The Application of the Index Method to Assess the Condition of Armwrestling Athletes with Different Levels of Sports Mastery

**Olga ROVNAYA¹,
Leonid PODRIGALO²,
Sergii IERMAKOV³, Tetiana
YERMAKOVA⁴,
Vladimir POTOP⁵**

¹Kharkiv State Academy of Physical Culture, Kharkiv, Ukraine,
rovnaya77@ukr.net

²Kharkiv State Academy of Physical Culture, Kharkiv, Ukraine,
lpodrigalo@mail.ru

³Gdansk University of Physical Education and Sport, Gdańsk, Poland,
sergey.yermakov@hnpu.edu.ua

⁴Kharkiv State Academy of Design and Arts, Kharkiv, Ukraine,
yermakova2015@gmail.com

⁵Ecological University of Bucharest, Romania, vladimir_potop@yahoo.com

Abstract: *The purpose of this study was a comparative analysis of the physical development of armwrestlers with different levels of sports mastery applying the index method. Participants: 37 athletes were divided into 2 groups. Group 1 (n = 17, age - 18.94 ± 0.57 years), qualification – from beginners to 1 rank athletes. Group 2 (n = 20) age – 25.60 ± 1.10 years), qualification – from the candidate for the master of sports to the international master of sport. 19 anthropometric indices were applied for the analysis. Results: average results dominated by body mass index. The athletes with a shoulder width index below the norm prevailed in group 1. Erisman index for the majority of participants in group 2 complied with the standards. The athletes with a strong body build prevailed by Pignet index. The average Livi index is set in 40-47% of athletes. All athletes had a hypersthenic body build by Verveke index. Qualified athletes demonstrated the significant increase in body mass index, shoulder width, Erisman index, Livi index, Verveke index, body surface and relative body surface, limb segment mass and conditional moments of the force of limb segments strength. It was impossible to determine any significant differences between the groups by power and vital indices. Conclusions: It was confirmed the effectiveness of the physical development analysis of armwrestling athletes by indexes. Qualified athletes are characterized by high index values demonstrated muscle development. The mass indices and conditional moments of force of the limb segments strength demonstrate the predictors of success.*

Keywords: *Armrestling; physical development; indices; sports mastery level.*

How to cite: Rovnaya, O., Podrigalo, L., Iermakov, S., Yermakova, T., & Potop, V. (2019). The Application of the Index Method to Assess the Condition of Armwrestling Athletes with Different Levels of Sports Mastery. *Revista Romaneasca pentru Educatie Multidimensional*, 11(4 Supl. 1), 242-256. doi:10.18662/rrem/187

1. Introduction

The prediction of success in sport is one of the most important problems. Various methods and indicators are applied to that. The biochemical methods are the most adequate for prediction. Research of Volodchenko, Podrigalo, Iermakov, Zychowska and Jagiello (2019) demonstrated the informative studies of the saliva in kickboxing athletes in the dynamics of training. Based on the obtained results were developed indexes to demonstrate the condition of “lipid peroxidation – antioxidant protection” system and its prognostic significance was confirmed.

Evaluation of the morphofunctional indicators' correlations applying the correlation analysis can be applied as a tool for predicting the success of elite judo athletes (Korobeynikov, Korobeynikova, Romanyuk, Dakal, & Danko, 2017).

Ishihara, Kuroda and Mizuno (2019) determine that the applied tests should reflect the specificity of the sport in sports success predicting. This significantly increases the efficiency of the prediction.

The study and analysis of the athletes' physical development is an informative, valid and effective method for predicting the success and evaluating the effectiveness of training. Burdukiewicz, Pietraszewska, Stachon and Andrzejewska (2018) revealed the importance of anthropometric characteristics in sports success. The analysis of biometric data of martial arts athletes allowed determining the features of the somatotype, peculiar to the certain sports. It is concluded that the development of an anthropometric profile specific to the sport allows predicting sports success.

Konstantinova, Semyenova and Okhlopkova (2019) evaluated the characteristics of the physical development and body build of freestyle wrestlers. It was determined the characteristic features of the somatotype. The brachimorphic type of bodybuild dominated in wrestlers. The authors applied Rohrer index to determine the level of wrestlers' physical development.

Increasing the success in martial arts depends on optimal body composition, development of muscle strength, flexibility, anaerobic and aerobic potential (Mata-Ordóñez, Sánchez-Oliver, & Domínguez-Herrera, 2018). The proposed strategies are based on continuous body mass control.

