

A PROPOSAL FOR SPECIAL KICKBOXING FITNESS TEST

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ABSTRACT

The aim of this study is to evaluate validity and reliability of a new special kickboxing fitness test. The test can be also useful in such combat sports as karate, taekwondo, ju-jitsu and MMA.

The study group was 25 elite level athletes from the KS Gladiator club in Grybów. The test was repeated in the same group for three times. In order to evaluate test reliability, test results were compared to the results obtained by study participants in

two special fitness tests proposed by Sterkowicz¹. The statistical analysis of the results was also performed.

The analysis of the results presented in this study shows that the specific character of the movements typical of the kickboxing fight justifies the introduction of the tests based on kicks and punches to the test battery that evaluates special fitness. Furthermore, the new special fitness test proposed in this study can be used for selection and interpretation of the achievements of kickboxers since it offers a reliable, valid and user-friendly research tool.

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INTRODUCTION

One of the key components of the effective management of the training process in combat sports is to develop the training plan based on experiences from the previous training. The training plan is evaluated and analysed through regular control that provides information about the level of determinants of sport performance and psychophysical adaptation of human body to the training-specific load. The information obtained in this manner can be used to model training and determine the effectiveness of the methods and resources used for training².

The control system should be planned in detail, included in the training plans and, implemented on regular basis. The periodical evaluation should be performed to verify the degree of achievement of the goals of each stage of athlete's preparation. Changes in the athlete's body should be compared to the training effects. Training evaluation in combat sports includes medical check-ups, psychological tests, evaluation by coaches (methodological) and self-control³.

¹ K. Sterkowicz, *Special fitness test in sports ju-jitsu*, [in:] S. Sterkowicz, T. Ambroży (eds.), *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków 2003, p. 93–102.

² H. Sozański (ed.), *Fundamentals of the training theory*, Biblioteka Trenera, COS, Warszawa 1999.

³ T. Ambroży, *Structure of ju-jitsu training*, Biblioteka Trenera, COS, Warszawa 2008.

One of the components controlled by coaches is special physical fitness. Special physical fitness is examined using biomechanical and subjective tests⁴ and methods of evaluation of the most efficient technical elements and tests of technical skills⁵, as well as special strength, special endurance tests and coordination⁶. Based on the results of general fitness tests and the level of achievement, several indices are obtained to characterize the level of sport skills of the athletes examined⁷.

The special fitness tests can be used to monitor the level of preparation of combat sport athletes at individual stages of training, and, if repeated on regular basis, the tests are likely to show progress or regress in fitness. Analysis of test results can be used to effectively modify training programs. The test battery should be used every 4 to 6 weeks in the preparation period. Due to the specific character of the exercise, the last test can be performed in the direct preparation period before competition⁸.

The test of technical skills and motor preparation which is the most adequate to training practice is the response to exercise which occurs in the real fight during competition.

⁴ J. Pawluk, *Coaching journals*, no 2, 3. PZJudo. Warszawa 1985; W. Chwała, T. Ambroży, S. Sterkowicz, *Three-dimensional analysis of the ju-jitsu competitors' motion during the performance of the ippon-seoi-nage throw*, "Archives of Budo Science of Martial Arts and Extreme Sport", 2013, vol. 9, p. 41–53.

⁵ S. Sterkowicz, T. Ambroży, (eds.) *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków 2003.

⁶ E. Franchini, M.Y. Takito, R.C.M. Bertuzzi, *Morphological, physiological and technical variables in high-level college judoists*, "Archives of Budo", 2005, vol. 1, p. 1–7; R. Lidor, Y. Melnik, A. Bilkevitz, B. Falk, *The tenstation judo ability test: a test of physical and skill components*, "Strength Conditioning Journal", 2006, vol. 28, no. 2, p. 18–20; S. Sterkowicz, E. Franchini, *Testing motor fitness in karate*, "Archives of Budo", 2009, vol. 5, p. 29–34; H. Sertić, T. Vidranski, I. Segedi, *Construction and Validation of Measurement Tools for the Evaluation of Specific Agility in Karate*, "IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology: Ido – Ruch dla Kultury", 2011, vol. 11, no. 1, p. 37–41.

