Reliability of karate-specific test and its associations with T-test and change of direction

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Abstract

Background and Study Aim: There is a lack of the test for evaluation sport-specific movements in karate. The aim of this study was empirical argumentation about reliability of karate-specific test (KSAT) and its associations with T-test and change of direction (CoD).

Material and Methods: The decomposition of the project goal into research tasks was based on three procedures: 1) to evaluate within-session reliability of newly introduced KSAT; 2) investigate correlations with CoD, T-test and training years; 3) to assess differences in tests performed on the preferred and non-preferred side/guard. The research was conducted among 39 elite karatekas (age: 19.3 ±0.1 year; training years' experience: 11.5 ±4.7). Participants performed the CoD test at 90° and 180°, T-test, and short and long KSAT.

Results: Our results showed good to excellent $ICC_{2.1}$ values and acceptable CV (<10%) and TE values for all agility tests. There was significant positive moderate correlation between the time in short KSAT in non-preferred guard and T-test. A greater number of moderate to large correlations were seen between long KSAT in non-preferred guard and agility test. Significant negative moderate to large correlations were found between training years and KSAT time. There were no significant differences between agility tests or KSAT comparing the preferred or non-preferred sides. The newly introduced KSAT test was shown as a potentially useful tool for evaluating the speed of movement in karate guard position. Moreover, correlations between training years and KSAT performance confirmed its specificity and relevance for measuring the performance of specific karate movement.

Conclusions: Coaches and practitioners can use the KSAT test for evaluating the movement of karatekas in preferred and non-preferred guards to detect weak points of movement.

Key words: agility • guard • kumite • movement • speed

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Reliability – an integral part of validity is reliability, which pertains to the consistency, or repeatability, of a measure. A test cannot be considered valid if it is not reliable. In other words, if the test is not consistent—if you cannot depend on successive trials to yield the same results—then the test cannot be trusted [19, p. 197]]

Agility – *noun* a combination of physical speed, suppleness and skill [20].

Movement – by moving, space is conquered and distance is maintained, and if necessary, evasion from the direction of the eventual attack is achieved.

Tactics – *plural noun* the art of finding and implementing means to achieve immediate or short-term aims [20].

Technique– *noun* a way of performing an action [20].

Tatami – traditional straw mats used in *jūdō* and *aikidō* training halls [21].

INTRODUCTION

Karate is one of the most popular combat sports in the World. Its popularity and attention from national and international sports organizations are growing after the official representation of karate kumite at the 2020 Olympic Games in Tokyo. Kumite is a karate fight that consists of freely chosen techniques for attacking or defending against the opponent [1].

For successful performance in karate kumite, a high level of fitness and developed technical and tactical skills are required. Most of the movement in karate kumite is composed of forward and backward movements, sidesteps and hopping. These movements are mostly performed at low-intensity, while different techniques of attack and defense are performed at maximum intensity [2]. Beneke et al. [2] reported that in a typical kumite match athletes perform 16.3 ±5.1 s of high intensity actions during the whole 2- or 3-min match. Although most of kumite match is performed at aerobic energy level (77.8 ±5.8 %), short-lasting high-intensity techniques are supported by anaerobic alactic (16.0 ±4.6 %) and anaerobic lactic metabolism (6.2 ±2.4 %).

In professional sport testing of athlete's capabilities should be focused on specific demands of the sport. There is a lack of karate-specific tests and protocols in the literature that could help coaches and karatekas in their training regime. To this end, only a few tests for evaluating specific karate capabilities have been developed. For example, Nunan [3] developed a reliable aerobic fitness test for competitive karate practitioners using a protocol simulating attack strikes with the decrease in recovery time. Moreover, Chaabene et al. [4] designed a reliable karate specific test suitable for field assessment of aerobic fitness of karate practitioners, consisted of sequential sets of straight punch and roundhouse kick combinations on a heavy punch-kick bag. Furthermore, Tabben et al. [5] validated a similar test protocol which consisted of sequential sets composed of two attacks to heavy punch bag on tatami until exhaustion. These previous studies and tests mainly evaluated aerobic and anaerobic metabolism and different physiological parameters during specific karate actions.

