UDC [796.8: 796.09 / 378.147: 004]

ISSN (English ed. Online) 2311-6374

2020. Vol. 8. No. 6, pp. 121-134

EVALUATION METHODS OF COMPETITIVE ACTIVITY OF WRESTLERS WITH THE USE OF COMPUTER TECHNOLOGIES

Vyacheslav Romanenko

Valeriy Goloha

Anatoly Aleksieiev

Julia Kovalenko

Kharkiv State Academy of Physical Culture, Kharkiv, Ukraine

Purpose of the study is to theoretically substantiate, develop and experimentally test evaluation methods of competitive activity of combat athletes using computer technologies.

Material and methods: theoretical analysis and systematization of scientific sources on the state of the research problem, generalization of modern practical experience, instrumental research method, computer programming method, methods of mathematical statistics. To carry out a research in this area Department of Martial Arts with the support of specialists of the Department of Informatics and Biomechanics developed a specialized computer program that allows to optimize the process of evaluation and analysis of competitive activity of wrestlers.

Results: based on the analysis of scientific and methodological information, Internet sources and generalization of best practices, it was found that the most effective means of assessing competitive activity is video computer analysis. Also, the main parameters of competitive activity evaluation were determined. Viewing video clips of combat situations at competitions allows to identify a particular action, conditions and evaluation of its implementation more accurately. On the basis of data

analysis of scientific and methodical literature and generalization of practical experience, concerning problems of an estimation and the analysis of competitive activity, the computer program "Martial Arts Video Analysis" is created. The use of the proposed computer program allows to optimize the process of analysis of competitive activities of wrestlers. The information obtained through this program will allow to form various models of competitive activity and develop guidelines for improving the quality of the training process.

Conclusions: based on the analysis of scientific and methodological literature, practical experience the most significant parameters for evaluating the competitive activity of wrestlers were identified, methods with the use of computer technology that will optimize the process of evaluation and analysis of competitive activities of wrestlers was developed and tested.

Key words: martial arts, competitive activity, video computer analysis, methods, parameters, computer programming.

Introduction

The study of various aspects of preparedness of leading wrestlers allows to form the most popular areas for improving the process of training athletes who begin to participate in competitions of different levels [1, 3, 4, 5].

Specialists who conduct researches in this field, study the parameters that reflect, in their opinion, features of competitive activity of wrestlers. Thus, Brazilian researchers studied the relationship between attack duration, sex and weight category of athletes [16]. Korean scientists have considered aspects of the performance of poomsae (formal exercises) in taekwondo, which affect the judges' decisions, namely the transfer of body weight, the height and angle of kicks, the length of stances [18]. Spanish scientists have analyzed the attacking actions depending on the round and the characteristics of the fight in taekwondo [14]. Turkish researchers [12], based on the analysis of the 12th World Wrestling Championship among universities, identified the main indicators of the technique of qualified wrestlers. Scientists from Poland [11] studied the impact of changes in taekwondo sports regulations on the

composition of technical actions used by athletes. Boxing specialists, based on the analysis of video recordings of fights, received various characteristics of competitive wrestling, namely: coefficients of attack, defense, coefficients of combat [6].

In our opinion, the most effective means of assessing competitive activity is video computer analysis. Viewing video clips of combat situations at competitions allows to identify a particular action, conditions and evaluation of its implementation more accurately. The development of a convenient, effective method of evaluating and analyzing the competitive activity of wrestlers at the present stage of development of martial arts and new opportunities for computer technology is relevant.

Connection of work with scientific programs, plans and themes. The study was conducted in accordance with the research topics of the Kharkiv State Academy of Physical Culture: "Psychosensory regulation of motor activity of athletes of situational sports" (state registration number 0116U008943), "Scientific and methodological foundations of information technology in training specialists in physical culture and sports" (state registration number 0113U001207).

Purpose of the study is to theoretically substantiate, develop and experimentally test evaluation methods for the competitive activity of wrestlers using computer technology.

Material and methods

The following methods were used to solve the research problems: analysis of scientific and methodological information, Internet sources and generalization of leading practical experience, instrumental research method, computer programming method, methods of mathematical statistics.