⁷ G. Lech, A. Tyka, T. Pałka, R. Krawczyk, *The physical efficiency and the course of fights and the sports level of judo contestants*, "Medicina Sportiva Practica", 2007, vol. 8, no. 3, p. 81–85; G. Lech, W. Chwała, A. Tyka, T. Pałka, J. Jaworski, W. Pilch, T. Ambroży, D. Mucha, *The use of k-means method for assessment of training and differences in motor abilities indices in judo contestants at different age*, "Archives of Budo", 2015, vol. 11, p. 319–328.

⁸ K. Sterkowicz, *Special fitness test in sports ju-jitsu*, [in:] S. Sterkowicz, T. Ambroży (eds.), *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków, 2003, p. 93–102.

The aim of this study is to evaluate validity and reliability of a new special kickboxing fitness test. The test can be also useful in such combat sports as karate, taekwondo, ju-jitsu and MMA.

The aim of the development of the new test was to meet expectations of coaches who need objective, user-friendly tools with high reliability and validity to comprehensively examine the level of special fitness of kickboxers. The main barrier that makes it difficult to implement certain evaluation methods is the necessity to use specialized apparatus. For this reason, the tests have been mainly unavailable to the most of coaches, with particular focus on those who work with groups of young people. The special fitness test, which can be used to monitor kickboxing training, should be easy to perform during training using the most basic sports equipment.

THE DESCRIPTION OF THE SPECIAL PHYSICAL FITNESS TEST FOR KICKBOXERS

Before the test is performed, one should perform a warm-up including 5 minutes of an easy run and around 10 minutes of general warm-up and stretching exercises.

The following tools are necessary to perform the test: adhesive tape to mark distances on the mat, stopwatch to measure time, kick shields and punch shields, protocol for recording the results and sport tester (heart rate monitor).

The athlete stands in the fighting stance and performs left and right straight punches to the shield held by the partner to the head level⁹ (Fig. 1) without stopping for 30 seconds. After completion of this part of the test, the athlete runs along a 10 m straight line¹⁰ to the next stand, where, for 30 seconds, he or she performs roundhouse kicks to the partner's shield from the fighting stance (Fig. 2): left roundhouse kicks and right roundhouse kicks to the head height¹¹. Next, the athlete runs back to the first shields and performs the left straight-right hook combination

⁹ Straight punches are the most frequent hand techniques used during a fight.

¹⁰ General regulations concerning boxing ring formats: Art. 2 Ring. 1. Fights are performed on the square boxing ring. The smallest dimensions of the boxing ring are 490 cm x 490 cm, whereas the biggest size is 720 cm x 720 cm, measured in the square formed by the lines. The distance of 10 metres used in the test corresponds to the diagonal of the biggest ring.

¹¹ These are the most effective and the most frequent leg techniques; furthermore, the head level kicks ensure the selectivity of the test, causing that it is unavailable to athletes who do not follow regular special workout routines and do not show adequate flexibility.

with the fists for 30 seconds¹² to the head level (Fig. 3). After completion of this part of the test, the athlete runs for 10 metres to the partner holding the shield and performs roundhouse kicks for 30 seconds (alternately with the right and left leg) to the body trunk (Fig. 4). Therefore, the total time of sport-specific work during the test is 2 minutes (4x30s), which corresponds to the duration of a single round during a kickboxing match. Figure 5 presents the diagram of individual test tasks and direction of the athlete's movements.

Correctly performed kicks and punches are counted in each of the four parts. Heart rate is measured directly after completion of the test and after 1 minute rest [bpm].

The aim of the special fitness test proposed in the study is to evaluate the technical level of athletes in terms of the most frequently used hand techniques (punches) and leg techniques (kicks), speed (number of punches and kicks performed per time unit) and special endurance (response of the circulatory system and number of punches and kicks) and coordination (combination of kicks and punches) and flexibility (kicking range).

