ESTABLISHING FREQUENCY SPEED OF KICK TEST CLASSIFICATORY TABLES IN MALE AND FEMALE TAEKWONDO ATHLETES

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Abstract:

Recently, the Frequency Speed of Kick Test ($FSKT_{10s}$) and its intermittent version (5 x 10s/10s intervals, $FSKT_{mult}$) have been used to assess the physical fitness of taekwondo athletes, but no classificatory normative table was found for these tests. Thus, the aim of this study was to present two normative classificatory tables for both the $FSKT_{10s}$ and $FSKT_{mult}$ for male and female taekwondo athletes. One hundred fifteen male taekwondo athletes (median [interquartile range] age: 20 [17;27] years; body height: 175 [170;182] cm; body mass: 67 [60;78] kg; experience time: 6 [3;10] years) and seventy female taekwondo athletes (median [interquartile range] age: 19 [(17;24] years; body height: 162 [157;169] cm; body mass: 57 [50;64] kg; experience time: 5 [3;9] years) volunteered to participate in the study. Their skills ranged between 4th *gub* and 2nd *dan*. All the participants were evaluated during their competitive period and were familiarized with this test. The classificatory tables are presented in five scales, as follows: excellent (≥95th percentile); good (≥75th percentile up to 94th percentile); regular (≥25th percentile up to 74th percentile); poor (≥6th percentile up to 24th percentile); and very poor (≤5th percentile). The classificatory tables for $FSKT_{10s}$ and $FSKT_{mult}$ can help coaches and strength and conditioning professionals to classify performance and monitor the physical fitness of taekwondo athletes in different stages of training and during the competitive season.

Key words: *specific test, combat sport, field test, physical performance*

Introduction

Taekwondo is a complex striking combat sport that requires highly developed physical, physiological, technical, tactical and psychological characteristics of athletes for their successful competitive performance (Bridge, Santos, Chaabène, Pieter, & Franchini, 2014). In the Olympic Games, male and female taekwondo athletes compete in four weight divisions (males: -58 kg, -68 kg, -80 kg and +80 kg; females: -49 kg, -57 kg, -67 kg and +67 kg). Match simulation investigations reported a predominance of oxidative pathway, followed by ATP-PCr and glycolytic energy systems, while the main high-intensity actions were supplied by ATP-PCr energy system (Campos, Bertuzzi, Dourado, Santos, & Franchini, 2012; Hausen, et al., 2017). Thus, it is considered that a high ATP-PCr energy system recruitment and the ability to perform successive high-intensity actions are key elements for successful performance in taekwondo matches (Bridge, et al., 2014). In a match, athletes perform brief periods of high-intensity (1.3 s) and the attack time and the number of attacks are higher in -58 kg weight category compared to +80 kg male taekwondo athletes (Santos, Franchini, & Lima-Silva, 2011), suggesting different physiological adaptations modulated by weight category.

Despite the relevance of sport-specific evaluation to monitor and to prescribe training (Hoffman, 2012; Kraemer, Comstock, Clark, & Dunn-Lewis, 2012), non-specific tests such as one-repetition