To carry out a research in this area the Department of Martial Arts with the support of specialists of the Department of Informatics and Biomechanics developed a specialized computer program that allows to optimize the process of evaluation and analysis of competitive activity of wrestlers.

Results of the research

Based on the analysis of scientific and methodological information, Internet sources and generalization of best practices, it was found that to assess the competitive activity using various methods, the most popular of which is video computer analysis.

Also, the most significant parameters for evaluating competitive activities are identified, which include: the number of actions, the number of points that are an assessment of the action, the effectiveness of the action, the variety of actions performed and more.

Based on the conclusions that were noted earlier, on the issues of evaluation and analysis of competitive activities, a computer program "Martial Arts Video Analysis" was created.

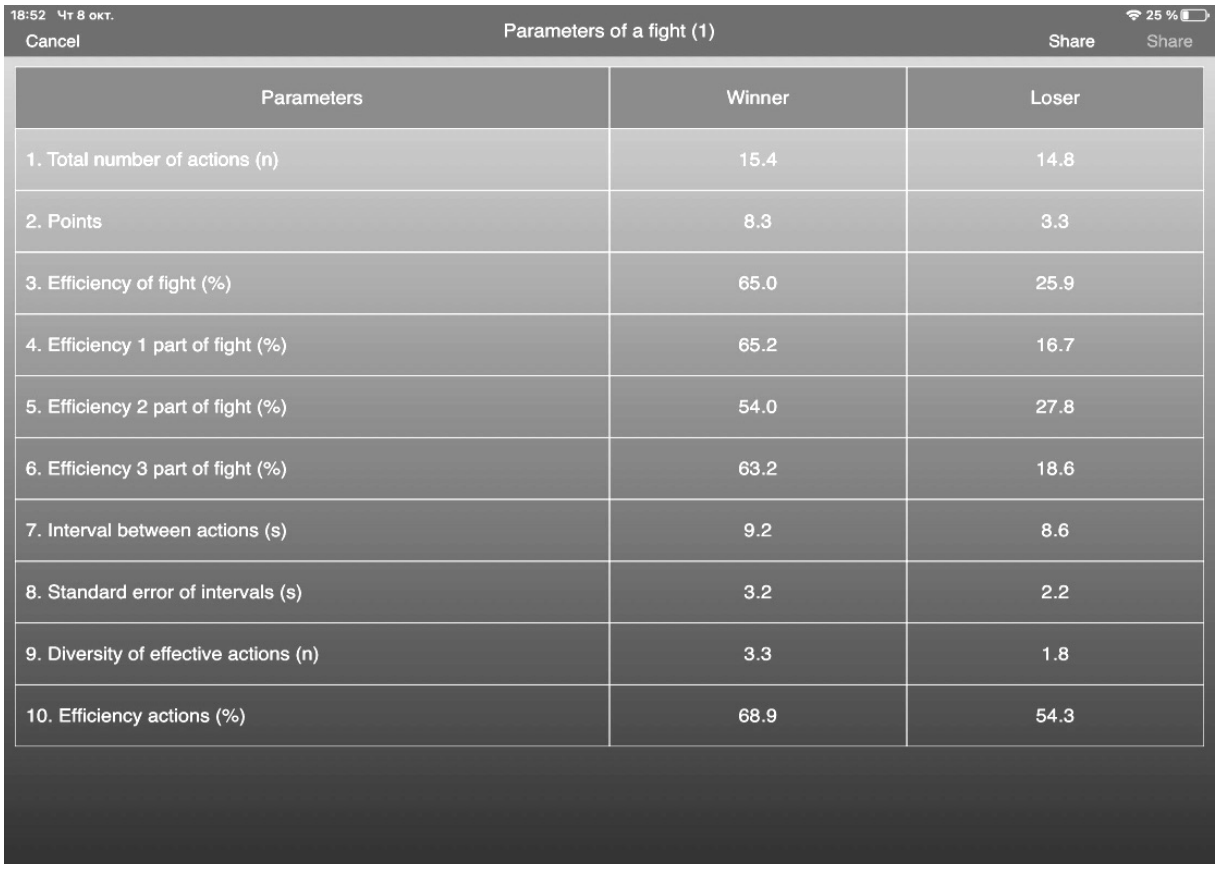
The algorithm of the computer program is developed in such a way that allows to capture the necessary moments of the competitive situation and evaluate them very quickly. The main feature of the program is that the parameters of evaluation of actions performed are created by the specialist, which allows to expand the scope of its use in various types of martial arts.