One of the important determinants for successful performance in karate kumite is the ability to move quickly and efficiently in various directions on a mat surface during attacking and defending. It was already noted that karate performance relies on the ability to perform sport-specific actions at high movement velocities [6]. In addition to kicking and punching, fast leg movement in kumite guard is required, during which appropriate leg power movement techniques are needed. Moreover, Blažević et al. [7] identified that speed and power were the most important underlying determinants of technical and fighting efficiency in karatekas. In their case, the speed of movement in karate guard was measured with side steps and movement in a triangle, however, these tests are poorly described and the reliability was not reported.

In general, there is a lack of reliable testing protocols for simple assessment of specific karate abilities, especially in terms of speed and agility. Therefore, in our study we try to recommend a new karate-specific agility test (KSAT) for measuring movement speed in karate guard in different directions. Moreover, the KSAT test allows us to compare karate movement speed in preferred and non-preferred guard.

We hypothesized that the within-session reliability of KSAT will be good to excellent. The second aim of our study was to investigate KSAT correlations with commonly used agility tests in sport science (90° and 180° Change of direction test (CoD), T-test) and with training years of karatekas. We hypothesized that only low-moderate correlations will be calculated between KSAT and other agility tests because of different characteristics of these movements.

The aim of this study was empirical argumentation about reliability of karate-specific test and its associations with T-test and change of direction.

The decomposition of the project goal into research tasks was based on three procedures: 1) to evaluate within-session reliability of newly introduced KSAT; 2) investigate correlations with change of direction (CoD), T-test and training years; 3) to assess differences in tests performed on the preferred and non-preferred side/guard.

Moreover, we hypothesized: "A" that KSAT performance and years of training will be in a moderate negative correlation; "B" that KSAT performance would be significantly better in preferred guard compared to non-preferred guard.

MATERIAL AND METHODS

Participants

Thirty-nine elite karatekas who volunteered to the study (Table 1). Participants were included into the study if they trained karate at least for five years at least twice per week. Participants with any lower limb injuries, neurological disorders and low back pain in the past six months were excluded from the study. The leg preference for CoD tests was determined by asking participants: "Which leg do you prefer when performing unilateral jumping movements". The preferred guard was determined by the question: "Which is your preferred front leg during a kumite match?". All the participants (or their parents/guardians – in case participants were under the age of 18) were informed about the testing procedures and provided informed consent prior to study participation.

Participants were instructed to avoid intense physical activities at least 48 h prior to testing. Slovenian Medical Ethics Committee (approval no. 0120-99/2018/5) approved the experiment which was conducted according to the Declaration of Helsinki guidelines.

Study design

In the cross-sectional single visit study participants performed different agility tests: CoD 90°, CoD 180°, T-test and KSAT in random order. There was a 5-min break between each agility test to avoid the influence of fatigue. They completed a 20-min warm-up (10 min of light running, 5 min of dynamic stretches of ankle extensors, knee flexors, knee extensors and hip flexors and 5 min of activation exercises such as maximal squat jumps, countermovement jumps and jump push-ups).

CoD tests were performed in shoes on a parquet floor in a sports gym. CoD and T-test were timed using photocell timing gates (Brower Timing Systems, Draper, UT, USA). For both tests, gates were placed at about hip height and three meters apart. Before each test, participants performed two familiarization trials (for CoD 90°, CoD 180° and T-test) at approximately 50% and 75% of their subjectively estimated maximal speed. For both tests, the starting line was 0.5 m behind the first timing gate to prevent early triggering. Participants performed three maximal CoD trials for each side turn (preferred and non-preferred) and task (CoD 90°, CoD 180°) in random orders. There was 1 min of rest between consecutive trials and 3 min rest between tasks (12 trials in total). During CoD execution, participants placed their foot (upon preference) on the middle of the starting line. Afterward they sprinted with maximal speed around the cone and made a 90° turn on one of the two sides and sprint through the finish line (second timing gate). There was a 5 m distance from the timing gate to the point of CoD (cone) and another 5 m between the cone and second timing gates (total distance was 10 m). For the CoD 180° participants sprinted around the cone and back to the first timing gate, subsequently the total distance was 10 m.

