphological variables, variables of force on jump without SJ, CMJ and elasticity index, between the two groups of athletic performance were evaluated with the Student t-test for independent samples. To evaluate the expression of different strength parameters in vertical jump (SJ vs. CMJ) in the two groups of judokas, was used the Student t-test for matched samples. The SPSS Software (v. 17; SPSS Inc, Chicago, IL) was used, and a probability of .05 in parametric analysis was considered.

Results

In SJ, no significant differences were observed in the (1) jump heights, (2) peak velocity, (3) peak power and (4) peak strength. Nevertheless, the rate of force development (RFD) on the Top-Elite group has an average of 312.07 NŸs-1Ÿkg-1 and on the Elite 238.75 NŸs-1Ÿkg-1, being highly significant differences between the two groups. Results are presented in Table 1.

Table 1. Average values (M), standard deviation (SD) and standard error of the average (ETM) of strength variables, resulting from the execution of the exercise jump without countermovement (SJ), in both groups (Top-Elite vs. Elite).

	Top-Elite (n=30)		Elite (n=33)		P-value	
	M±SD	ETM	M±SD	ETM		
Jump height (cm)	39.51±4.95	0.90	39.85±4.62	0.80	.780	NS
Vmáx (mŸs-1)	2.99±0.30	0.06	2.98±0.37	0.06	.899	NS
Pmáx (WŸkg-1)	34.30±7.49	1.37	35.59±5.81	1.01	.443	NS
Fmáx (NŸkg-1)	15.34±3.58	0.65	15.23±2.68	0.47	.886	NS
TPF (NŸs-1Ÿkg-1)	312.07±103.25	18.85	238.81±75.55	13.15	.002	**

No significant differences were observed between the two groups in the variables studied in the CMJ. The results are presented in Table 2.

Table 2. Average values (M), standard deviation (SD) and standard error of the average (ETM) of strength variables, resulting from the execution of the exercise countermovement jump (CMJ), in both groups (Top-Elite vs. Elite).

	Top-Elite (n=30)		Elite (n=33)		P-value	
	M±SD	ETM	M±SD	ETM		
Jump height (cm)	41.18±5.77	1.05	41.77±6.59	1.15	.709	NS
$V_{máx}$ (mŸs^{-1})	3.19±0.37	0.07	3.27±0.37	0.06	.380	NS
$P_{máx}$ Eccentric (WŸkg^{-1})	12.19±4.39	0.80	13.97±5.37	0.93	.156	NS
$F_{máx}$ Eccentric (NŸkg^{-1})	15.29±3.91	0.71	15.78±3.52	0.61	.608	NS
$P_{máx}$ Concentric (WŸkg^{-1})	29.02±6.61	1.21	30.78±6.79	1.18	.300	NS
$F_{máx}$ Concentric (NŸkg^{-1})	15.21±3.42	0.63	15.33±2.48	0.43	.873	NS
TPF (NŸs^{-1}Ÿkg^{-1})	368.88±108.98	19.90	355.04±83.61	14.55	.572	NS

In the elasticity index the Top-Elite and Elite groups were very similar (p=0.956), and revealing a profile of elastic-explosive strength in both groups of judokas under overall. In both groups (Top-Elite and Elite), but more accentuated in the Elite group, were observed significant statistically differences between the SJ and the concentric phase of the CMJ in: jump height (SJ>CMJ), peak velocity (SJ<CMJ), peak power (SJ>CMJ) and RFD (SJ<CMJ). Also noteworthy that we observed between SJ and CMJ significant statistically differences in the variable peak strength (in the two groups of judokas). Results are presented in Table 3.

Table 3. Expression of different strength parameters of the concentric phase, resulting from the execution of the exercises jump without countermovement (SJ) vs. countermovement jump (CMJ), in both groups of athletic performance (Top-Elite vs. Elite).

