Functional state of martial arts athletes during implementation process of controlled activity - comparative analysis

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Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract

Introduction: The study of athletes' psychophysiological characteristics is one of the major problem at sports science. The aim of the study is to perform comparative analysis of athletes' power and adaptive capacities during the implementation process of controlled activity, like performing screen-selection activity. *Materials and methods:* In research participated divided into 3 groups martial arts athletes: taekwon-do ITF and karate WTF (n=34); Greco-Roman and freestyle wrestling athletes (n=18); sambo and judo athletes (n=11). As a device, a tablet of Apple company - iPad, fourth-generation, with 9,7-inch screen was used. For the heart rate (HR) registration it was used BT4.0&ANT+ Heart Rate Monitor. Participants performed a sample: the response rate of the selection. The attempt was to react to one given signal from the five proposed. *Results:* Taekwon-do ITF athletes, karate WTF, hand-to-hand combat showed the best reaction selection time rates. The worst reaction selection time rates were shown by Greco-Roman and freestyle wrestling athletes. *Conclusions:* The handled comparative analysis reaction time of selection for athletes of different kinds of martial arts has verified its high informative value. Taekwon-do ITF, karate WTF, hand-to-hand combat athletes have better results. The results suggest that participants' state of adaptiveness was normal. The high informative value of used test allows recommend it as screening in the selection of promising athletes to the combat martial arts which mostly emphasize striking techniques.

Keywords: martial arts, athletes, psychophysiological tests, functional state.

INTRODUCTION

Solution of actual problems of Sports Science demands on qualitatively new approaches for the analysis and the interpretation of results. Balagué et al. [1] emphasize the integration importance in sports, carrying out the research on the verge of physiology, biomechanics, psychology, phenomenology and sociology. This is evident in many studies [2,3,4]. The use of different statistical methods allows to define the basic patterns of organism reactive approach to the physical activity.

The research of athletes' physical and motor skills development is analyzed in the other survey [5]. Applied design (categorization according to skill level) allowed to reveal the most informative rates. These are the criteria that should be implemented while projecting sport success. According to the other authors [6], the leading predictors of successfulness are motor skills condition, psychophysiological specificities and somatotype structure of athletes. The sensorimotor capacities hold a prominent place within athletes' successfulness predictors. Krasich et al. [7] emphasize, that improvement of these skills allows to remarkably increase the functional state of athletes. Test applied for projecting should take into account the specificities of each sport. In the work of Vandorpe et al. [8], it was affirmed that the test for motor coordination is the most informative. Its projecting value is higher than the test for evaluation of anthropomorphic and physical characteristics. The very close results were obtained by Lawton et al. [9] in relation to the rowsport. Authors confirmed that the most informative tests are those that simulate leg pressing.

Other authors [10] emphasize that in relation to football, the most informative tests are for evaluating the speed and precision of hitting ball. The analysis allowed to evaluate them as the important predictors of players' successfulness. The close results were obtained by Francioni et al. [11]. Authors held a comparative analysis of dynamics of anthropomorphic, technique and functional tests of different age categories football players during the season. The importance of this testing for improvement of training effectiveness was confirmed. Similar conclusions were made by Nikolaidis et al. [12]. Authors applied the whole set of physical and physiological characteristics for improvement of training effectiveness in volleyball. The importance of the psychophysiological volleyball players marks testing for the condition analysis was confirmed. Furthermore, authors emphasize that there are the interlinkages between physical and physiological characteristics.

Kalina et al. [13] point out the importance of integrated approach in the selection and projecting of successfulness in the mature arts. Personal physical training, motor skills, intellectual predispositions and state of health should take into account. In the other research [14], there have studied the interlinkages between morphological and functional rates of martial artists. The importance of this testing for the athletes' effectiveness projecting was confirmed. Korobeynikov et al. [15] were studying links of psychophysiological characteristics with different motivation level within highly qualified judo players. Authors have found that the athletes with high success motivation level have predominant values of neurodynamic functions: nervous system resilience; speed of visual reaction.