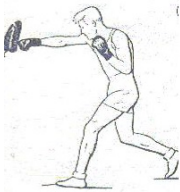


Fig. 1. Straight punch¹³



Fig. 2. The roundhouse kick to the head¹⁴



Fig. 3. Hook¹⁵



Fig. 4. Roundhouse kick to the body trunk¹⁶

¹² The most effective hand technique (T. Ambroży, P. Snopkowski, D. Mucha, Ł. Tota. *Observation and analysis of sports fights in boxing*, "Security Economy & Law. Scientific Journal for Students and PhD Candidates", 2015, vol. 4, p. 58–71).

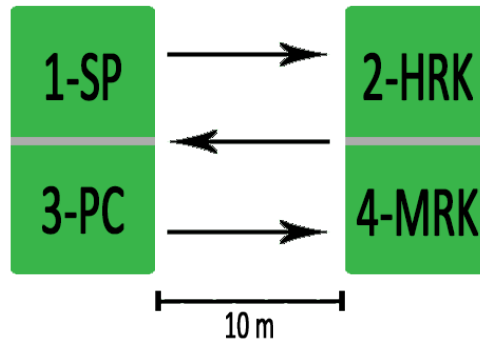
¹³ K.W. Gradopołow, *Boxing*, Wyd. Sport i Turystyka, Warszawa 1969.

¹⁴ K.W. Gradopołow, *Boxing*, Wyd. Sport i Turystyka, Warszawa 1969.

¹⁵ www.karaterawa.pl

¹⁶ www.karaterawa.pl

FIG. 5. GRAPHICAL DIAGRAM OF THE SPECIAL PHYSICAL FITNESS TEST FOR KICKBOXERS



Notes:

SP- straight punches

HRK – roundhouse kick to the head/high roundhouse kick

PC – combinations of kicks and punches/punch combinations

MRK – roundhouse kick to body trunk/middle roundhouse kick

MATERIAL AND METHODOLOGY

The study group was comprised of 25 athletes from the Klub Sportowy Gladiator sports club in Grybów, Poland, with the mean age of 19,2 years, body height of 173,6 cm and body mass of 71,1 kg. All the athletes were characterized by at least 4-year training experience and had participated in national-level elite tournaments with very high level of achievement. The group included a world champion in kickboxing, winners of medals of Polish championships, Polish Cups, European Cups and World Cups.

The test was repeated for the same group on 15 July 2016, 31 July 2016 and 12 August 2016 in Grybów. The repetition of the test was aimed to eliminate random results and allow for evaluation of reliability. Resting heart rate [bpm] was also recorded on the test day. A physical capacity index was evaluated¹⁷. Heart rate was measured using a heart monitor.

¹⁷ S. Sterkowicz, *The Special Judo Fitness Test*, "Antropomotoryka", 1995, 12, 13, p. 29-44;

$$\text{Index} = \frac{\text{Final HR, immediately after completion of the test (bpm)} + \text{HR after 60 s rest } \Sigma \text{ kicks and punches}}{\text{rest } \Sigma \text{ kicks and punches}}$$

Σ number of kicks and punches = number of punches 1 set of 30 s + number of kicks with legs 1 set of 30 s + number of punches 2 set 30 s + number of kicks 2 set 30 s.

In order to evaluate test reliability, test results were compared to the results obtained by study participants in two special fitness tests proposed by Sterkowicz¹⁸:

1. Punching speed (frequency) test: combination of two punches performed with fists: left straight punch and right straight punch performed from the fighting stance for 30 times.
2. Kicking speed (frequency) test: performing 30 *Chudan-mawashi-geri* kicks from the fighting stance with the front leg to the shield held by the partner.

