Original Article

Comparative Analysis of a functional state of martial arts athletes

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Abstract
The success rate problem is one of the major at sports. The main factors of rate and selection at sports are physical education, development level of motor skills and functional state.
Purpose: analysis of a functional state of martial athletes through the series of psycho-physiological methods. Participants: 76 martial artists, divided into 3 groups. 1st group – Kickboxers, (n=17), age - 17,29±0,55 years, candidates' skill level in Master of Sports – Master of Sports; 2nd group – striking, combat martial artists (karate, taekwondo, hand-to-hand combat, MMA), (n=35), age - 23,00±0,21 years, skill level first-class sportsmen – World-class athletes; 3rd group – freestyle and Greco-Roman wrestling athletes, (n=24), age - 21,17±0,20 age, skill level first-class sportsmen – Master of Sports. Design: body sensor systems research through the series of psycho-physiological sampling. Battery of tests included 5 functional samplings. The result had been judged by 7 rates.
Results: kickboxers shown the best simple motor skills, choice reaction time and a line's speed, karate and taekwondo athletes were in the second place, the worst results shown wrestling athletes. Level of stability to deceiving signals of simple motor skills, simple quick motor glances and reaction to moving object in all groups were close and not noticeably different. The test plot-wise linear gradient level of line reproduction was minimal in 2nd group. This rate was significantly better than wrestling athletes had.
Conclusions: It was determined differences in the functional status of kick-boxing athletes in comparison with other martial athletes. These sportsmen are characterized by showing better motor skills. Their reaction to a differential stimuli, and the motor analyzer speed is faster than other martial artists shown. Karate and taekwondo athletes have slightly worse results. The wrestling athletes had the lowest scores. The results' similarity of the stability to the disorienting signals of simple motor skills, simple visual motor reaction and reaction to a moving object illustrate the specifics of martial arts. The results obtained prevent recommending a tested complex as an instrument of athletes' functional condition monitoring. It can be used both at the stage of selection and during ongoing monitoring of the current state, measuring the maturity and athletes' success projection.
Key words: martial arts, athletes, psycho-physiological methods, functional condition.

Introduction.

The problem of success projection is one of the central issues in sports. The study of states that reflect the sportsmanship and the setting of linkages between them allow to optimize the selection of prospective athletes, and predict their competitive activities.

The main projection and selection factors in sports are physical education, the development level of motor skills and functional condition (Kalina, Jagiello, & Chodala, 2015). The using of special tests for projection in martial arts is possible upon existence of the results correlation.

Similar findings were achieved by Podrigalo, Iermakov, Alekseev and Rovnaya (2016). The authors confirmed the dependence importance between morphological and functional indices of martial arts athletes.

Close findings were achieved by Pietraszewska, Burdukiewicz, Stachon, Andrzejewska & Pietraszewski (2015). The very important place among the factors determining success, belongs to the motor skills state, psycho-physiological specificities and athletes' somatotype structure.

Gaskov, Kuzmin, Kudryavtsev and Iermakov (2016) highlighted indicators of general and special physical training as priorities for success in boxing. This analysis allowed them to build up prognostic models.

Projecting process entails the use of various statistical methods. Rovniy, Pasko and Grebeniuk (2016), Rovniy, Pasko, Stepanenko and Grebeniuk (2017) used the regression analysis in analyzing the state of runners. These constructed regression equations can be used as a predictor of success.

The correlations' determination between physiological parameters and the sprinters' special working capacity were used for projecting by Yefremenko et al. (2016).

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Nosko, M., Razumeyko, N., Iermakov, S. and Yermakova, T. (2016) confirmed the informational significance of muscle tone to evaluate the balance of the functional state. Kriventsova, Iermakov, Bartik, Nosko and Cynarski (2017) determined that exercises of remote maneuvering, battles without defenses and the combat implementation under the teacher guidance speed up the formation of a personal style of combat.

Jarraya, Jarraya, Chtourou and Souissi (2014) confirmed that the reaction speed is one of the main factors that ensure success in handball. Study of this indicator allows to judge the functional state of athletes.

El Ashker (2012) studied the possibilities of mastering a variety of complex motor skills in boxing. Certain skills help to improve physical and technical abilities and increase the competitive activities effectiveness.

Andreato et al. (2016) analyzed a set of characteristics of Brazilian Jujitsu athletes. A significant contribution to the sports shape is given by physiological indicators, primarily the reaction rate.