The importance of the physical development indices application is determined in population studies of physical fitness. Wyss, Roos, Studer, Mäder, Beuchat and Staub (2019) applied body mass index for comparative

evaluation of young Swiss men. The stability of this indicator is associated with sufficient physical fitness.

Similar results are reported by Sandercock and Cohen (2019). The authors applied the anthropometric indicators to predict the physical development of English schoolchildren.

Other studies show the correlations between physical development and physical fitness of youth. It was confirmed the high significance of body mass index and thickness of skin and fat folds for predicting the condition of youth with different body types (Agata & Monyeki, 2018; Kolokoltsev, Iermakov, & Jagiello, 2018).

The comparative analysis of the physical, anthropometric and power qualities of rugby players was carried out by Pearce, Sinclair, Leicht and Woods (2018). The authors confirmed the high significance of these indicators for the prediction of success. It was proposed to apply the discriminant analysis for this purpose.

Turğut, Bağır, Sarıkaya and Tınaz (2019) applied the anthropometric indicators and indices as criteria for the effectiveness of women's health training.

Masanovic, Bavcevic and Prskalo (2019) proposed to apply the anthropometric indicators and indices based on them for selection in sports games.

Expressed power orientation of armwrestling is combined with the nature of martial arts. The success in armwrestling is largely determined by the strength of the athlete. This is confirmed by the results of many studies. Akpina, Zileli, Senyüzlü and Tunca (2013) studied the predictors of success in this sport. The main place among the determining factors is occupied by the power index, the length, and circumference of the forearm.

Harcarik (2013) emphasized the importance of strength training in armwrestling for success. The author offers various training options to achieve this goal.

The comprehensive system for predicting success in armwrestling developed by Podrigalo, Galashko, Iermakov, Rovnaya and Bulashev (2017) is based on the application of morphofunctional indicators. The important place among them is occupied by indices, in particular, the determination of the relative strength of the forearm muscles.

Silva et al. (2009) investigated the electromyographic activity of muscles involved in armwrestling. It was determined the dependence of the muscles' condition on the level of load and the position of the limb.

The *purpose of this study* was a comparative analysis of the armwrestling athletes' physical development with different levels of sports mastery applying the index method.

2. Material and methods

2.1. Subjects

The study involved 37 armwrestlers divided into 2 groups. Group 1 ($n = 17$, age – 18.94 ± 0.57 years), qualification – from beginners to 1 rank athletes. Group 2 ($n = 20$) age – 25.60 ± 1.10 years), qualification – from the candidate for the master of sports to the international master of sport.

2.2. Measures

The design of the study assumed the definition of 15 anthropometric indicators. The measurements were carried out according to the requirements of the international standardized methodology of anthropometric research (International Standards for Anthropometric Assessment, 2001). It was determined the length and body mass, the circumference of the chest, the width of the shoulders, the length and circumference of the limbs and its segments, the hand dynamometry of both hands, and the vital capacity of the lungs. The range of 19 indices was used for comparative analysis.

2.3. Procedure

The body mass index (BMI) was defined as the ratio of body mass (kg) to body length (m) squared. The norm is taken values of 20-25.

Erismann index was found as the difference of chest circumference and half the body length. Proportional physical development is characterized by a positive value of this indicator. Its value should be at least 5.8 cm in athletes.

Pignet index (PI) was determined by the formula:

$$PI = SB - (WB + CCP), (1)$$

where SB is the body length (cm), WB is the body mass (kg), CCP is the chest circumference in the pause (cm).

The index value less than 10 is rated as a strong bodybuild, 10-20 is good, 21-25 is average, 26-35 is weak, more than 36 is very weak.

The index of the width of the shoulders was found as the ratio of this parameter to the length of the body, expressed as a percentage. The norm is taken values of 23-25%.

The body surface according to Isaakson was defined by the formula:

$$S=1+\frac{WB+(SB-160)}{100} \quad (2),$$

where S is body surface (m²); WB– body mass (kg), SB– body length (cm).

Vervek index (VI) was determined by the formula:

$$VI = SB / (2 \times WB + CCP) \quad (3),$$

where SB is the body length (cm), WB is the body mass (kg), CCP is the chest circumference in the pause (cm).

In the VI value in the range of 0.75-0.85, the bodybuild is assessed as hypersthenic, 0.85-1.25 – normostenic and 1.25-1.35 is asthenic.