The T-test was performed as suggested by Semenick [8]. Participants started the test behind the starting point (starting line) on their own and sprinted forward 9.14 m to the first cone (touch with the right hand). They proceeded to the left using lateral movement and touched the left cone (4.57 m) with the left hand. Participants than shuffled to the right (9.14 m) and touched the right cone with the right hand. Afterward they shuffled back to the middle cone (4.57 m), after they touched it, they ran backwards to the finish line (time gate). Each participant performed three trials with 3 min rest.

Table 1. Characteristics of participants (n = 39).

Group	N	Age (years)	Body height (cm)	Body mass (kg)	BMI (kg/m^2)	Left preferred (n)	Right preferred (n)	Training years	Number of training sessions (n/week)
Male	22	19.5 ±3.9	178.9 ±4.7	71.4 ±10.5	22.7 ±2.8	15	7	11.1 ±4.9	5,6 ±3.1
Female	17	19.1 ±4.4	167.5 ±6.9	58.8 ±6.0	20.7 ±1.5	5	12	11.9 ±7.0	6.4 ±1.7
All	39	19.3 ±4.1	173.2 ±8.2	65.4 ±10.6	21.8 ±2.5	20	19	11.5 ±4.7	6.0 ±2.6

The KSAT was performed on a tatami surface (Figure 1). During the movement to the right (in left guard) the test started in zone 1. The front (left foot) was placed behind the blue starting line while the back (right) foot was placed freely behind. In between legs, there was a photocell timing pair. Time started to run when the participant disrupted the timing gates with the front foot - moving backward in the left guard – with the intention to cross over the selected cone indicator with the front foot (Figure 1; zone 1 – red, zone 2 – yellow). Afterward they performed lateral movement to the right (to the section 2) without placing the front foot across the selected cone line. After their feet were in section 2 they performed forward movement in left guard to disrupt the timing gates by placing the front foot across the blue line. Immediately after they started to move backward until the first foot was placed behind the selected cone line in section 2. Again, the lateral movement to the right was performed moving to section 3. Forward movement across the blue line and backward movement across the selected cone line was repeated in section three. Finally, right lateral movement was performed to section 4 where participants performed the last forward movement across the blue line to finish the test. The same movement was performed in the right guard moving to the left side (from zone 4 to zone 1). Participants performed 3 trials in