Nikolaidis et al. (2015) note the importance of testing the psycho-physiological indicators of volleyball players. The results confirmed the existence of correlation between physical and physiological characteristics. Similar results were obtained by Nikolaidis, Ingebrigtsen, Povoas, Moss and Torres-Luque (2015)and they can be applied to handball.

In this way, the available literature data confirm the study relevance of the athletes functional status for monitoring the functional state and success projection.

Purpose of the study is to analyze the features of the functional state of the martial artists using a set of psycho-physiological methods.

Materials and methods.

Participants: 76 martial artists participated in study, were divided into 3 groups. 1st group – Kickboxers, (n=17), age - 17,29±0,55 years, candidates' skill level in Master of Sports – Master of Sports; 2nd group – striking, combat martial artists (karate, taekwondo, hand-to-hand combat, MMA), (n-35), age - 23,00±0,21 years, skill level first-class sportsmen – World-class athletes; 3rd group – freestyle and Greco-Roman wrestling athletes, (n=24), age - 21,17±0,20 age, skill level first-class sportsmen – Master of Sports. All study participants gave informed consent for participation in the experiment.

The study design was scheduled to conduct a set of psycho-physiological sampling aimed at evaluating the body sensory systems. The tests battery included 5 functional samples. The results were evaluated basing on 7 indicators.

The evaluation of simple motor skills (SMS) was carried out by the fastest pressing on the circles, randomly appearing on the screen, during 10 seconds. Circles of a different color appeared as a differential stimulus, the pressure on which was estimated as an error. The results were assessed by the average number of touches and resistance to the disorienting signals - the percentage of correct answers.

Chronoreflexometry included the definition of a simple quick motor glances (SQMG). In contrast to the generally accepted method, the time of finger releasing recorded, and not the time of pressing.

The choice reaction time (CRT) was estimated according to the time of selecting the object of the specified color from five possible ones.

The response time of the selection (BPV) was estimated from the time of selecting the object of the specified color from five possible ones.

The reaction to a moving object (RMO) consisted in stopping the object at a given location at a given speed. As a result, the time of discrepancy with the correct execution is used.

The line reproduction test (LRT) consisted of holding lines around the template. The linear deviation (mm) and the test speed (mm / s) were fixed.

The statistical analysis of the data received was reviewed using licensed Excel full-featured spreadsheet (2010). The descriptive statistic rates were defined (such as arithmetic value, standard deviation and average mistake). The credibility of values differences was assessed by the Student's *t*-test (t), the Rosenbaum's *Q*-test (Q) and Wilcoxon-Mann-Whitney *U*-test (U), the differences were considered to be reliable with p <0.05.

Results

Results can be seen in the Table 1.

Table 1. Results of psycho-physiological test for martial artists.

Indicator	1 group (n=17)	2 group (n=35)	3 group (n=24)
Sample motor skills (quantity of touches for 10 c)	27.38±0,41	26,94±0,05	25.31±0,06[1,2]
Stability to the disorienting signals (%)	82.77±1,06	82,27±0,14	80.51±0,28[1,2]
Simple visual motor reaction (ms)	233.31±3,64	230,23±0,49	231.54±0,72
Reaction to a moving object (ms)	18.59±1,44	19,48±0,19	19.42±0,27
Choice reaction time (ms)	576.16±14,81	611,94±1,95[1]	641.26±2,98[1,2]
Linear deviation (mm)	0.44±0,03	0,383±0,003	0.46±0,01[2]
Line reproduction time (mm/s)	136.76±6,11	72,18±1,00[1]	84.95±0,09[1,2]

Note. 1 – difference with 1 group is reliable with (p<0,05). 2 – difference with 2 group is reliable with (p<0,05).

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The results analysis allows us to conclude that there are differences in the psycho-physiological status of martial athletes. In this way, representatives of striking fights (1 and 2 group) had a much higher level of SMS in comparison with wrestlers according to the Student's t-test. At the same time, the kickboxers results of this test and other "strikers" were significantly different within Wilcoxon-Mann-Whitney U-test (U = 60, p <0.05). The results of data comparison between 1st and 3rd groups confirmed significant differences with the use of Rosenbaum's Q-test (Q = 13) and Wilcoxon-Mann-Whitney U-test (U = 72) test. At the same time, during the assessing of stability to the disorienting signals of the SMS test, differences among the groups were not recorded.