While watching the video of the competition, the researcher has the opportunity to stop for the required period of time and evaluate the athlete's performance. The computer program records the time, the name of the competitive action and the score on which it was performed. Frame-by-frame viewing of the video, which is provided in the program, allows to create the timing of all important actions in the opinion of the researcher more accurately.

In the process of creating a project of a competitive fight, the specialist has the opportunity to review the already recorded values and, if necessary, change them. If, after saving the project, there is a need to edit it, the program allows to change the data on athletes, change action ratings, add or delete individual actions.

After creating a project, the program allows to get a variety of reports, both for a single bout and a series of fights. Also, it is possible to get a report for the match, which consists of several rounds.

Report №1 presents general characteristics of a bout or series of fights: the total number of actions performed (n), the number of points received (points), the effectiveness of the whole fight (the ratio of effective actions to their total number,%), efficiency in different parts of the fight (%), the average value of the intervals between actions (c), the number of different actions that were evaluated with points (n) and their effectiveness (%) (Fig. 1).



Parameters	Winner	Loser
1. Total number of actions (n)	15.4	14.8
2. Points	8.3	3.3
3. Efficiency of fight (%)	65.0	25.9
4. Efficiency 1 part of fight (%)	65.2	16.7
5. Efficiency 2 part of fight (%)	54.0	27.8
6. Efficiency 3 part of fight (%)	63.2	18.6
7. Interval between actions (s)	9.2	8.6
8. Standard error of intervals (s)	3.2	2.2
9. Diversity of effective actions (n)	3.3	1.8
10. Efficiency actions (%)	68.9	54.3

Fig. 1. Characteristics of competitive activity (report №1)

Report №2 presents characteristics of the bout or series of fights: a list of competitive actions that were effective, the total number of actions performed (average per battle, n), the number of points received (average per battle, score), the effectiveness of actions (ratio of effective actions to their total number,%).

Report №3 is devoted to the analysis of competitive actions in a bout, which consists of several rounds. This report shows, for each round separately, the total number of competitive actions, the number of points obtained and the effectiveness of

these actions. When choosing a round, the researcher has the opportunity to view the timing of all actions or one of their choice (Fig. 2).