	Top-Elite (n=30)		Elite (n=33)	
	r	P-value	r	P-value
Jump height (cm)	.046	*	.009	**
Vmáx (mŸs-1)	.018	*	.001	**
Pmáx (WŸkg-1)	.006	**	<.001	***
Fmáx (NŸkg-1)	.856	NS	.857	NS
TPF (NŸs-1Ÿkg-1)	.038	*	<.001	***

Discussion

We validated that in most of the studied variables (ie, the jump height, peak velocity, peak relative power and relative peak force) did not show statistically significant differences between the two groups of judokas. It has been described in the literature, that sports-called "power" present values jump height greater than 40 cm, while the disciplines of "resistance" may show less than 30 cm (González-Badillo & Gorostiaga, 1995). In the data provided on combat sports and some sports equipment, the values are between 30 cm and 40 cm (Bosco, 1994). In a study by Monteiro et al. (2011) were observed values related to SJ of 39.25 cm (SD=5.64), similar to our study, however, lower than the junior judokas with 42.73 cm (SD=7.26), and not judokas, team sport members 48.58 cm (SD=9.12). These results might have a logical explanation from the point of view of competition specificity of the studied disciplines. The judokas target is to move their center of gravity as low as possible as long as allow them to act explosively, team sports athletes, especially basketball players or volleyball players, they train in order to raise the center of gravity to improve their chances of success in their reference sports. The CMJ results obtained by the judokas of our study are higher than the 36.5 cm and 36.4 cm achieved by judokas and wrestlers respectively (Mansilla et al., 2000).

Other data has been found in the literature about the jumping ability in judo, but the comparison is difficult due to the use of different methods to test this capability, i.e.: (1) Tumilty et al. (1986) presented values of 52 cm for judokas of the Australian national team; (2) Thomas et al. (1989) Canadian national judo medalists, describes values of 55 cm; and (3) Claessens et al. (1986) provide, in their work with the Belgian judo team, values of 52 cm. In some of these studies, the CMJ was employed as a measure, but the jump test Detent or Sargent. However, studies using the same technology as ours, Force Platform, the results are more similar, i.e.: (1) Monteiro et al. (2011) with judokas seniors (41.20±6.71 cm), however, the junior judokas (44.50±5.86 cm) and no judokas, surf sports equipment (55.11±10.70 cm) submit higher values; (2) Kurt et al. (2010) describes values of 40.4cm (SD=3.5 cm); (3) Monteiro et al. (2009) with Portuguese judoka (43.8±5.4 cm); (4) Chaouachi et al. (2009) with athletes from Tunisia (42±3.2 cm); and (5) Busko et al. (2008) and Detanico et al. (2011), with judokas, had higher values (respectively 50.2±4.8 cm and 45.4±3.1cm).

Typically, the height reached in the CMJ is higher than in the SJ as reflected in our results. In fact, it's clearly visible the use of CMJ elastic energy generated during bending - Extension or stretching. However, the average values given in this quality are very similar in the two groups studied related to performance, revealing a profile judokas elastic force in general is low. In our study the rate of elasticity obtained in the two groups was very similar (Top-Elite, 4.5% vs Elite, 4.65%), and lower than the results presented by (1) Zaggelidis et al. (2012) with judo athletes trained and untrained (11.4% and 7.2%, respectively), and (2) Mansilla-Fernández et al. (2000) judokas and athletes Leones combat (10.82±1.05% and 9.55±1.07%, respectively). Values are given this quality varies between 10% and 20% (Bosco, 1982).

Hirose et al. (1998), study of judokas and throwers concluded that the leg strength of judokas was significantly lower than the throwers. Wit et al. (1993) found that Elite judokas of both sexes had higher values for maximum strength and power in the flexors and extensors of the legs, than the ones published for endurance athlete and lower than sprinters, additionally, regarding the extensors of the legs, judokas have a characteristic profile of isometric force.