Livi index (LI) was determined by the formula:

$$LI = CCP/SB \quad (4),$$

where CCP is the chest circumference in the pause (cm), SB is the body length (cm).

The average LI is equal to 50-55%.

The relative body surface was defined by dividing the body mass (kg) by the surface area (m²).

The power index was defined as the ratio of hand dynamometry to body mass, expressed in percentage. The norm is taken values of 50-75%.

Vital index was defined as a correlation of vital lung capacity (ml) to body mass (kg). The norm is taken values of 65-70 ml/kg.

It was determined the indicators of the arm segment (shoulder, forearm) mass and the conditional moments of the shoulder and forearm strength, according to the formulas given in the study (Epyphanov, 1999):

Segment mass index = segment circumference * 100% / segment length, (5)

The conditional moment of the segment strength = segment circumference * segment length, (6).

2.4. Statistical analysis

Statistical analysis of the obtained data was carried out applying licensed MS Excel. It was determined the descriptive statistics indicators: arithmetic average, standard deviation, and error of the mean. It was determined the prevalence of the trait and its error in assessing the individual traits intensity. The significance of differences in the groups was evaluated applying the parametric Student's t-test (t) and the non-parametric Wilcoxon-Mann-Whitney (U) and Rosenbaum (Q) criteria.

3. Results

The obtained results are shown in table 1. The results of the carried out analysis indicate the significant differences between certain indices of physical development depending on the level of athletes' sports mastery.

Table 1. Indices of physical development of athletes armwrestling of different levels of sports mastery ($M \pm m$)

Development indices	Group 1	Group 2
Body mass index, kg / m ²	22.69±0.91	24.80±0.81
Erisman index, cm	4.65±1.90 ¹	10.25±1.92
Pignet index, ea	12.97±4.82 ¹	-1.30±4.87
Body surface according to Isaacson, m ²	1.85±0.04 ¹	2.01±0.05
Relative surface to body mass, kg / m ²	37.46±0.95	39.94±0.82
Shoulder width index, %	22.72±0.23	23.35±0.25
Power index of the left hand, %	75.89±2.60	78.69±2.18
Power index of the right hand, %	83.62±2.86	84.46±2.91
Vervek index, ea	0.77±0.02 ¹	0.70±0.02
Livi index, ea	0.53±0.01 ¹	0.56±0.01
Vital index, ml / kg	52.55±2.86	55.83±1.64
The right shoulder mass, ea	99.70±2.18 ¹	109.69±2.64
The left shoulder mass, ea	99.32±3.10 ¹	108.56±2.57
The right forearm mass, ea	114.45±2.42 ¹	125.44±2.07
The left forearm mass, ea	113.57±2.45 ¹	121.84±1.80
The right shoulder conditional moment of force, ea	1204.91±47.28 ¹	1338.96±39.72
The left shoulder conditional moment of force, ea	1180.16±47.63 ¹	1317.65±41.20
The right forearm conditional moment of force, ea	920.12±41.59	974.03±26.27
The left forearm conditional moment of force, ea	900.35±39.59	958.26±24.23

Note. ¹ – $p < 0.05$

Individual analysis of obtained results confirmed certain features in the distribution of data. According to the body mass index, the average results prevailed ($52.94 \pm 12.11\%$) in athletes of group 1 and ($60.00 \pm 10.95\%$) in athletes of group 2. The condition above average is set in ($17.65 \pm 9.25\%$) of group 1 and in ($35.00 \pm 10.67\%$) of group 2. The participants with the value of this index below the norm were ($29.41 \pm 11.05\%$) of group 1 and ($5.00 \pm 4.87\%$) of group 2. The average body mass index in the groups was within the normal range, but in group 2 it was significantly higher ($Q = 7, p < 0.05; U = 110, p < 0.05$).

The athletes with a shoulder width index below the norm prevailed in group 1; its proportion was ($64.71 \pm 11.59\%$). The average value of this index was ($35.29 \pm 11.59\%$) in beginner athletes. In group 2 ($70.00 \pm 10.25\%$), the average index value was ($5.00 \pm 4.87\%$) above the average and ($25.00 \pm 9.68\%$) below the average. The average index of the shoulders width in the groups was within the normal range, but in group 2 it was significantly increased ($U = 105, p < 0.05$).

The value of the Erisman index in the groups was different. In the majority of participants of group 2 met the standards ($70.00 \pm 10.25\%$). The proportion of such athletes in group 1 was ($47.06 \pm 12.11\%$). Athletes with this index below the norm were ($52.94 \pm 12.11\%$) in group 1 and ($30.00 \pm 10.25\%$) in group 2. This index was also significantly higher in group 2.