maximum, sit-and-reach, Wingate and running maximal graded exercise tests have been frequently used to evaluate taekwondo athletes' fitness (Bridge, et al., 2014; Pieter, 1991). These tests are performed using different body positions, muscle actions and temporal characteristics than those observed during taekwondo training and competition, thus limiting their value to the taekwondo training process. In an attempt to measure and assess the physical fitness of taekwondo athletes using specific actions, some tests have been developed (Araujo, et al., 2017; Sant'Ana, et al., 2014; Sant'Ana, Franchini, Murias, & Diefenthaeler, 2019; Santos, & Franchini, 2018; Santos, & Franchini, 2016; Santos, Herrera-Valenzuela, Mota, & Franchini, 2016; Santos, Loturco, & Franchini, 2018; Santos, Valenzuela, & Franchini, 2015). Among these tests, the Frequency Speed of Kick Test ($FSKT_{10s}$) is the only that is mainly related to the ATP-PCr energy system, due to its all-out nature and short duration (10 s), and that resulted in a derived version which is intermittent (5 x 10 s/10 s intervals, $FSKT_{mult}$). Moreover, both tests can be easily applied in the taekwondo training facility and do not require sophisticated equipment (Santos & Franchini, 2018; Santos & Franchini, 2016; Santos, et al., 2018). Additionally, the FSKT is sensitive enough to identify acute (Santos, et al., 2015) and long-term performance changes (Santos & Franchini, 2016), and has been reported to properly discriminate international/national and state/regional female taekwondo athletes' performance (Santos & Franchini, 2018). However, no classificatory table for the FSKT was found. Thus, the aim of this study was to develop two classificatory tables for FSKT, one for males and another for females, as an instrument to help coaches and strength and conditioning professionals to improve taekwondo athletes' classification, as well as the process of training monitoring and prescription. As taekwondo athletes are classified in weight categories, this study also compared the performance in these two tests to verify if the classification can be used for the different Olympic weight divisions.

Methods

Sample

One hundred fifteen male taekwondo athletes (by the competitive level: regional n=24; state n=44; national n=26; international n=21; by the Olympic weight category (for two male athletes the body mass was not measured): under 58 kg n=21; under 68 kg n=41; under 80 kg n=33; over 80 kg n=18) volunteered to participate in the study (median [interquartile range] age: 20 [17;27] years; body height: 175 [170;182] cm; body mass: 67 [60;78] kg; experience time: 6 [3;10] years). Their taekwondo skills ranged between 4th *gub* and 2nd *dan*. Seventy female taekwondo athletes (by the competitive level: recreational n=14; regional n=8; state n=20; national n=23; international n=5; by the Olympic weight category: under 49 kg n=16; under 57 kg n=22; under 67 kg n=19; over 67 kg n=13) volunteered to participate in the study (median [interquartile range] age: 19 [17;24] years; body height: 162 [157;169] cm; body mass: 57 [50;64] kg; experience time: 5 [3;9] years). Their taekwondo skills ranged between 4th *gub* and 1st *dan*. All the participants were evaluated during their competitive period and were familiarized with this test. The test was conducted by an experienced evaluator (the first author of the study). Prior to testing, the athletes were informed of the procedures, including the possible risks involved, and signed an informed consent form. They were free from any injury or neuromuscular disorder. The research was approved by the Institutional Ethics Committee.

Experimental procedures

This was a descriptive study as subjects were submitted to FSKT and FSKTmult once. All the athletes involved in this study had experience with testing procedures. The tests were executed in each athlete's training center. Before the testing session, a warm-up was conducted, composed of running (self-selected jogging for 5-min), stretching (4 exercises for 15-s, below the discomfort threshold) and low-intensity kicks and punches (4 x 10 repetitions of low-intensity actions with ~90-s intervals, totaling 5-min), totaling approximately 15 minutes.

Performance assessment

Frequency Speed of Kick Test. The FSKT is 10 s long, and during its execution each athlete is placed in front of the stand bag equipped with a simple trunk taekwondo protector. After a command, the athlete performs the maximal number of kicks possible, alternating the right and the left leg. The turning kick, known as *Bandal Tchagui*, is used during the test (Santos & Franchini, 2018; Santos & Franchini, 2016; Santos, et al., 2018; Santos, et al., 2015). $FSKT_{10s}$ presents a very high intraclass correlation coefficient between test-retest (ICC = .95). The test and retest coefficient of variation was 2.9%.