The analysis of Brazilian jiu-jitsu athletes' main characteristics is performed by Andreato et al. [16]. It was found that the physiological rates have the sizable contribution into a skill level, such as reaction speed. Georgiy et al. [17] propose to use the integral criteria of functional state of elite athletes. In the psychophysiological characteristic of elite martial arts athletes, the leading role is held by sensorimotor response.

Mirzaei el al. [18] were studying success factors in martial arts. It was found that the fitness level and functional state improvement hold the leading place in the athletes' preparation. Similar results were obtained by Jafari et al. [19]. It was confirmed that there is a link between physical activity and somatotype, anthropomorphic profile, body composition, physiological and physical profile of young athletes. Accounting the interlinkages allow to increase the competition successfulness of athletes. In the other research it was found that for activation of competitive combat intensity a special dosage load should be used [20]. It was found that performing exercises with weight while ignoring special dosage load leads to reducing of athletes moving speed and to slowing down the rate of battle. Authors have developed a special diagnostic instrumentation for monitoring the effectiveness of martial artists' preparation for 3 indicators: physicality, intensity and efficiency.

Açak [21] emphasizes the importance of screening research in the field of martial arts. The application of screening-tests with Turkish martial arts athletes' beginners allowed significantly reduce the probability of sportive traumatism. Similar conclusions were made by Bodnar and Andres [22]. Authors confirmed the effectiveness of applying the tests focused on express-control of students' physical preparation. The effectiveness of such kind of control is also confirmed in training modelling of micro cycles for qualified football players [23]. In this way, the available literature information confirms the relevance of study of athletes' psychophysiological characteristics, the application of this premise's for functional state control. However to date the matter of choice of the most informative tests for rapid assessment of martial arts athletes' conditions is still unresolved. The possibility of psychophysiological methodologies application for martial arts athletes screening has not been yet substantiated. And this has led to the research relevance.

The aim of this study is to perform the comparative analysis of productivity and adaptive capabilities of martial arts athletes during the implementation process of dosage work like performing screen-selection activity.

MATERIALS AND METHODS

Participants

63 martial arts athletes participated in study, divided into 3 groups. 1st group - 34 representatives of striking, combat martial arts athletes (Taekwon-do ITF, karate WTF, hand-to-hand combat) with average age – 17.58±0.08 yeras. 2nd group was composed of 18 Greco-Roman and freestyle wrestling athletes, average age – 18.94±0.33 yeras. The 3rd was formed by 11 sambo and judo players, average age – 18.73±0.23 yeras. Athletes' skill level varies from first-class sportsmen to Master of Sports.

The study design

The study was conducted with the usage of special computer programs for devices with iOS authorship software operating system. As a device, a tablet of Apple company - iPad, fourth-generation, with 9.7-inch screen was used. For the heart rate (HR) registration it was used BT4.0&ANT+ Heart Rate Monitor.

Participants performed a sample: the response rate of the selection. The attempt was to react to one given signal from the five proposed. The duration of the attempt varied randomly between 3 and 10 seconds. The participant performed 3 series of 10 attempts. The average duration of the test was 168.02±1.27 seconds. The registration of the reaction time was synchronized with the recording of the heart rate.

Statistical analysis

It was used licensed packages of Excel 2010 spreadsheet. Minimal and maximal rates of selection reaction time and HR were fixed, also the average rate of these indicators throughout the whole test and for every period separately. There were defining arithmetical means, standard deviations and errors in mean. The validity of differences in groups was assessed using parametrical indices (Student criterion) and non-parametrical indices [the Rosenbaum's Q-test].

RESULTS

The obtained results are given in the tables 1, 2. The testing overall time didn't have any significant differences between groups. All the participants were characterized by high reliability; the percentage of correct reactions has been more than 93%.

At the same time the best result of maximum reaction was found at 1st group, and the results of 1st and 3rd groups were not substantially different. A similar correlation is confirmed for the average reaction time. It was the highest at the 2nd group, 1st and 2nd groups had not substantially different results. According to duration of maximum reaction among groups, the results were not substantially different (table 1).

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Table 1. Results of selection reaction time of martial arts athletes.