STATISTICAL ANALYSIS

The material collected was analysed statistically by calculation of mean measures and variability measures. Normality of distribution was verified by means of the Shapiro-Wilk test. Pearson's linear correlation coefficients were calculated to evaluate the validity of measurements. Furthermore, the intraclass correlation coefficients were calculated in order to evaluate the consistency (reliability) using the random model for the analysis of variance for dependent data (ICC_{2,1}). The significance of the study results was evaluated for the level of significance set at $\alpha=0.05$. All the calculations were performed using the Statistica 12.5 PL software (StatSoft, USA).

RESULTS AND DISCUSSION

Measurement of the resting heart rate conducted on the test day revealed adequate adaptation of the kickboxers studied to physical exercise, with mean values being 58,6 bpm.

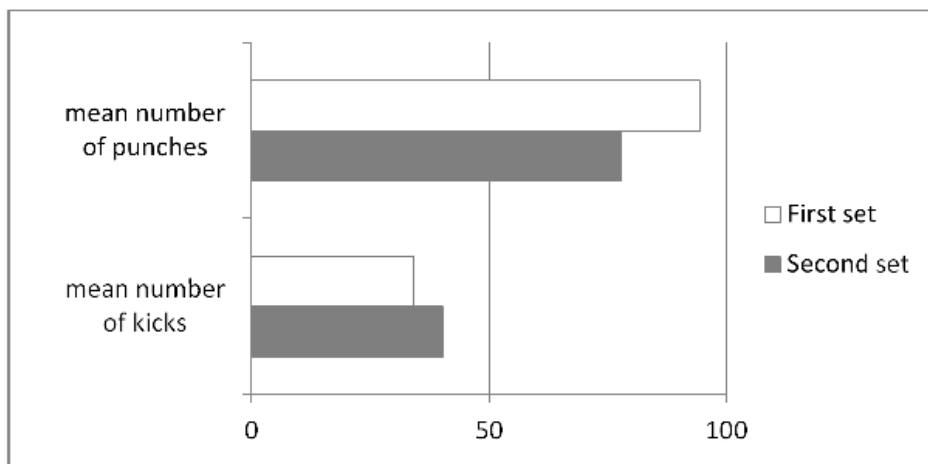
Analysis of the test (Fig. 6) showed that mean number of hits in the first set (94,4) was substantially higher than in the second (77,8), which could have been caused by both fatigue and the hitting method. Combination of straight punches is easier and faster than the combination of straight punches and hooks, which are characterized by greater effectiveness in ju-jitsu and boxing¹⁹. Furthermore, the number of kicks to the head was in

¹⁸ K. Sterkowicz, *Special fitness test in sports ju-jitsu*, [in:] S. Sterkowicz, T. Ambroży (eds.), *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków, 2003, p. 93–102.

¹⁹ S. Sterkowicz, T. Ambroży (eds.), *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków 2003; T. Ambroży, P. Snopkowski, D. Mucha, Ł. Tota. *Observation and analysis of sports fights in boxing*, "Security Economy & Law. Scientific Journal for Students and PhD Candidates", 2015, vol. 4, p. 58–71.

all three tests substantially lower in the first set (mean 34,2) than in the second set (mean 40,3), where the kicks were performed to the body trunk level. This finding seems to be interesting since the analysis of the ju-jitsu fight shows that the effectiveness and the number of performed leg techniques reduces with the time of the fight²⁰. It can be expected that, despite fatigue, the number of kicks was determined by the difficulty of performance of the techniques caused by the height of the kick.

FIG. 6. MEAN NUMBER OF PUNCHES AND KICKS IN INDIVIDUAL SERIES FOR ALL THREE TESTS



The exercise during the test was of medium intensity since mean heart rate immediately following the completion of the exercise was 190,35 bpm, whereas after 60 seconds of rest, it declined to the mean value of 145,23 bpm. As results from the literature, in trained athletes, two minutes of intensive exercise based on the performance of combat sport techniques leads to the increase in minute heart rate ranging from 165 to 185 bpm²¹, whereas its level after a 60 s rest can be 120–140 bpm²².