Frequency Speed of Kick Test Mult. The same procedures adopted in the $FSKT_{10s}$ are used during the $FSKT_{mult}$. Briefly, five FSKTs with a 10-s rest interval between repetitions are executed. Performance is determined by the total number of kicks in each set, the total number of kicks in five sets, and the kick fatigue index (Santos & Franchini, 2018; Santos & Franchini, 2016; Santos, et al., 2016; Santos, et al., 2018). $FSKT_{mult}$ presented a mean intraclass correlation coefficient (ICC) = .85 between test and retest. The mean test and retest coefficient of variation was 3.9%.

Kick Decrement Index. Kick decrement indicates performance decrease during the test. To

calculate the kick decrement the number of kicks applied during the multiple FSKT is considered. The equation takes into account the results of all FSKT sets (Equation) (Girard, Mendez-Villanueva, & Bishop, 2011).

$$\text{KICK DECREMENT INDEX (\%)} = \left[1 - \frac{(FSKT1+FSKT2+FSKT3+FSKT4+FSKT5)}{\text{Best FSKT SET X Number of Sets}}\right] \times 100 \quad \text{(Equation)}$$

Video analysis. Kinovea software (Kinovea®, Version 0.8.15) was used to count the kicks applied during the FSKT. If the athlete started a kick before completing 10 s, but reached the target only after 10 s period has elapsed, the kick was not considered valid.

Statistical analysis

Seven variables were considered ($FSKT_{10s}$, $FSKT_{mult}$ – $FSKT_1$, $FSKT_2$, $FSKT_3$, $FSKT_4$, $FSKT_5$ and $FSKT_{total}$). A five-point scale using percentile values was adopted to establish the following categories for each variable: excellent (≥95th percentile); good (≥75th percentile up to 94th percentile); regular (≥25th percentile up to 74th percentile); poor (≥6th percentile up to 24th percentile); and very poor (≤5th percentile) after the analysis of data distribution to classify variables. The Kolmogorov-Smirnov test (D_{K-S}) was used to assess data normality, which was not confirmed. The level of significance was set at 5%. To compare weight categories the Kruskal Wallis test and the Mann-Whitney test with Bonferroni correction were used. The level of significance to *post-hoc* was at .0083%. The effect size (ESr) was calculated using the following formula: $r = Z/\sqrt{N}$ (Rosenthal, 1991) and classified using the following scale (Hopkins, 2006): ≤0.2 (trivial); >0.2 – 0.6 (small); >0.6 – 1.2 (moderate); >1.2 – 2.0 (large); >2.0 (very large).

Results

The main results of $FSKT_{10s}$ and $FSKT_{mult}$ are presented in Tables 1 to 4 for males and females respectively.

Male taekwondo athletes

Male classificatory table for the Frequency Speed of Kick Test is presented in Table 1 and performance in FSKT by weight categories is presented in Table 2. No difference was observed considering weight categories for $FSKT_{10s}$ ($H[3] = 3.74$, $p>.05$), $FSKT_1$ ($H[3] = 5.10$, $p>.05$), $FSKT_2$ ($H[3] = 4.73$, $p>.05$), $FSKT_5$ ($H[3] = 5.13$, $p>.05$), $FSKT_{total}$ ($H[3] = 6.89$, $p>.05$). Despite a significant difference in $FSKT_3$ ($H[3] = 9.49$, $p = .02$) established by Kruskal-Wallis, no differences were identified in the *post-hoc* (-58 kg vs -68 kg: $U = 422.00$, $p=.90$; -58 kg vs -80 kg: U =

Table 1. Male classificatory table for the Frequency Speed of Kick Test (n=115)

		FSKTmult						
Classification	$FSKT_{10s}$ (kicks)	$FSKT_1$ (kicks)	$FSKT_2$ (kicks)	$FSKT_3$ (kicks)	$FSKT_4$ (kicks)	$FSKT_5$ (kicks)	$FSKT_{total}$ (kicks)	KDI (%)
Excellent	≥24	≥24	≥23	≥22	≥20	≥20	≥108	≤3.3
Good	22-23	22-23	21-22	20-21	19	19	97-107	3.4-5.9
Regular	18-21	19-21	18-20	17-19	16-18	16-18	85-96	6.0-11.4
Poor	17	18	17	16	15	15	80-84	11.5-19.9
Very poor	≤16	≤17	≤16	≤15	≤14	≤14	≤79	≥20.0

Note. FSKT: Frequency Speed of Kick Test; KDI: Kick Decrement Index.