There are few references on the evolution of lower body power in Judo and explosive jumps as SJ and CMJ, particularly the strength force platform. According to our results, the maximum power, average, eccentric, concentric and relative power in both jumps are much more similar, not differentiating judoka Top-Elite from Elite judoka in these variables. Although few studies have been conducted in Judo, with this methodology (force platform), found a study by Busko et al. (2008), with male judokas with high relative power values of 40.34±6.46 WŸkg-1. Monteiro et al. (2011) showed in their study on seniors judokas values of 29.63±6.29 WŸkg-1, on juniors judokas 31.58±6.64 WŸkg-1 and in team sports athletes, 40.19±7.27 WŸkg-1, concluding that team sports athletes have higher values of concentric power in the lower body. In another, Monteiro et al. (2012) observed that the juniors judokas in relation to seniors athletes showed significant differences in eccentric relative power (Juniors, 11.5±5.9 WŸkg-1 vs. Seniors, 13.5±3.9 WŸkg-1).

Power differences with higher values in the SJ of our study is explained by the explosive force without pre stretch, which depends heavily on the contractile capacity, i.e, dynamic isometric maximum strength, and its manifestation is based on the ability to develop a large force by the recruiting and more instant synchronization of motor units (González- Badillo & Gorostiaga , 1995). In SJ, the RFD of Top- Elite group has values, on average, significantly higher than the Elite group. If we analyze the variable peak velocity in CMJ, we note that the group Top-Elite is faster and than the Elite group. It can be conclude that the group of Top-Elite manages to produce at a higher rate stronger than the Elite group. These results suggest that sports success is related to the greater speed of execution. However, although there is no statistically significant difference between groups, the Top- Elite group presents higher values in the variable RFD Relative.

As we noted in the lower body, there is also an agreement on the utmost importance of the explosive force in Judo, however, it is very difficult to find studies that provide us values of explosive force expressed in NŸs-1 characterizing the legs profile in a group of excellent athletes (García-García, 2012). However, Monteiro et al. (2011) found significant differences between SJ Judo Juniors (218.20±81.81 NŸs-1Ÿkg-1) and Seniors (280.14±94.75 NŸs-1Ÿkg-1), and sports team athletes (299.03±97.07 NŸs-1Ÿkg-1), but no significant differences were observed between all groups in CMJ (Senior Judo, 361.24±105.31 NŸs-1Ÿkg-1; Junior Judo, 350.30±93.84 NŸs-1Ÿkg-1; sports team, 367.28±78.80 NŸs-1Ÿkg-1). McLellan et al. (2011) in their study with physically active subjects, recreational sports members, Rugby and Football, found values CMJ of 10728±4014 NŸs-1and SJ of 9718±3380 NŸs-1, and Kawamori et al. (2006), with weightlifting obtained values CMJ and SJ very different from those obtained with our judokas (CMJ, 12093±1273.3 NŸs-1vs. SJ, 9718±3380 NŸs-1). However, it is stressed that these values should be viewed with caution due to possible different methodologies and technologies used.

The RFD variability in an individual, however, is very likely to be caused by changes in the neural impulse, which have significant influence on the development of strength during the first phase (0-50 ms) and middle phase (50-200 ms) application of force (Aagaard et al., 2002). However, because the RFD in jumping almost always occurs within 250 ms, may suggest that RFD is more important than maximum force in jump height (Cronin & Sleiver, 2005). Furthermore it appears that the maximum RFD and activation of the motor units in maximum shrinkage efforts are relatively constant on a person and generally is not influenced by the external load or by the speed of movement (Sale, 1991).

Conclusion

It indicates that the main prerequisite for the success of Top-Elite judokas, is to have a higher peak in RFD actions do not involve the participation of muscle stretch shortening cycle (relative to the actions of the SSC, this prerequisite not verified). Actually, with the peak of similar strength between judokas of the two groups, the muscle variables do not justify the observed differences, so it can be said that the judokas TOP WORLD (top-elite) are more optimized in neural terms, translated into a greater recruitment of motor units (MU) or more frequent activation of MU, or both. Thus, the results suggest that the nervous factors in highly trained judo athletes (remember that all participants are world-class athletes) may be decisive for the podium. However, no differences in the variables that characterize the CMJ, emphasizes the relevance of further study as a future line of research, the complex workings of the SSC in the lower body musculature judokas worldwide (Narazaki et al., 2007), namely how to behave in situations of fatigue (i.e, strength of the explosive force).

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