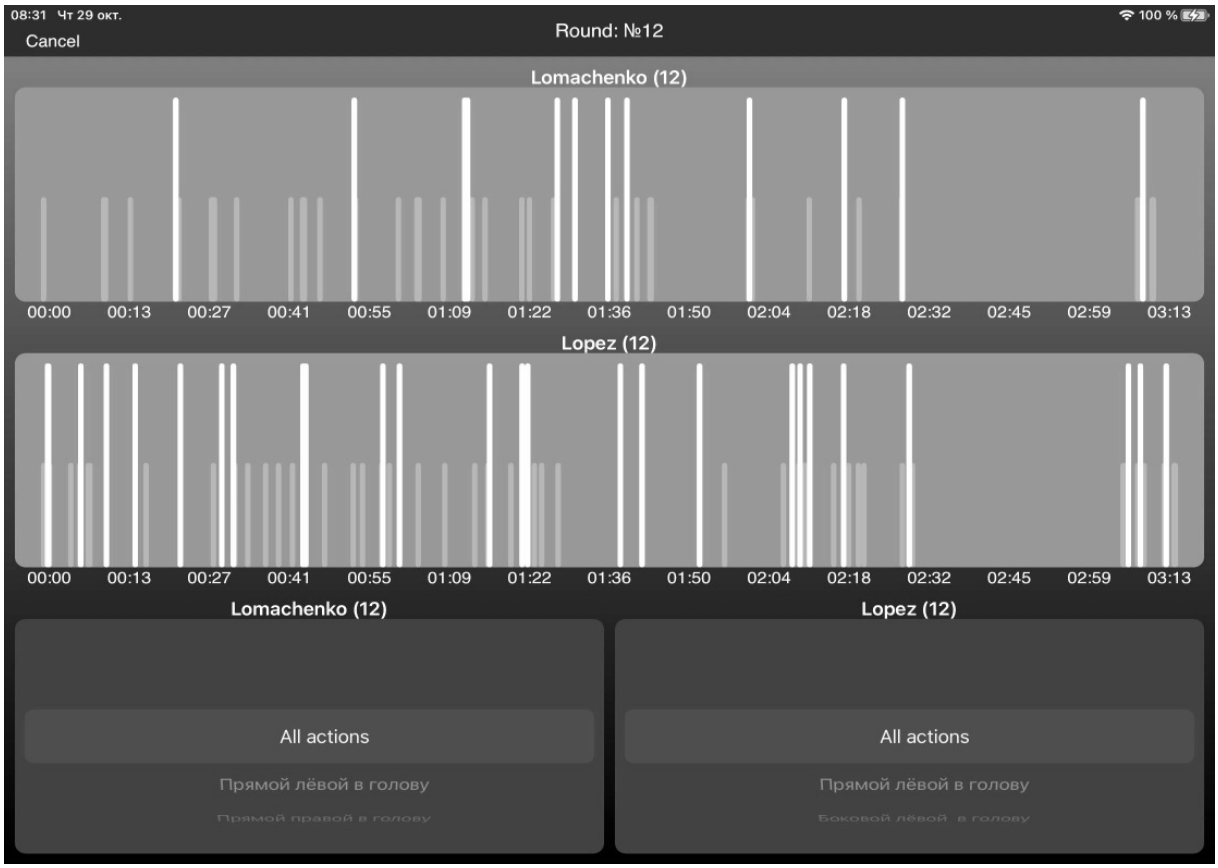


Fig. 2. Timing of competitive actions in the bout (report №3)

The computer program "Martial Arts Video Analysis" provides many opportunities to use the projects of competitive fights that have been created, namely: saving projects in the program itself or in a place specified by the user, the ability to forward projects to other devices and their further adjustment (if there is a corresponding video in the device).

Conclusions / Discussion

Researches of specialists Ashanin, V.S., Romanenko, V.V. (2015), Podrigalo, O., Borisova, O., Podrigalo, L., Iermakov S., Romanenko, V., Podavalenko, O., Volodchenko, O. (2019), Romanenko, V., Podrigalo, L., Cynarski, W., Rovnaya, O., Korobeynikova, L., Goloha, V., Robak, I. (2020) confirm the necessity and convenience of using computer technologies in the analysis of various aspects of training of wrestlers.

The study by González, D.E.L. (2013) claim that based on video-computer analysis of the competitive activities of skilled wrestlers, it is possible to determine the variety of actions, effectiveness of attack and defense, coefficients of work in the parterre, coefficients of tactical proactivity, average effective distances. Based on the study of these parameters, the researcher has the opportunity to create different models of competitive activities of wrestlers.

Specialists like Ostyanov, V.N., Hryb, A.I., Kopachko, O.V. (2010) in this kind of martial arts, such as boxing, argue that counting the number of strikes, different types of defense, as well as their effectiveness, you can identify some features of the individual manner of fighting. The number of such actions determines what form of combat is characteristic of a particular athlete. If attacking strikes prevail, respectively, the boxer is more prone to attacking form.

Analysis of the study results of the competitive activity of Greco-Roman wrestlers by Tropin, Y.M., Korobeynikov, G.V., Shatsky, V.V., Korobeynikov, L.G., Vorontsov, A.V. (2019) allowed to create model characteristics of technical and tactical training of wrestlers depending on their weight categories. Models presented by the experts can be used in solving problems of planning and management in the training process of wrestlers.

According to Romanenko V.V., Golokha V.L., Veretelnikova N.A. (2018), Romanenko V.V., Veretelnikova (2019) the use of video computer analysis in the assessment of competitive activities allows to determine the most important areas of technical and tactical training of wrestlers and the development of their functionality.

Approbation of the computer program "Martial Arts Video Analysis" was carried out by specialists from the Department of Martial Arts of KhDAFK. More than 50 bouts in such types of martial arts as taekwondo, wrestling (Greco-Roman, freestyle), boxing were analyzed. As an example, we provide several models of competitive activities that have been created in this program.