It was defined that persons with strong with body build prevailed among armwrestling athletes in assessing Pignet index. There were ($41.18 \pm 11.94\%$) of group 1 and ($70.00 \pm 10.25\%$) of group 2. A good body build was determined respectively, in ($5.88 \pm 5.71\%$) and ($10.00 \pm 6.71\%$), the average – in ($29.41 \pm 11.05\%$) and ($10.00 \pm 6.71\%$) and weak – in ($10.00 \pm 6.71\%$) and ($23.53 \pm 10.29\%$). The Pinet index was significantly less in group 2.

The average value of Livi index is set in ($47.06 \pm 12.11\%$) group 1 and ($40.00 \pm 10.95\%$) in group2. The level was above average, respectively, in ($29.41 \pm 11.05\%$) and ($50.00 \pm 11.18\%$), below the average in ($23.53 \pm 10.29\%$) and ($10.00 \pm 6.71\%$). This index was also significantly higher in group 2.

The analysis of Vervek index confirmed that all athletes are characterized by a hypersthenic body build. This index was significantly higher in group 2.

The increased level of power proportion index prevailed in athletes. The proportion of such participants was for the right hand ($76.47 \pm 10.29\%$) of group 1 and ($70.000 \pm 10.25\%$) of group 2. For the left hand, respectively, ($64.71 \pm 11.59\%$) and ($65.00 \pm 10.67\%$). The proportion of

athletes with a normal power index was for the right hand (23.53 ± 10.29)% of group 1 and (30.00 ± 10.25)% of group 2, for the left hand (35.29 ± 11.59)% of group 1 and (35.00 ± 10.67)% of group 2. There weren't athletes with a low level of power indices among the participants. It was impossible to define the significant differences between the groups for these indices.

The opposite trend is set according to the vital index. The level below the average is determined in (82.35 ± 9.25)% of group 1 and in (85.00 ± 7.98)% of group 2. The proportion of athletes with an average value of this index was, respectively, (5.88 ± 5.71)% and (15.00 ± 7.98)%. There were (11.76 ± 7.81)% of athletes with the index above the average in group 1, there weren't such athletes in group 2. The index also failed to determine the significant differences between the groups.

The significant increase in body surface and relative body surface ($p < 0.05$) was determined in qualified athletes.

The mass indexes of limb segments were higher in qualified athletes: right shoulder, left shoulder, right forearm, left forearm.

The similar correlation is determined for the limb segments conditional moments of force: right shoulder, left shoulder, right forearm and left forearm.

4. Discussion

The determined differences in the athletes of average age reflect the different experience of training and demonstrate the differences in the level of sports mastery.

The study design was aimed at identifying the specificity of the sport's influence on the functional condition of athletes. This can be confirmed in various ways. It is possible to apply the design based on a comparison of different sports athletes. This option was applied by Podrigalo et al. (2019a); Romanenko et al. (2018). This allowed identifying the most informative methods and tests for screening.

Comparison of the athletes' condition with different levels of sports mastery is more correspond with the task of predicting success. This study in synchronized swimming athletes was conducted by Rovnaya, Podrigalo, Aghyppo, Cieslicka and Stankiewicz (2016). The analysis of the functional condition of the respiratory system allowed the authors to identify indicators that are most significant for success in this sport.

The choice of physical development indices for prediction is stipulated by its widespread application in sports science. Ersoy, Kalkan and Ersoy (2019) applied physical development indexes to evaluate the

effectiveness of the football players' nutrition. The dynamics of body mass index allows to more accurately assessing the correlation between energy costs and energy consumption. This index and body fat content are informative indicators of physical development and nutrition.

Andres (2017) applied physical development indices to assess the characteristics of adaptation to study conditions. Body mass indexes, power index, indices reflecting the condition of the cardiovascular system were highly informative.

The range of indices reflecting physical fitness and adaptive capacity was applied to assess the dynamics of physical health under the influence of a multi-level system of differentiated education (Masliak & Mameshina, 2018). Krivoruchko, Masliak, Bala, Skripka and Honcharenko (2018) applied the physical development indices as a criterion for the effectiveness of training in cheerleading.