Table 2. Male performance in the Frequency Speed of Kick Test divided by weight category (n=113); data are presented as median and (interquartile range)

		FSKTmult						
Weight Category	$FSKT_{10s}$ (kicks)	$FSKT_1$ (kicks)	$FSKT_2$ (kicks)	$FSKT_3$ (kicks)	$FSKT_4$ (kicks)	$FSKT_5$ (kicks)	$FSKT_{total}$ (kicks)	KDI (%)
-58 kg	20 (19;22)	21 (19;23)	19 (18;21)	19 (18;20)	18 (17;19)	17 (16;19)	93 (88;101)	9.5 (8.1;12.2)
-68 kg	20 (18;22)	19 (19;22)	19 (18;21)	18 (18;20)	18 (17;19)	17 (16;19)	91 (87;100)	7.1 (4.5;10.3)
-80 kg	19 (18;21)	20 (18;21)	19 (18;20)	18 (17;19)	17 (16;18)	16 (16;18)	89 (85;95)	8.6 (6.0;11.7)
+80 kg	19 (19;21)	19 (18;21)	18 (17;20)	18 (17;19)	17 (16;18)	16 (16;18)	88 (83;95)	7.1 (5.5;12.1)

Note. FSKT: Frequency Speed of Kick Test; KDI: Kick Decrement Index.

Table 3. Female classificatory table for the Frequency Speed of Kick Test (n=70)

Classification	$FSKT_{10s}$ (kicks)	FSKTmult						
		$FSKT_1$ (kicks)	$FSKT_2$ (kicks)	$FSKT_3$ (kicks)	$FSKT_4$ (kicks)	$FSKT_5$ (kicks)	$FSKT_{total}$ (kicks)	KDI (%)
Excellent	≥22	≥22	≥21	≥20	≥20	≥19	≥97	≤1.2
Good	21	21	20	19	19	18	92-96	1.3-3.4
Regular	17-20	18-20	17-19	16-18	16-18	15-17	82-91	3.5-10.5
Poor	16	17	16	15	15	14	73-81	10.6-14.4
Very poor	≤15	≤16	≤15	≤14	≤14	≤13	≤72	≥14.5

Note. FSKT: Frequency Speed of Kick Test; KDI: Kick Decrement Index.

Table 4. Female performance in the Frequency Speed of Kick Test divided by weight category (n=70); data are presented as median and (interquartile range)

Weight Category	$FSKT_{10s}$ (kicks)	FSKTmult						
		$FSKT_1$ (kicks)	$FSKT_2$ (kicks)	$FSKT_3$ (kicks)	$FSKT_4$ (kicks)	$FSKT_5$ (kicks)	$FSKT_{total}$ (kicks)	KDI (%)
-49 kg	18 (17;20)	18 (17;20)	18 (17;19)	17 (16;18)	17 (15;18)	16 (15;17)	85 (82;90)	6.4 (5.1;8.3)
-57 kg	19 (18;20)	19 (18;20)	18 (18;19)	18 (17;18)	17 (16;18)	17 (16;17)	88 (82;90)	8.3 (3.2;10.5)
-67 kg	19 (17;20)	19 (17;20)	18 (17;20)	17 (16;18)	17 (16;18)	16 (16;17)	87 (82;93)	7.8 (3.5;9.5)
+67 kg	18 (17;20)	19 (18;20)	18 (17;19)	17 (16;18)	16 (15;17)	15 (15;16)	85 (80;89)	10.0 (3.4;11.1)

Note. FSKT: Frequency Speed of Kick Test; KDI: Kick Decrement Index.