The first two models of competitive activity (Tables 1, 2) were developed from the review of the World Taekwondo Championship 2019 (a series of bouts n=10, medium weight categories).

According to the analysis of the obtained results, the athletes who won perform on average 1.4 actions more per match than those who lost (17,3±3,13; 15,9±2,43), the winners receive an average of 6, 7 points more (Table 1).

Table 1

Model characteristics of competitive fights of qualified taekwondo fighters (model №1)

№ п/п	Parametrs	Winner	SEM*(W)	Loser	SEM*(L)
1	Total number of actions (n)	17,3	3,13	15,9	2,43
2	Points	10	1,49	3,3	0,9
3	Efficiency of the fight (%)	37,3	6,32	16,6	5,95
4	Efficiency of the first part (%)	33,1	7,13	13,3	5,72
5	Efficiency of the second part (%)	38,5	13,19	23,5	11,9
6	Efficiency of the third part (%)	32,1	8,88	15,5	8,43
7	Interval between actions (s)	9,5	2,06	8,9	0,63
8	Diversity of effective actions (n)	3,3	0,56	1,6	0,32
9	Efficiency actions (%)	77,0	9,43	73,0	10,73

** SEM - standard error of the mean*

The efficiency of competitive actions of the winners is 20.7% higher than that of the losers (37,3±6,32%, 16,6±5,95%). The variety of actions that allow you to get points, the winners average 3,3±0,56 action per bout with their effectiveness of 77,0±9,43%, those who lost 1,6±0,32 action per fight with their efficiency is 73,0±10,7%.

Also, it should be noted the large values of SEM (standard error of the mean). For the reliability of the conclusions on the analysis of competitive activities of wrestlers a larger number of studied fights is needed.

Also, it is interesting to determine which competitive actions ensure victory (Table 2).

Thus, according to the analysis of the results (Table 2), most often the winners perform a "Yop chagi" kick, the one that is closer to the opponent (n=4,14), the efficiency of which is 13.8% and receive for its performance 1,14 points and "Ap

joomuk chirugi" hand strike, the one that is farther from the opponent (n=3,43), the efficiency of which is 54.2% and get 1.86 points for its performance. Some strikes for this series of fights (Pandae Dollyo chagi, Toro Yop chagi, Yop chagi jumping kick, Ap joomuk chirugi, front kick) are highly effective (100%), this is due to the fact that these actions are quite difficult in technical performance and are rarely used but the probability of winning points is high.

Table 2

Model characteristics of competitive fights of qualified taekwondo fighters (model №2)

№	Actions (points & n > 0	Total number	Efficiency of actions (%)	Points
1	Dollyo chagi, that is closer to the opponent	1,71	16,7	0,57
2	Dollyo chagi, that is farther from the opponent	1,29	33,3	0,86
3	Dollyo chagi, turning kick	0,43	66,7	0,86
4	Pandae Dollyo chagi	0,14	100	0,43
5	Twid chagi	0,43	33,3	0,29
6	Toro Yop chagi	0,43	100	0,86
7	Toro Yop chagi jumping kick	0,43	66,7	0,57
8	Yop chagi jumping kick	0,14	100	0,29
9	Yop chagi, that is closer to the opponent	4,14	13,8	1,14
10	Yop chagi, that is closer to the opponent, front kick	0,43	66,7	0,57
11	Ap chagi	0,57	25	0,29
12	Ap joomuk chirugi jumping kick	0,14	100	0,29
13	Ap joomuk chirugi, that is closer, front kick	0,57	75	0,43
14	Ap joomuk chirugi, that is farther, front kick	0,29	100	0,29
15	Ap joomuk chirugi, that is closer	1,14	50	0,57
16	Ap joomuk chirugi, that is farther	3,43	54,2	1,86

The second model was developed on the basis of the revision of the Ukrainian Freestyle Wrestling Championship 2020 (a series of fights n=30, middle age categories) (Table 3).