²⁰ S. Sterkowicz, T. Ambroży (eds.), *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków 2003; T. Ambroży, *Structure of ju-jitsu training*, "Trenera, COS, Warszawa 2008.

²¹ K.A. Matsushigue, K. Hartmann, E. Franchini, *Taekwondo: Physiological responses and match analysis*, "The Journal of Strength and Conditioning Research", 2009, vol. 23, no. 4, p. 1112–1117.

²² A.G. Diembo, *Sports medicine*, Fizkultura i Sport, Moskwa 1975; A. Ronikier, *Sports physiology*, Biblioteka Trenera, COS, Warszawa 2001.

Much longer rest is needed in order for the heart rate to return to the standard level. In a ju-jitsu fight, which lasts for 3 minutes, with the first phase characterized by the use of techniques similar to kickboxing, an increase in heart rate ranges from 150 to 190 bpm (200 bpm in extreme cases), depending on the duration and intensity. The return to the standard heart rate depends on the fitness level and ranges from 50 to 60 minutes²³.

Classification and pattern of physiological mechanisms used in human body during performing of the author's special fitness test is consistent with the pattern of a kickboxing fight. It should be emphasized that the direct energy source for muscular work is supplied by adenosine triphosphate (ATP). ATP resources in human body are not substantial (around 100g). Therefore, this compound has to be constantly recovered. The main source of ATP recovery is carbohydrates and fats, but if the exercise is extended, this compound is recovered at the expense of phosphocreatine. Another mechanism released by human body when the exercise is continued is to produce energy from glycolysis. In the first phase, it occurs in anaerobic conditions, which leads to the release of lactic acid²⁴. The highest contribution of anaerobic processes in meeting the energy demands is observed at the initial stage of the exercise, before aerobic transitions are activated in mitochondria, whereas the activity of the circulatory and respiratory systems reach the level that corresponds to the oxygen demand. This period is characterized by oxygen debt and usually takes several minutes. A kickboxing fight and the exercise performed by a person during the special fitness test discussed in this study can be also analysed within this period of time. This exercise can be qualified a high-intensity anaerobic glycolytic-lactic exercise that determines the level of anaerobic endurance of the athlete studied (see Tab. 1).

The evaluation of the athletic-motor tests consists in searching for the relationships between the results of newly developed tests with the results of those previously developed, verified and found reliable²⁵.

²³ T. Ambroży, *Structure of ju-jitsu training*, Biblioteka Trenera, COS, Warszawa 2008.

²⁴ J. Chmura, *Dynamics of changes in physiological and psychomotor fitness following the physical exercise*, AWF, Katowice 1994; A. Ronikier, *Sports physiology*, Biblioteka Trenera, COS, Warszawa 2001.

²⁵ M. Spieszny, *Test of speed and strength abilities for team games and standards and point scores for training girls and boys ages 11 to 16 years*, "Monografie", no. 2, AWF, Kraków 2011.

Such reliable tests include the test of punching and kicking speed developed by²⁶.

TABLE 1. DIVISION AND CHARACTERIZATION OF THE WORK PERFORMED BASED ON ENERGY TRANSITIONS²⁷

Anaerobic Processes	Alactic Anaerobic System	ATP+CP	Speed, Dynamic Strength
	Alactic Anaerobic System	Glycogen-Lactic Acid	Anaerobic Endurance
Aerobic Processes	Aerobic-Anaerobic System	Glycogen-Glucose + O ₂	Anaerobic-Aerobic Endurance
	Aerobic System	Fat + O ₂	Aerobic Endurance

The reliability of the special kickboxing fitness test was evaluated based on the relation expressed by the Pearson's linear correlation coefficient with two special fitness tests proposed by Sterkowicz²⁸. The correlation coefficient for the relationship between the total number of hits performed by each study participant in the special kickboxing fitness test and the test of speed of punches was $r=0,9$, whereas this correlation with the test of the speed of kicks was $r=0,69$. Both high correlation coefficients are statistically significant ($p=0,001$) and point to a high level of reliability of the two different tests. Figures 7 and 8 present the relationships between these variables.