227.50, p=.31; -58 kg vs +80 kg: U = 130.50, p=.10; -68 kg vs -80 kg: U = 445.00, p=.01; -68 kg vs +80 kg: U = 253.00, p=.52 and -80 kg vs +80 kg: U = 295.50, p=.98). Only performance during $FSKT_4$ differed between weight categories. The athletes from the -68 kg performed better (U = 403.50, p = .003, ESr = -.35 [small]) than the athletes from -80 kg. KDI was smaller (U: 243.50, p=.005, ESr = -.35 [small]) for the -58 kg compared to the -68 kg weight category.

Female taekwondo athletes

Female classificatory table for the Frequency Speed of Kick Test is presented in Table 3 and performance in FSKT by weight category in Table 4. No difference was observed considering weight categories for $FSKT_{10s}$ (H[3]= .65, p>.05), $FSKT_1$ (H[3]= 2.10, p>.05), $FSKT_2$ (H[3]= 1.29, p>.05), $FSKT_3$ (H[3]= 1.83, p>.05), $FSKT_4$ (H[3]= 2.60, p>.05), $FSKT_5$ (H[3]= 7.16, p>.05), $FSKT_{total}$ (H[3]= 2.49, p>.05), and KDI (H[3]= 1.66, p>.05).

Discussion and conclusion

The main purpose of the present study was to develop two classificatory tables for the Frequency Speed of Kick Test, one for males and another for females. Two tests were used, $FSKT_{10s}$ and $FSKT_{mult}$, and kicks by set and total kicks were used to create the classificatory tables. No differences were generated in FSKT variables regarding weight categories for the female group. For males, as only $FSKT_4$ and KDI differed between weight categories, caution is needed when analyzing athletes from different weight categories for these two variables. However, for all the other variables, male athletes from different weight categories can be properly classified.

This is the first study to present taekwondo-specific classificatory tables for both male and female athletes. A previous study conducted with female taekwondo athletes described the difference in FSKT performance between the groups divided by competitive levels (national/international vs regional/state) (Santos & Franchini, 2018). Additionally, until the present moment no description in performance of FSKT was reported among male taekwondo athletes of different competitive levels.

The classificatory tables presented here can help coaches to monitor their athletes' training evolution, classify their performance for selection purposes and monitor short-term variation in performance in intensified or tapering training phases. Previous studies reported FSKT performance improvement after acute complex exercise (Santos, et al., 2015) and after eleven weeks of taekwondo-specific plus strength and conditioning training (Santos & Franchini, 2016). Another possible application is the

rehabilitation process, i.e., coaches can compare athletes' FSKT regular results with performance after the rehabilitation to establish the progress to more complex taekwondo-specific exercises according to the athletes' physical fitness.

Need analysis is a key element in training organization, and it involves metabolic, biomechanical and injury profiles (Hoffman, 2012; Kraemer, et al., 2012; Rhea & Peterson, 2012). The FSKT presents both metabolic (i.e., it is intense and the intermittent protocol can be used) and biomechanical (i.e., the technique used is the main technique applied during high-level taekwondo competitions) specificity. Additionally, these two FSKT protocols can be easily applied by the athletes` coaches, they do not require the use of expensive material, can be applied in the athlete's training site, and as it involves taekwondo-specific actions, athletes feel more motivated to execute them compared to other non-specific tests. Moreover, the FSKT normative table can be used to classify performance of male and female competitors from different weight categories as only two variables differed between weight categories and the magnitude of these differences was quite small. Future studies should be conducted to classify the FSKT performance of athletes from different age groups.

Based on the classificatory tables presented, it is possible to classify taekwondo-specific anaerobic fitness and high-intensity intermittent performance, monitor the training progress and establish goals for taekwondo athletes from different weight categories, providing coaches and strength and conditioning professionals with an important tool to objectively deal with these aspects that are considered key elements during training organization.

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