According to the analysis of the obtained results, the athletes who won on average perform 2.1 times more actions per match than those who lost (n=7,9; n=5,8) and receive 7,6±0,48 winning points, those who lost 1,4±0,36 points. The effectiveness of the winners' competitive actions is higher than that of the losers (per bout: 53,7±3,72%, by 11,4±2,5%). Also, it was noted that in all parts of the bout the winners have more effective technique (1 part of the duel – 53,5±5,74% by

17,7±5,21%, 2nd part – 37,6±6,97% by 2,2±1,52%, part 3–34,3±5,96% at 6,9±2,65%). The interval between competitive actions for the winners was 40,6±4,36 s, for those who lost 8,8 s more (49,4±6,0 s). The variety of actions that allow to get points, the winners average 2,6±0,17 action per bout with their effectiveness 92,4%, those who lost 0,8±0,17 action per bout with their effectiveness 40,8±8,35% (Table 3).

Table 3

Model characteristics of competitive fights of qualified wrestlers

№ п/п	Parametrs	Winner	SEM*(W)	Loser	SEM*(L)
1	Total number of actions (n)	7,9	0,53	5,8	0,59
2	Points	7,6	0,48	1,4	0,36
3	Efficiency of the fight (%)	53,7	3,72	11,4	2,5
4	Efficiency of the first part (%)	53,5	5,74	17,7	5,21
5	Efficiency of the second part (%)	37,6	6,97	2,2	1,52
6	Efficiency of the third part (%)	34,3	5,96	6,9	2,65
7	Interval between actions (s)	40,6	4,36	49,4	6
8	Diversity of effective actions (n)	2,6	0,17	0,8	0,17
9	Efficiency actions (%)	92,4	2,51	40,8	8,35

**SEM - standard error of the mean*

The computer program "Martial Arts Video Analysis" allows to create different models of competitive activities. Having a sufficient number of fights in the database and using the selection function, it is possible to analyze the weight categories, age, rank of the competition, to evaluate women's bouts separately and more.

Based on the analysis of scientific and methodological literature, practical experience the most important parameters for assessing the competitive activities of wrestlers are identified, namely: the number of actions, evaluation and effectiveness of their implementation, diversity, interval between actions and more.

Methods with the use of computer technology, that will optimize the process of evaluation and analysis of competitive activities of wrestlers is developed and tested.

Prospects for further research will be aimed at expanding the capabilities of the computer program "Martial Arts Video Analysis" in terms of analysis of competitive activities, increasing productivity and stability of its work.

Conflict of interests. The authors declare that no conflict of interest.

Financing sources. This article didn't get the financial support from the state, public or commercial organization.

References

1. Aranson, M. V., Shustin, B. N. (2018), "Actual directions of the analysis of the competitive activity of combatants", Pedagogicheskie nauki, Vypusк 9(75), pp. 99-101 (in Russ).
2. Ashanin, V. S., Romanenko, V. V. (2015), "The use of computer technologies to assess sensorimotor reactions in single combats", Slobozhans'kij naukovo-sportivnij visnik, No. 4, pp. 15-18 (in Russ).
3. Kozina, Zh. L., Demura, I. M. (2010), "The results of the application of mathematical modeling methods to determine the individual tactical manners of the fight in high-class judokas", Teorija ta metodika fizichnogo vihovannja, No. 7, pp. 17-38. (in Ukr.).
4. Korobejnikov, G. V., Aksjutin, V. V., Smoljar, I. I. (2015), "The relationship between boxing styles and psycho-physiological characteristics", Pedagogika, psihologija ta mediko-biologichni problemi fizichnogo vihovannja i sportu, No. 9, pp. 33-37 (in Ukr.).
5. Korobejnikov, G. V., Tropin, Ju. M., Vol's'kij, D. S., Zhirnov, O. V., Korobejnikova, L. G., Chernozub, A. A. (2020), "Development of an algorithm for assessing the neurodynamic properties of kickboxing athletes", Єdinoborstva, No. 3, pp. 36-48 (in Ukr.).
6. Ost'janov, V. N., Grib, A. I., Kopachko, O. V. (2010), "Competitive activity of boxers of heavy and light weight categories", Pedagogika, psihologija ta mediko-biologichni nauki, pp. 94-98 (in Ukr.).