It should be emphasized that the results obtained in the study are satisfactory since they demonstrated the validity of the tests. Therefore, they can be used to measure the characteristics they were designed for, i.e. speed and special anaerobic endurance during performance of punches and kicks, which are the basic techniques used in kickboxing²⁹.

²⁶ K. Sterkowicz, *Special fitness test in sports ju-jitsu*, [in:] S. Sterkowicz, T. Ambroży (eds.), *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków, 2003, p. 93–102.

²⁷ J. Chmura, *Training resources in the development of aerobic endurance*, Zakład Motoryczności Gracza, AWF, Wrocław 2007 as cited in M. Fortuna, *The fundamentals of the development and control of aerobic and anaerobic fitness level*, Kolegium Karkonoskie w Jeleniej Górze, PWSZ, Jelenia Góra, 2008, p. 15, 36.

²⁸ K. Sterkowicz, *Special fitness test in sports ju-jitsu*, [in:] S. Sterkowicz, T. Ambroży (eds.), *Sports ju-jitsu: Training process (coach's textbook)*, EAS, Kraków, 2003, p. 93–102.

²⁹ L. Ufel, *The world of kickboxing*, Wyd. Sport i Turystyka, Warszawa 1991.

FIG. 7. CORRELATION BETWEEN SPECIAL KICKBOXING FITNESS TEST AND THE PUNCHING SPEED TEST

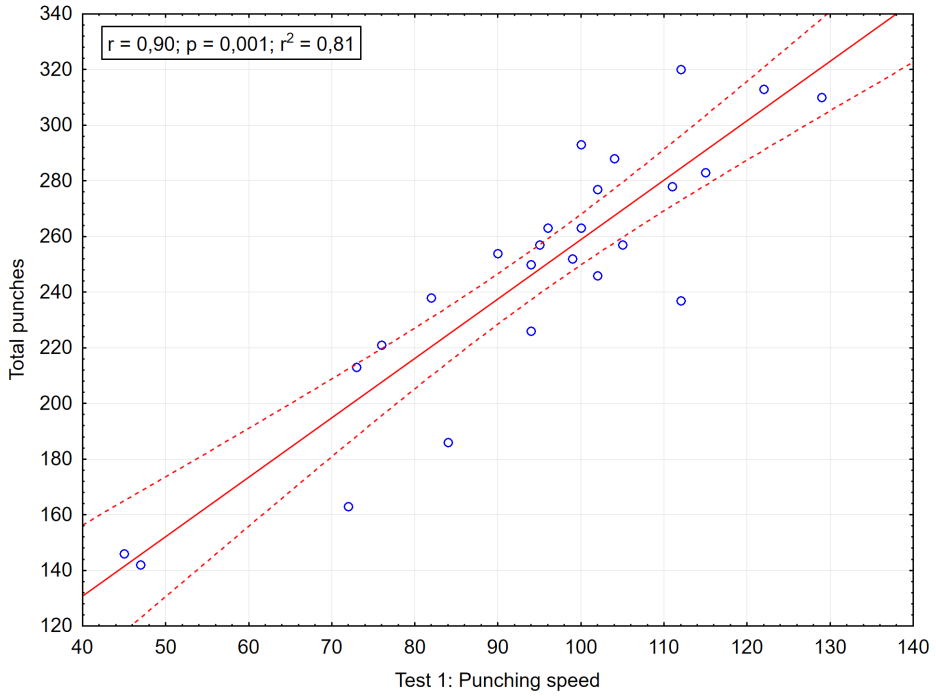
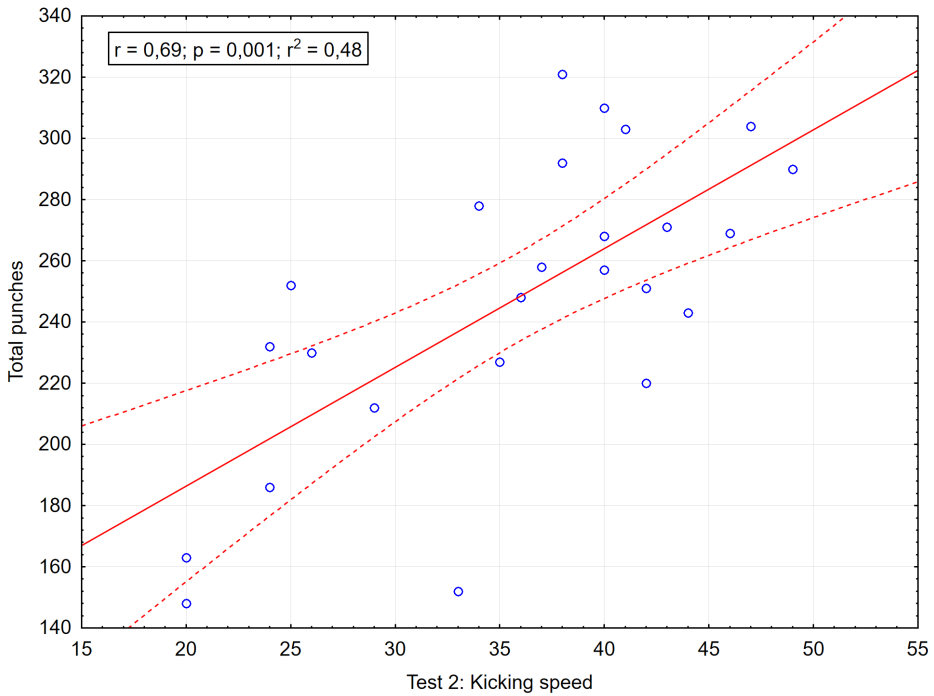