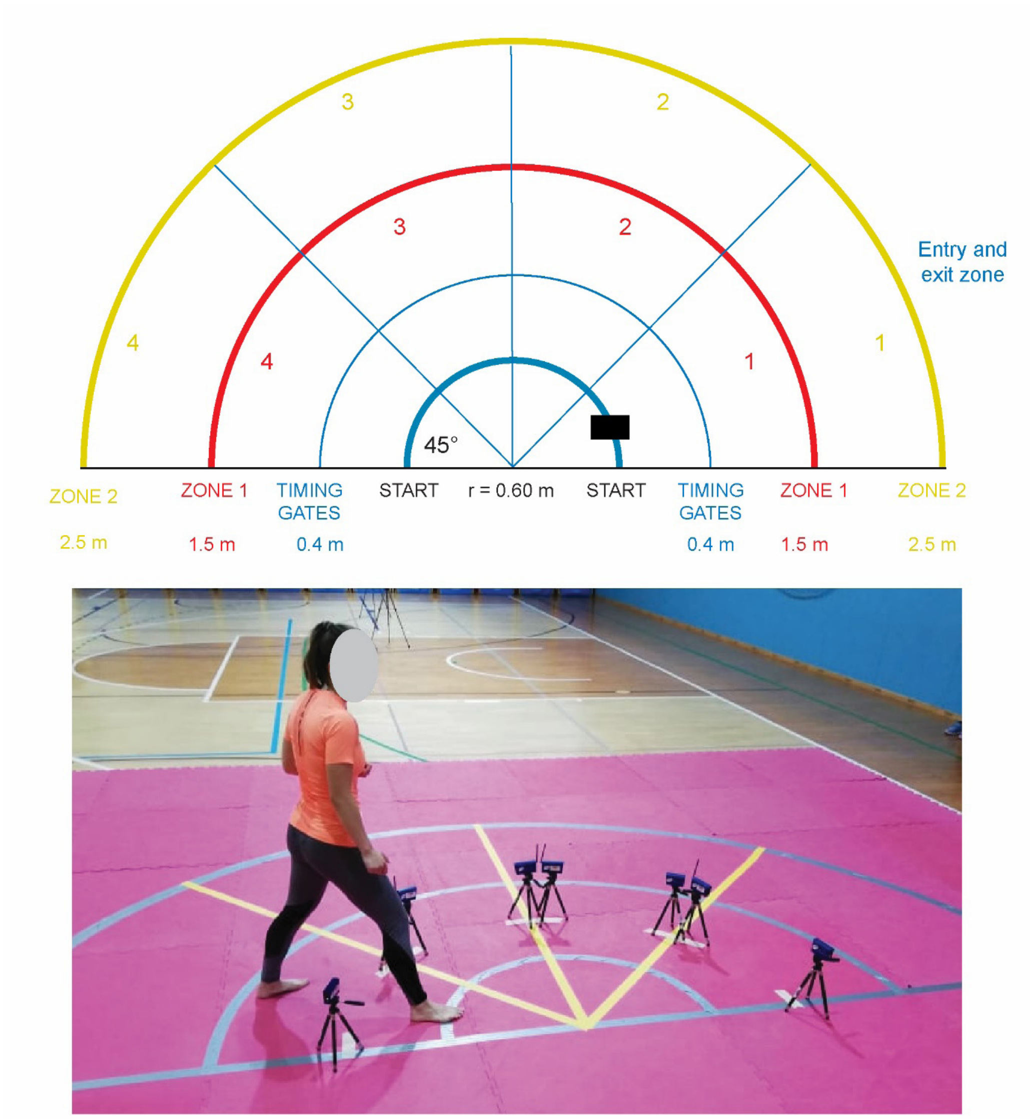

Figure 1. Measurement set-up for karate specific agility test.

the right direction (left guard) and 3 trials in the left direction (right guard). This protocol was performed in zone 1, where starting and cone line indicators where 1.5 m apart (short KSAT), and in zone 2 where this distance was 2.5 m (long KSAT). Altogether 12 trials were performed.

To ensure maximum effort loud verbal encouragement was provided for all agility tests. The main outcome measure was the best total time (s) for each test or condition within the test (left or right turn, left or right guard). Results of the agility tests were organized regarding the leg which was responsible for the turn and participants self-reported preferred push-off leg (preferred, non-preferred). In the case of KSAT test results were organized based on participants' self-reported preferred guard – based on their preferred front leg.

Statistical analysis

All statistical analyses were performed using SPSS (IBM SPSS version 26.0, Chichago, IL, USA) software package. Descriptive statistics of the dependent variables are presented as means and standard deviations (SD or ±). Within-session reliability (using three trials per condition) was evaluated using intraclass correlation coefficients ($ICC_{2.1}$) with 95% confidence intervals (CI), coefficients of variation (CV) with 95% confidence intervals and typical error. $ICC_{2.1}$ were interpreted according to Koo and Li [9] ($ICC_{2.1}$ >0.90 = excellent, 0.75 to 0.90 = good, 0.50 to 0.74 = moderate and <0.50 = poor). CV values <10% were deemed acceptable. Typical error (TE) was also calculated for each outcome measure [10]. Correlations between agility tests, training years and KSAT performance were assessed by Pearson's correlation coefficients and interpreted according to Hopkins et al. [11] (0.00 to 0.19 trivial; 0.20 to 0.29 small; 0.30 to 0.49 moderate; 0.50 to 0.69 large; 0.70 to 0.89 very large; 0.90 to 0.99 nearly perfect; 1.00 perfect). Paired samples t-test was used to identify absolute differences between the results. Cohen's d effect size (d) was used to quantify the magnitude of the differences, using the following interpretation: negligible (<0.2), small (0.2 to 0.5), moderate (0.5 to 0.8) and large (>0.8) [12]. Significance level was set at $p<0.05$ (two-tailed).

For investigating correlations and absolute differences, agility tests were organized based on participants preferred and non-preferred leg, while the KSAT test was organized based on their preferred and non-preferred guard.

RESULTS

In general, within-session reliability showed good to excellent $ICC_{2.1}$ values for all outcome measures and acceptable CV (<10%) and TE values (Table 2).

Table 2. Reliability results for agility tests.