7. Romanenko, V. V. (2008), "Biomechanical analysis of basic techniques performed by the legs", Fizicheskoe vospitanie studentov tvorcheskih special'nostej, No. 3, pp. 44-49 (in Russ).
8. Romanenko, V. V., Veretel'nikova, N. A. (2019), "Assessment of biomechanical characteristics in percussion martial arts using a mobile application", Edinoborstva, No. 1, pp. 48-57 (in Russ).
9. Tropin, Ju. M., Korobejnikov, G. V., Shackih V. V., Korobejnikova, L. G., Voroncov, A. V. (2019), "Model characteristics of technical and tactical readiness of highly qualified wrestlers in Greco-Roman style of various weight categories", Nauka v olimpijskom sporte, No. 1, pp. 29-35 (in Russ).
10. González, D.E.L. (2013), "Wrestler's Performance Analysis through Notational Techniques", International Journal of Wrestling Science, Vol.3, Issue2, pp. 68–89 (in Eng.).
11. Iermakov, S., Podrigalo, L., Romanenko, V., Tropin, Y., Boychenko, N., Rovnaya, O. (2016), "Psycho-physiological features of sportsmen in impact and throwing martial arts", Journal of Physical Education and Sport, Vol. 16(2), pp. 433-441 (in Eng.).
12. İmamoğlu, O., Erkin, A., Mayda, M.H. et al. (2017), "12 th Universities Wrestling Championship Free Style Competition Technical Analysis", European Journal of Physical Education and Sport Science. Volume 3, Issue 11, pp. 182 – 193 (in Eng.).
13. Kruszewski, A., Kuźmicki, S., Podchul, A., Kruszewski, M. (2014), "Effect of change sinthe sports regulations on the fight of taekwondo female players on the example of Beijing Olympic Tournaments 2008 and London 2012", Journal of Combat Sports and Martial Arts, Vol. 5, 2(2), pp. 97-100 (in Eng.).
14. Menescardi, C., Lopez-Lopez, J.A., Falco, C. et al. (2015), "Tactical aspect so fanational university taekwondo championship in relation to round and match out come", J Strength Cond Res 29(2), pp. 466–471 (in Eng.).
15. Romanenko, V., Podrigalo, L., Cynarski, W., Rovnaya, O., Korobeynikova, L., Goloha, V., Robak, I. (2020), "A comparative analysis of the short-term memory of

martial arts' athletes of different level of sportsmanship", Journal of Martial Arts Anthropology, No. 20(3), pp. 18-24 (in Eng.).
16. Santos, V.G.F., F.de Oliveira Pires, Bertuzzi, R. et al. (2014), "Relationship between attack and pause in world taekwondo championship contests: effects of gender and weight category", Muscles, Ligaments and Tendons Journal, 4 (2), pp. 127-131 (in Eng.).
17. Podrigalo, O., Borisova, O., Podrigalo, L., Iermakov S., Romanenko, V., Podavalenko, O., Volodchenko, O. (2019), "Comparative analysis of the athletes' functional condition in cyclic and situational sports", Physical education of students No. 23(6), pp. 313-319 (in Eng.).
18. Jo, Y.M., Kim, Y.S., Hong, S.H. et al. (2018), "Kinematic Analysis of Taekwondo Koryo Poomsae for Accurate Scoring in Competition", Journal of the International Association for Taekwondo Research, No. 3(2), pp. 17-25 (in Eng.).

Received: 07.12.2020.
Published: 21.12.2020.

Information about the Authors

Vyacheslav Romanenko: PhD (Physical Education and Sport), Associate Professor; Kharkiv State Academy of Physical Culture: Klochkivska st., 99, Kharkov, 61058, Ukraine.
orcid.org /0000-0002-3878-0861
E-mail: slavaromash@gmail.com

Valeriy Goloha: Kharkiv State Academy of Physical Culture: Klochkivska st., 99, Kharkov, 61058, Ukraine.
orcid.org /0000-0003-3733-5560
E-mail: vgolokha@gmail.com

Anatoly Aleksieiev: professor; Kharkiv State Academy of Physical Culture: Klochkivska st., 99, Kharkov, 61058, Ukraine.
orcid.org /0000-0002-9311-2858
E-mail: af.aleks38@gmail.com

Julia Kovalenko: Kharkiv State Academy of Physical Culture: 99 Klochkivska St., Kharkiv, 61058, Ukraine.
orcid.org /0000-0002-5736-4249
E-mail: julawa09@gmail.com