FIG. 8. CORRELATION BETWEEN SPECIAL KICKBOXING FITNESS TEST AND THE KICKING SPEED TEST



The consistency, i.e. the degree of reproducibility of the measurements, was evaluated based on the intraclass correlation coefficient determined in the random model of the analysis of variance for dependent samples. The results contained in Table 2 show a high consistency (reliability) of the measurements in each component of the special kickboxing fitness test ($ICC > 0,91$), with the intraclass correlation coefficient for the total test result being 0,97. This level of consistency demonstrates the high reliability of the test.

In conclusion, it should be emphasized that the proposed test allows for a comprehensive evaluation of the level of preparation in terms of special kickboxing fitness without the need for using specialized apparatus. However, it should be also stressed that the final level of achievement in a sports fight depends not only on physical fitness and technical excellence but also on mental preparedness and tactics used during the fight³⁰.

³⁰ T. Ambroży, *Structure of ju-jitsu training*, Biblioteka Trenera, COS, Warszawa 2008.

TABLE 2. COEFFICIENTS OF INTRACLASS CORRELATION FOR EACH COMPONENT OF SPECIAL KICKBOXING FITNESS MEASURED ON 3 DIFFERENT DAYS

Variable	Total of Punches or Kicks	S1_Punch	S1_Kick	S2_Punch	S2_Kick	HR_final	HR_after_min
ICC	0,97	0,97	0,94	0,96	0,92	0,91	0,97
Lower limit CI	0,94	0,95	0,89	0,93	0,85	0,84	0,94
Upper limit CI	0,99	0,99	0,97	0,98	0,96	0,96	0,99

CI – confidence interval

CONCLUSION

The analysis presented in this study leads to the formulation of the following conclusions:

1. The specific nature of the movements typical of the kickboxing fight justifies the introduction of the tests based on kicks and punches to the test battery that evaluates special fitness.
2. The new special fitness test proposed in this study can be effectively used for selection and interpretation of the achievements of kickboxers since it offers a reliable, valid and user-friendly research tool. Furthermore, the test is also based on the specific exercise that simulates the structure of the fight and the energy systems used.

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