Variable	Mean 1, SD	Mean 2, SD	Mean 3, SD	$ICC_{2.1}$ (95% CI)	CV (95% CI)	TE
CoD 90° - preferred (s)	2.58 ±0.13	2.57 ±0.14	2.56 ±0.14	0.82 (0.72, 0.90)	2.2 (1.8, 2.0)	0.4
CoD 90° - non-preferred (s)	2.56 ±0.14	2.55 ±0.12	2.56 ±0.13	0.84 (0.73, 0.91)	2.3 (1.9, 3.0)	0.4
CoD 180° -preferred (s)	3.12 ± 0.16	3.12 ±0.15	3.10 ±0.15	0.76 (0.63, 0.86)	2.5 (2.1, 3.2)	0.5
CoD 180° - non-preferred (s)	3.14 ±0.15	3.13 ±0.15	3.12 ±0.15	0.84 (0.76, 0.92)	2.0 (1.6, 2.5)	0.4
T-test (s)	10.35 ±0.60	10.19 ±0.63	10.19 ±0.54	0.92 (0.86, 0.95)	1.7 (1.3, 2.2)	0.2
Short KSAT – preferred (s)	3.19 ±0.56	3.05 ±0.55	2.93 ±0.51	0.92 (0.86, 0.95)	5.5 (4.5, 7.1)	0.3
Short KSAT – non-preferred (s)	3.08 ±0.48	2.82 ±0.39	2.90 ±0.50	0.90 (0.83, 0.94)	3.8 (3.1, 4.9)	0.3
Long KSAT – preferred (s)	5.12 ±0.57	5.08 ±0.53	4.96 ±0.51	0.93 (0.88, 0.96)	3.1 (259, 4.0)	0.3
Long KSAT – non-preferred (s)	5.16 ±0.46	5.08 ±0.50	5.00 ±0.48	0.83 (0.72, 0.90)	4.1 (3.4, 5.3)	0.2

CoD change of direction; **KSAT** karate specific agility test; **ICC** intraclass correlation coefficients; **CV** coefficients of variation; **CI** confidence intervals; **TE** typical error.

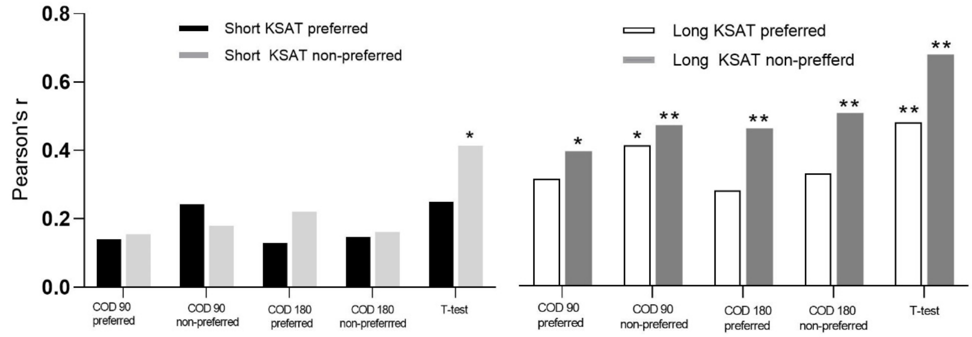

Figure 2. Pearson's correlation coefficients between standard agility tests and karate specific agility tests (KSAT).

The time in short KSAT in the non-preferred guard was in statistically significant moderate correlation with T-test (0.414, $p<0.05$). The time in long KSAT in non-preferred guard was in significant moderate to large correlations with all standard agility tests ($r = 0.362$ to 0.621, $p<0.05$), while long KSAT time in the preferred guard was in significant correlation with non-preferred CoD 90° and T-test (0.439, $p<0.01$) (Figure 2).

Significant negative moderate correlations were calculated between training years and short KSAT time in preferred guard ($r = -0.517$, $p<0.01$), long KSAT time in preferred ($r = -0.377$, $p<0.05$) and non-preferred guard ($r = -0.465$, $p<0.01$), while large negative correlations were seen between training years and short KSAT in non-preferred guard ($r = -0.517$, $p<0.01$) (Figure 3).