The SVMR and RMO results were very close in all groups and did not differ significantly on all applied indicators.

The best CRT results were identified for 1st group, in second place - the results of other striking martial artists. The wrestlers' rates were the lowest in comparison with other groups (see Table 1). The Rosenbaum's Q-test usage confirmed the essential differences between 1st and 3rd groups, Q = 8.

In LRT assessing , the kickboxers results should also be judged as the best ones. The line reproduction time was maximal in1st group, in second place were the wrestlers. The lowest speed was shown by representatives striking combat. Differences for this indicator are assessed through the Student's t-test (see Table 1) and through the Rosenbaum's Q-test. For 1st and 2nd groups Q = 26, for 1st and 3rd groups Q = 21.

The LRT linear deviation was minimal in 2nd group. It was significantly different from the wrestlers' results (see Table 1).

Discussion.

Success in martial arts is determined by winning the fights. And for its part, it depends on a set of factors. These factors includes the physical and technical athlete preparedness, as well as psycho-physiological qualities (the reaction speed for various stimuli, coordination, etc.).

The effectiveness of the analysis of athletes condition depends on methods and tests that were used. The main criterion for their selection can be tailored to the specificities of each sport and the informativeness of the indicators that were used. The competence of this approach is confirmed at the time of analysis of synchronized swimming athletes condition who had different skill levels (Rovnaya, Podrigalo, Aghyppo, Cieślicka, & Stankiewicz, 2016).

Mirzaei, Rahmani-Nia, Lotfi and Nabati (2016) found that improving physical education and functional state in martial arts helps to increase success in the fight.

Rahmat, Arsalan, Bahman and Hadi (2016) studied the relationship between motor activity and somatic type, anthropometric profile, body's composition, physiological and physical profile of young wrestlers. Wrestlers' profile accounting allows to increase their competitive success.

Georgiy, Lesia and Shatskih (2013) note the importance of using integral criterias for the functional state of elite athletes. It was confirmed that psycho-physiological diagnostics of elite fighters is characterized by three components of functional states: sensory-motor responding, neurodynamic characteristics and heart rate regulation.

In our view, the assessed differences are determined by the specifics of martial arts in all sports. Increasing the results of a SM sample means being ready to carry out the maximum number of movements over a time interval. For strike martial arts it's a quite important indicator. It can be interpreted as the ability to inflict a large number of strokes in a short time. This rate can be explained by the fact that the representatives of strike martial arts (1st and 2nd groups) didn't have much differences among themselves in the SM results. At the same time, the comparison with wrestlers showed significant differences. 1st and 2nd groups had a higher number of touches and a lower mistake percentage. Neto, Marzullo, Bolander and Bir (2013) give the similar results. The authors evaluated in a special test the interactions between the speed and the precision of strikes. The high speed and the precision of strikes were confirmed at experienced participants.

Larson, Sherlin, Talley and Gervais (2012) analyzed the factors that affect the success in boxing. Among them the level of attention, the reaction speed variability and the reduction in the number of errors in carrying out the tests occupy a prominent place among factors that affect the success in boxing.

Increasing the effectiveness of the analysis is achieved through an integrated approach, the use of various methods. The studies of Logan, Robinson, Rudisill, Wadsworth and Morera (2014) were based exactly at the observance of this principles. The authors carried out a comparative analysis of various tests evaluating motor skills. It was assessed that the tests evaluating different aspects of skills should be used. Their results complement each other and give a comprehensive assessment of full functional state.

Podrigalo, Galashko, Iermakov, Rovnaya and Bulashev (2017) give the similar results. The authors have substantiated and developed a methodology of success projecting success Arm wrestling. The complex of tests included morphological, functional, goniometric methods.

The methodological approach that was used is the comparison of different types of single combats, which allows taking into account their specific nature and highlighting the most significant factors. And the

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participation of high-level athletes allows us to increase significantly the informativeness and validation of the projections generated.

The available results confirm the validity of this approach. It is assessed that variations exist in body characteristics of wrestlers and athletes of striking martial arts (Iermakov, Podrigalo, & Jagiełło, 2016). Sport specificity is illustrated by an increase in the upper arm and shoulder circumferences, the gripstrength in dynamic and static modes.