Indices	1st group	2nd group	3rd group
Overall testing time [sec]	167.47±1.19	169.33±2.25	167.55±2.97
Correct reactions [%]	97.65±1.91	93.54±3.10	94.17±2.95
Maximum time [ms]	947.96±21.03	**1102.09±50.36***	984.82±33.53
Minimum time [ms]	474.22±13.78	482.81±8.95	489.19±12.37
Average time [ms]	620.49±16.34	**679.71±18.94***	644.18±14.80
1st period duration [ms]	651.29±12.49	**706.76±24.01***	679.23±21.18
2nd period duration [ms]	**606.34±18.02****	655.24±20.00	**622.76±18.44****
3rd period duration [ms]	**603.85±20.30****	**677.12±19.33***	630.55±13.39

* – differences with 1st group are credible (p<0.05); ** – differences with 1st period are credible (p<0.05).

Table 2. The martial arts athletes HR analysis results in the process of test implementation

Indicators	1st group	2nd group	3rd group
Initial HR [beats per minute]	92.76±3.38	84.72±3.25	93.45±4.58
Maximum HR [beats per minute]	102.26±2.95	92.00±3.06*	103.73±5.10
Minimum HR [beats per minute]	79.09±2.03	75.50±3.07	80.36±4.38
Average HR [beats per minute]	88.60±2.49	82.04±2.92	89.68±4.49
1st period HR [beats per minute]	91.05±2.90	82.92±2.91	93.45±4.91
2nd period HR [beats per minute]	87.10±2.40	82.02±2.86	86.16±4.40
3rd period HR [beats per minute]	87.66±2.63	81.21±3.17	89.42±4.59

* – differences with 1st group are credible.

The time of 1st and 3rd periods was also the maximum at the 2nd group; the differences between 1st and 3rd groups have not been found. The Rosenbaum's Q-test results confirmed authentic increase of average time at the 2nd group in comparison with 1st group (Q=9). A similar correlation is confirmed for the 1st period time (Q=10) and 2nd period duration (Q=14).

Distinctions were found by comparison of results at runtime of test implementation. Thus, at the 1st group there has been observed results' progressive enhancement: the time of 2nd and 3rd periods was essentially lower by comparison with 1st period time. This conformity was affirmed by parametrical and non-parametrical indices. At the 1st group the 1st period time was credibly higher by comparison with times of 2nd (z=10) and 3rd periods (z=10). At the 2nd group it was found the credible time reduction for the 2nd period (z=2). At the 2nd group it was found the credible time reduction for the 2nd period (z=2) and the 3rd period (z=2).

The dynamic HR analysis is given in the Table 2. The results indicate about the absence of this indicator sharp deviation. The usage of parametrical indices (Student criterion) confirmed the significant reduce of maximum HR in the 2nd group by comparison with representatives of combat martial arts. The usage of non-parametrical indices confirmed more expressed changes. According to the criterion of signs at the 1st group HR credibly reduced during 1st and 2nd periods (z=10). At the 3rd group HR credibly reduced during 1st and 2nd periods (z=2). According to the Rosenbaum's Q-test the initial HR was credibly lower at the 2nd group by comparison with the 1st one (Q=9). A similar correlation is confirmed for 1st period HR (Q=10). 1st period HR at the 2nd group was credibly lower by comparison with the 3rd group (Q=7).

DISCUSSION

The comparison of specific characters of different martial arts athletes is widely used in sport science. This allows to estimate the influence specificity of sport, to identify the most informative indicators, to justify selection criteria and criteria of successfulness projection. This analysis allows more clearly define the influence specificity of sport at the organism. Thus Iermakov et al. [24] confirmed the presence of certain peculiarities of martial arts athletes and athletes of combat martial arts builds. A meaningful illustration of the influence specificity of different martial arts is also confirmed with index method [25]. There is available data about differences of psychophysiological

specific characters of different martial arts athletes [26]. Authors have found that the representatives of combat martial arts by comparison with wrestlers are characterized by better ability to mobilize, more optimal readiness to action and more developed differentiation functions. The choice of test for selection reaction rime identification as the dosed work naturally follows from the available literature information. The specific characters comparison of wrestlers, kickboxers, karate and taekwondo athletes etc., confirmed the high informative value of given test [27].