Paired sample t-test between CoD 90° on the preferred (2.52 ±0.12) or non-preferred side (2.52 ±0.11) showed no significant differences ($p = 0.88$, SE = 0.02). Similar results were seen between the preferred (3.06 ±0.14) and the non-preferred side (3.07 ±0.14) in CoD 180° ($p = 0.4$, SE = 0.2). There were no significant differences in the short KSAT time performed in the preferred (2.89 ±0.51 s) or non-preferred (2.85 ±0.38 s) guard ($p = 0.50$, SE = 0.09). Similar was seen in long KSAT time performed in preferred (4.91 ±0.53 s) and non-preferred guard (4.87 ±0.49 s) ($p = 0.49$, SE = 0.11) (Figure 4).

DISCUSSION

Our study showed good to excellent $ICC_{2.1}$ values and acceptable CV (<10%) and TE values for all agility tests, including short and long

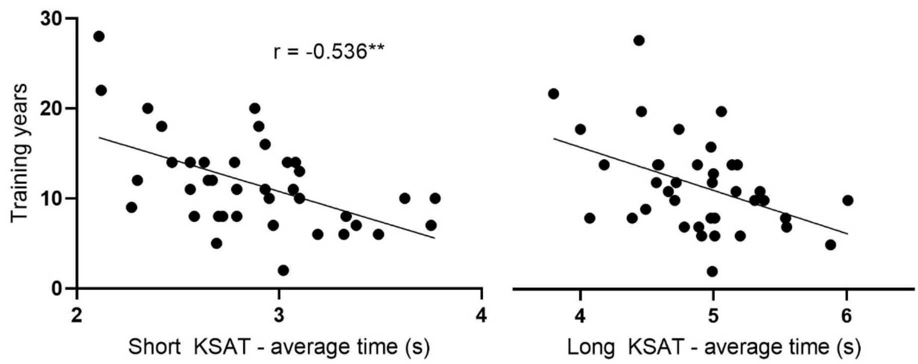

Figure 3. Correlation between training years and average time in short and long karate specific agility test (KSAT).

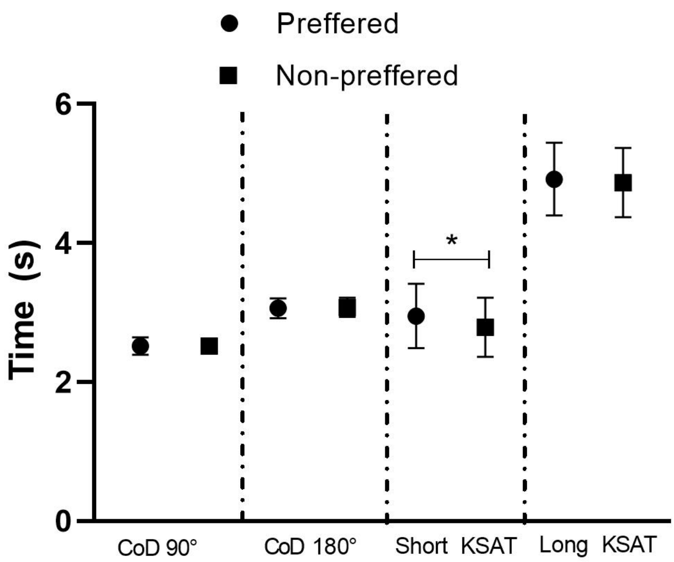

Figure 4. Differences between the preferred and non-preferred side in agility tests and karate specific agility test (KSAT).

KSAT. There was only one significant correlation regarding short KSAT, specifically, positive moderate correlation between the time in short KSAT in non-preferred guard and T-test. A greater number of correlations (moderate to large) were seen between long KSAT and agility test, especially in case when long KSAT was performed in non-preferred guard. Significant negative moderate to large correlations were found between training years and KSAT test time. Finally, there were no significant differences between agility tests or KSAT comparing the preferred or non-preferred sides.

Even though efficient and quick movement in various directions on mat surface is extremely important during karate kumite matches, there is a lack of literature and tests for evaluation of karate-specific movement. The only specific test which evaluated specific karate movement was reported by Blažević [7]. The test evaluated movement in a triangle in a fighting guard along the sides of an equilateral triangle. They showed that karatekas above 75 kg need more time to perform the test compared to karatekas below 75 kg. However, a more specific description and reliability of the test are lacking.