Podrigalo, Iermakov, Jagiełło (2017) used the index method for projection of success of single combat athletes. The revealed differences illustrate the sports specificity, the differences in particularities of fighters' physiques and athletes of martial arts.

The psycho-physiological studies results confirmed that the representatives of strike martial are characterized by a better ability to mobilize, more optimal readiness to act and more developed differentiation roles in comparison with wrestlers (Iermakov et al., 2016).

All athletes SVMR results are quite high, that, in our opinion, reflects the specificities of martial arts. The reaction speed is an important factor for success in martial arts. High reaction speed means the effectiveness of attacking and protective actions. The lack of ability to react quickly in a fight means a loss because of a missed strike or an opponent's move.

Similar results were obtained by Ridini (1968). The author studied the possibility of tests application for athletes' selection. Following facts were assessed: the high informativeness of reaction speed, the state of the visual analyzer and the implement of technical processes. These tests can also be used for sportsmanship projection.

The RMO test should also be evaluated as an important factor for the projection in martial arts. The performed task - stopping a moving object in a given location - simulates a typical fight situation. An opponent conducts an attack, it's needed to commit a protective action. The test terms allow assessing not only the speed, but the athlete ability to calculate his actions. The absence of significant differences in results illustrates the high skill level and tactical preparation level of athletes, regardless of martial arts type.

Gierczuk and Ljach (2012) give the similar results. The authors used computer tests for assessing the advancement of wrestlers' motor skills. The Greco-Roman wrestling athletes showed the tests informativeness that study the reaction speed, the frequency of moves, spatial orientation, and adaptation to moves.

Using the CRT test, it's possible to study the athlete's reaction to a differentiating stimulus. The subject is in the so-called "decision-making standby mode". The main factors affecting the functional state are the time crunch and the need to implement the correct action. The analysis of test results allows us to take it as important in projection and selection exactly in strike martial arts.

LRT lets us to investigate the fine motor coordination of the hand muscles. This test assesses the speed and accuracy of sample implement. It can be considered as the variant of the tremorometry methods. Kick-boxers were characterized by a higher speed of the test impementation, with no significant differences in the accuracy of the sample implement. This allows to consider their level of motor analyzer development as better one, and the fine motor coordination of the hand muscles is better than other martial artists have.

Modern martial arts raise very high standards about the demonstration of motor coordination (Starosta & Fostiak, 2013). This ability belongs to the leading, and even according to some, it's the most important for athletes of these sports.

Vandorpe et al. (2012) conducted monitoring of young gymnasts condition to identify the most important qualities and the success projection. They used anthropometric and physical measurements, coordination and motor analyzer tests. The tests that assess the coordination of movements are concerned as the most significant for the projection in gymnastics.

Another fact in favor of the assumptions made about the evaluation of the results, on the basis of the specificity of sports, is reference to relative ages. Kick-boxers were the youngest, that is, they had the least training experience. At the same time, their results were better than more experienced athletes showed. The obtained data are inconsistent with available data in literature. The dependence on age of athletes' functional state was studied by Baker and Tang (2010). It was assessed the range of differences of athletes' functional state. Training experience increasing helped reducing the number of mistakes in tests. In our opinion, this fact reaffirmed the assumption about the importance of specific factors determining the sports specificities. Similar results were obtained by Podrigalo et al. (2017). Recent research has found the better functional condition of experienced athletes of striking martial arts. The increase in the number of touches and credibility, their results of SVMR are indicative of better training, and a higher level of efficiency. The high indicators in the differentiating stimuli tests of experienced martial artists reflect a higher level of reaction readiness under extreme conditions, i.e. readiness to the fight.

Conclusions.
In this way, it was assessed the differences in the functional state of kick-boxers in comparison with representatives of other martial arts. These athletes are characterized by showing better motor skills. Their reaction to a differentiating stimulus, the motor analyzer speed is faster than other martial artists have. Results of

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karate and taekwondo representatives were slightly worse. The wrestlers had the lowest scores. The similarity of the results in stability to the disorienting signals of simple motor skills, simple visual motor reaction and reaction to a moving object illustrate the specificity of martial arts. The results obtained prevent recommending a tested complex as an instrument of athletes' functional condition monitoring. It can be used both at the stage of selection and during ongoing monitoring of the current state, measuring the maturity and athletes' success projection.

Conflict of interest
The authors state there is no conflict of interest.

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