Balkó et al. give the similar results [28]. Authors used selection reaction time for the estimation of preparation level of fencers and demonstrated the positive dynamic of given test in the process of training. The next inference is deduced: the given test is highly perspective for the effectiveness preparation increase in the martial arts. In our opinion this test is the closest to the battle situation. An athlete is feeling rush the whole time. He is just put in the situation of choosing different strategies and application of different techniques. This situation demands on quick reaction for the opponent actions, while any mistake can lead to the failure. In this context, the results of time estimation for test implementation and the analysis of specific gravity of correct reactions confirm considerably high athletes' capability to concentrate and mobilize their attention.

The combat martial arts athletes have better results of maximum and average selection time by comparison with wrestlers. This reflects the specificity of given sports. At such sports, as karate and taekwondo the main actions of athletes are punches and protection that should be performed as quickly as possible. At such sports as Greco-Roman and freestyle wrestling the successfulness depends on qualitatively performed hack, and on its basis athletes perform the next possible grip. In other words, the reaction speed in this case plays a small part. The given results are confirmed by previous research data. The set of psychophysiological tests allowed determining the differences in functional state of martial artists. The combat martial arts athletes have enhanced capability to mobilize, optimize reaction readiness and highly developed differentiation functions [29].

The comparative time analysis of 3 test implementation periods confirms given suppositions. The combat martial arts athletes have had better results. Besides, at the 1st group it was clearly seen the increase of test implementation dynamic. This should be interpreted as effectiveness forwardness, organism adaptation to the test implementation. The worst results of wrestlers, sambo and judo athletes testified to their inferior adaptation to the test implementation.

Analysis of HR dynamic in the progress of test implementation allows tracking changes of working capacity. It is well known, that cardiac rate – it's the integral indicator of human adaptive capabilities. The importance of athletes' adaptive changes estimation in period of loads is emphasized by Roda et al. [30]. In the work of Zych et al. [31] it is mentioned, that HR is the informative and important factor of the adaptive capabilities' state estimation. Its correlation with other physiological indicators could be used for the preparation level projection. The research of Podrigalo et al. [32] is dedicated to the study of adaptive capabilities of kickboxers' Cardiovascular system. It was found that within the conditions of standard ergographical loads the HR dynamic demonstrates adaptive potential of martial artists.

It is well known, that HR dynamic is the fastest reaction of organism for the environmental changes. In this context the given results could be interpreted in different ways. On the one hand the absence of HR sharp changes confirms the loads' affordability. Moreover, the lowest maximum HR among wrestlers shows their higher adaptability for the intensive loads. On the other hand, the HR largeness among combat martial athletes should be estimated as adaptability tension, but the best mobilization of sensor system. Just because of this state the 1st group participants showed the better results in process of implementation of test. Perhaps the changes in heart rate are related to the stressful effect of the sample. This assumption needs further study.

CONCLUSION

The comparative analysis selection reaction time definition by athletes of different martial arts, confirmed its high informative level. Taekwon-do, karate, hand-to-hand athletes have better results by comparison with wrestlers. This is due to the specific requirements of each sport and its effect on adaptive capacities. In the process of the test implementation the athletes have been characterized by

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results implementation through the developing of concentration state. The combining heart rate estimation allows controlling of loads affordability. The results suggest that participants' state of adaptiveness was normal. The high informative value of used test allows recommending it as screening in the selection of promising athletes to the combat martial arts taekwon-do, karate and hand-to-hand combat.