One of the previous studies reported that karatekas perform 3.4 ±2.0 actions per minute, with individual actions lasting between 1 to 3 s each [2]. Based on that, we designed a short KSAT where the best results of participants were between 2.0 and 3.77 s. As karate match also includes longer attacking od defending actions in the duration of 1 to 7 s [13], we designed a long KSAT where the best results of participants were between 3.74 and 6.36 s. In general, good to excellent within-session reliability was calculated for all tests (Table 2). Specifically, excellent $ICC_{2.1}$ was seen in short KSAT, while good to excellent $ICC_{2.1}$ was calculated for long KSAT. For both tests, acceptable CV (3.1 to 5.5 %) and TE (0.2 to 0.3 s) were calculated. Based on that we can confirm our hypothesis "A".

Correlations between standard agility tests (CoD 90°, CoD 180° and T-test) and newly introduced short and long KSAT test showed a greater number of correlations in the case when KSAT was performed in non-preferred guard (when their push-off leg was at the back). In the case of the short KSAT, there was only one significant correlation with agility tests, more specifically, a correlation between KSAT time in non-preferred guard and T-test. Interestingly, the time in the long KSAT in non-preferred guard was in significant moderate to large correlation with all the agility tests, while the long KSAT time in preferred guard was in moderate significant correlation with the non-preferred CoD 90° time. This could be explained by the fact that most karatekas choose their preferred guard based on their technical skills, type and length of attacking actions and their preferred attacking/defending actions. Moreover, in their non-preferred guard, their push-off leg was at the back. In this position, they were able to create more propulsion with their push-off leg, especially in forward movement.

It seems that in this position they were able to move in a similar manner as in other agility tests, while such movement in the preferred guard was less associated with other agility tests. Greater correlations of KSAT tests with T-test can be explained with a large amount of lateral movement which is performed in T-test and KSAT test, compared to CoD tests where only one quick change of direction is performed. This type of movement is more important physical quality in more multidirectional sports where CoD is performed during running, such as soccer and basketball [14, 15]. Even though there are big differences in movement between standard agility tests and newly introduced KSAT test, abilities such as power and speed play important role in all performed tests [7, 16]. Significant negative moderate to large correlations between performance in KSAT tests and training years can confirm the specificity of newly introduced KSAT. Karatekas with longer training years outperformed karatkekas with less experience which can confirm the sensitivity of our agility test. Based on our results we can partly confirm our hypothesis "B".

Finally, we compared the performance of agility tests when CoD was performed with the preferred or non-preferred leg and between KSAT performed in the preferred and non-preferred guard. There were no significant differences between agility tests between preferred and non-preferred CoD. Similar was found by Dos'Santos et al.[17] who evaluated CoD ability in athletes from different team sports while there is no evidence about CoD differences between the preferred and non-preferred side in karatekas. More important finding of our study is the fact that speed of movement in karatekas was not limited when KSAT was performed in non-preferred guard. This should encourage coaches and karatekas to perform attacking and defending techniques in non-preferred guard more often.

One of the limitations of our study represents the fact that our test did not measure the direct CoD ability, but also the linear speed ability [18], especially in both CoD tests and T-test, while in KSAT test more isolated CoD are performed in different directions. Moreover, agility tests were performed in different conditions – regarding friction. CoD tests were performed in shoes on parquet surface, while KSAT test was performed barefoot on tatami surface. Furthermore, this test only assesses the ability to move the lower limbs in karate guard without performing any attacking or defending actions, which could limit its ecological validity.

CONCLUSIONS

In conclusion, the newly introduced KSAT test was shown as a potentially useful tool for evaluating the speed of movement in karate guard position. This is the first specific karate agility test with reported reliability and information about correlations with other agility tests. Moreover, correlations between training years and KSAT performance confirmed its specificity and relevance for measuring the performance of specific karate movements. Future studies should investigate associations with other agility tests, different physicals abilities and other specific karate movements to reveal more information regarding its practical application. Coaches and practitioners can use short and long KSAT test for evaluating the movement of karatekas in preferred and non-preferred guard to detect weak points of movement.

HIGHLIGHTS

- The new karate specific agility test (KSAT) is useful tool for evaluating the speed of movement in karate guard position.
- Karatekas with longer training years are more successful in KSAT.
- There is no differences in KSAT time in preferred and non-preferred guard.

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