REFERENCES

1. Balague N, Torrents C, Hristovski R, Kelso JAS. Sport science integration: An evolutionary synthesis. European Journal of Sport Science 2017; 17: 51–62. doi: 10.1080/17461391.2016.1198422
2. Pilis K, Wąsik J, Pilis A, Stec K, Michalski C, Zych M et al. Physiological aspects of post-training adaptation in martial arts. In: Kalina RM (ed.) Proceedings of the 1st World Congress on Health and Martial Arts in Interdisciplinary Approach, HMA 2015, 17–19 September 2015, Czestochowa, Poland. Warsaw: Archives of Budo; 2015. p. 98–105
3. Wąsik J, Ortenburger D, Góra T. The kinematic effects of taekwondo strokes in various conditions the outside environment. Interpretation in the psychological aspect and perspective of application in sport, health-related training and survival abilities. Archive of Budo 2016; 12: 287-292
4. Ortenburger D, Wąsik J, Góra T. Selected dimensions of the self-esteem and a kinematic effect of the intentional target at taekwondo athletes. Archives of Budo Science of Martial Arts and Extreme Sports 2016; 12: 117-121
5. Lidor R, Cote J, Hackfort D. ISSP position stand: To test or not to test? The use of physical skill tests in talent detection and in early phases of sport development. International Journal of Sport and Exercise Psychology 2009; 7: 131–46. doi: 10.1080/1612197X.2009.9671896
6. Pietraszewska J, Burdukiewicz A, Stachon A, Andrzejewska J, Pietraszewski B. Anthropometric characteristics and lower limb power of professional female volleyball players. South African Journal for Research in Sport Physical Education and Recreation 2015; 37(1): 99–112.
7. Krasich K, Ramger B, Holton L, Wang L, Mitroff SR, Gregory Appelbaum L. Sensorimotor Learning in a Computerized Athletic Training Battery. Journal of Motor Behavior 2016; 48: 401–12. doi: 10.1080/00222895.2015.1113918
8. Vandorpe B, Vandendriessche JB, Vaeyens R, Pion J, Lefevre J, Philippaerts RM, et al. The value of a non-sport-specific motor test battery in predicting performance in young female gymnasts. Journal of Sports Sciences 2012; 30: 497–505. doi: 10.1080/02640414.2012.654399
9. Lawton TW, Cronin JB, McGuigan MR. Strength tests for elite rowers: low- or high-repetition? Journal of Sports Sciences 2014; 32: 701–9. doi: 10.1080/02640414.2013.849001.
10. Woods TEC, Raynor JA, Bruce L, McDonald Z. The use of skill tests to predict status in junior Australian football. Journal of Sports Sciences 2015; 33: 1132–40. doi: 10.1080/02640414.2014.986501
11. Francioni FM, Figueiredo AJ, Terribili M, Tessitore A. Analysis of the intraseasonal stability of field test performances in young academy soccer players. Journal of Sports Sciences 2016; 34: 966–72. doi: 10.1080/02640414.2015.1082612
12. Nikolaidis PT, Afonso J, Busko K, Ingebrigtsen J, Chtourous H, Martin JJ. Positional differences of physical traits and physiological characteristics in female volleyball players - the role of age. Kinesiology 2015; 47(1): 75-81.
13. Kalina RM, Jagiello W, Chodala A. The result of "testing fights in a vertical posture" as a criterion of talent for combat sports and self-defence - secondary validation (part I: the reliability). Archives of Budo Science of Martial Arts and Extreme Sports 2015;11: 229-238.
14. Podrigalo LV, Iermakov SS, Alekseev AF, Rovnaya OA. Studying of interconnectios of morphological functional indicators of students, who practice martial arts. Physical education of students 2016; 20(1): 64-70. doi: 10.15561/20755279.2016.0109
15. Korobeynikov GV, Korobeynikova LG, Romanyuk LV, Dakal NA, Danko GV. Relationship of psychophysiological characteristics with different levels of motivation in judo athletes of high qualification. Pedagogics, psychology, medical-biological problems of physical training and sports 2017; 21(6): 272-278. doi:10.15561/18189172.2017.0603
16. Andreato LV, Santos JF, Esteves JV, Panissa VL, Julio UF, Franchini E. Physiological, Nutritional and Performance Profiles of Brazilian Jiu-Jitsu Athletes. Journal of Human Kinetics 2016;53. doi: 10.1515/hukin-2016-0029
17. Georgiy K, Lesia K, Shatskih V. Psychophysiological Diagnostics of the Functional States in Wrestlers. International Journal of Wrestling Science 2013; 3: 5–13. doi: 10.1080/21615667.2013.10878983

18. Mirzaei B, Rahmani-Nia F, Lotfi N, Nabati SM. Trainability of body composition, aerobic power and muscular endurance of cadet wrestlers. Pedagogics, psychology, medical-biological problems of physical training and sports 2016; 20(5): 53-57. doi: 10.15561/18189172.2016.0508

19. Jafari RA, Damirchi A, Mirzaei B, Nobari H. Anthropometrical profile and bio-motor abilities of young elite wrestlers. Physical Education of Students 2016;20(6):63-69. doi: 10.15561/20755279.2016.0608

20. Nagovitsyn RS, Volkov PB, Miroshnichenko AA, Tutolmin AA, Senator SYu. The influence of special graduated weight load in Greco-Roman wrestling on the growth of students' sports results. Physical education of students 2017; 21(6): 294-301. doi: 10.15561/20755279.2017.0606

21. Acak M. The Importance of Motor Tests in Reducing the Injury of Children Who Are New to Wrestling. International Journal of Wrestling Science 2015; 5: 47–51. doi: 10.1080/21615667.2015.1028126.

22. Bodnar IR, Andres AS. Tests and standards for express-control of physical fitness and health of middle school age pupils. Pedagogics, psychology, medical-biological problems of physical training and sports 2016; 20(4): 11-16. doi: 10.15561/18189172.2016.0402

23. Kostiukevich VM, Stasiuk VA, Shchepotina NYu, Dyachenko AA. Programming of skilled football players training process in the second cycle of specially created training during the year. Physical education of students 2017; 21(6): 262-269. doi: 10.15561/20755279.2017.0602

24. Iermakov SS, Podrigalo LV, Jagiełło W. Hand-grip strength as an indicator for predicting the success in martial arts athletes. Archives of Budo 2016;12: 179-186.

25. Podrigalo LV, Iermakov SS, Jagiełło W. Special indices of body composition as a criterion of somatic development of martial arts practitioners. Arch Budo Sci Martial Art Extreme Sport 2017; 13: 5-12.

26. Iermakov S, Podrigalo L, Romanenko V, Tropin Y, Boychenko N, Rovnaya O, et al. Psycho-physiological features of sportsmen in impact and throwing martial arts. Journal of Physical Education and Sport 2016;16(2):433-441. doi: 10.7752/jpes.2016.02067

27. Volodchenko O, Podrigalo L, Aghyppo O, Romanenko V, Rovnaya O. Comparative analysis of a functional state of martial arts athletes. Journal of Physical Education and Sport 2017; 17 (Suppl. issue 4): 2142 – 2147.

28. Balko S, Rous M, Balko I, Hnizdil J, Borysiuk Z. Influence of a 9-week training intervention on the reaction time of fencers aged 15 to 18 years. Physical Activity Review 2017;5: 146-154. doi: 10.16926/par.2017.05.19

29. Podrigalo L, Iermakov S, Potop V, Romanenko V, Boychenko N, Rovnaya O, et al. Special aspects of psycho-physiological reactions of different skillfulness athletes, practicing martial arts. Journal of Physical Education and Sport 2017; 17: 519-526. doi: 10.7752/jpes.2017.s2078

30. Roda O, Kalytka S, Vashchuk L, Demianchuk O. The changes in the adaptive processes of the male organism during training physical exercises. Physical Activity Review 2017; 5: 10-18. doi: 10.16926/par.2017.05.03

31. Zych M, Stec K, Pilis A, Pilis W, Michalski C, Pilis K, Kosinski D. Approaches to describe ventilatory threshold in professional sports. Physical Activity Review 2017; 5: 113-123. doi: 10.16926/par.2017.05.16

32. Podrigalo LV, Volodchenko AA, Rovnaya OA, Ruban LA, Sokol KM. Analysis of adaptation potentials of kickboxers'cardio-vascular system. Pedagogics, psychology, medical-biological problems of physical training and sports 2017; 21(4): 185–191. doi:10.15561/18189172.2017.0407