In our study, 19 indices were applied to demonstrate both the general physical development and the condition of individual systems, the development of individual groups of muscles. The similar range of indices was applied in the work of Podrigalo, Iermakov, Jagiello (2017). The authors applied it for a comparative analysis of the body build of different types of martial art athletes. It was confirmed the presence of features stipulated by the specifics of martial arts. The increased body mass index in wrestlers reflects the predominance of the muscle component of the somatotype. The Erisman and Pignet indices, the shoulder width index demonstrate the best muscle development in wrestlers and kickboxing athletes in comparison with karate and taekwondo athletes. The increase in the power index confirms the importance of grip force for success in the fight. The correlations of limb segments reflect the characteristics of martial arts techniques. It is proved the competence of applying special indices, especially demonstrating the correlation of limb segments in monitoring the functional condition of athletes.

The analysis of body mass index allows concluding that physical training has a significant effect on the athletes' condition. Among qualified athletes, there are more persons with a high level of this index and less with this index below the norm. This should be evaluated as a demonstration of the regular strength training effect on physical development. This index is widely applied in sports science and practice.

Podrigalo et al. (2019b) applied the body mass index for a comparative analysis of physical development and the somatotype of girls and females involved in dance and gymnastic sports.

The analysis of the shoulders width also supports this assumption. The distribution of athletes within the groups according to this index was close. The determined excess of the indicator for qualified athletes reflects the best development of the shoulder muscles.

The Erisman index demonstrates the development of body muscles. Its analysis confirms the best condition of qualified arm wrestlers. The average values of Erisman index were more than double in group 2. The athletes with normal levels of the index prevailed in group 2. There was a little less than half among beginner athletes.

The Pignet index should be rated as one of the main for athletes strength sports. Its distribution confirms this fact. Persons with a strong body build are the largest segment in both groups. The less value of the average value of this indicator in qualified athletes once again confirms the assumption concerning the effect of strength training on physical development.

Similar results were obtained by Priymak and Terentieva (2017). The authors evaluated the somatological characteristics of biathlonists as indicators of sports success. It was applied body mass indexes, Erisman, Pignet and vital index. It is concluded that success in a particular sport depends on the body build characteristics.

The proportion of athletes with an average Livi index is close in the studied groups. The distribution of participants according to the deviation from the norm is the opposite. The decrease of this index prevailed in the beginner athletes. On the contrary, half of the qualified armwrestlers had Livi index above the average. This once again demonstrates the long-term strength training effect on physical development. This assumption is confirmed by a comparative analysis of Vervek index.

Podrigalo, Istomin and Galashko (2010) proved that the power index is a predictor of success in armwrestling. The obtained results once again confirm this fact. Regular loads on the hand and forearm muscles led to the fact that the number of athletes with increased values of the power index prevailed and there are no athletes with decreased values. The lack of significant differences between groups should be assessed as a result of specialized training in armwrestling.

The opposite trend is revealed in analyzing the vital index. Available studies suggest armwrestling as a predominantly anaerobic sport (Podrigalo et al., 2010). The duration of the fights often does not exceed 20-40 seconds. Athletes do not need increased functionality of the respiratory system. This is precisely reflected by the decreased values of the vital index and the absence of significant differences between the groups. In addition, the

decrease in the vital index is possibly stipulated by the increase in muscles in athletes. This leads to an increase in body mass and also confirms the previous assumptions.

The importance of determining the body surface for success in martial arts was emphasized by the study of Tumanian and Martirosov (1976). The authors believed that the absolute and relative values of the surface allow judging the intensity of the metabolism of athletes.

In the work of Podrigalo et al. (2019b), it is indicated that the increase in body surface indices is due to an increase in the muscular component of the athletic athletes' somatotype. These indices are evaluated as success factors in martial arts. That is, the results obtained once again confirm the assumption of an increase in the proportion of the muscle component in qualified armwrestlers in comparison with beginners.

Podrigalo, Istomin and Galashko (2010) determined the need to apply the specific indices in armwrestling reflecting the correlation of the longitudinal and circumference sizes of limb segments, power index, indicators of the relative strength of forearm muscles, finger strength.

In our study, indices of limb segments mass and conditional moments of force were applied in this quality. These indices were proposed by Epyphanov (1999) to assess the effectiveness of rehabilitation. The determined excess of these indices in the group of qualified athletes also confirms the assumption of the importance of developing the limbs' muscles for success in armwrestling. The application of longitudinal indicators in these indices reflects the importance of long levers for armwrestling. The inclusion of limb segments in the indexes perimeter demonstrates the importance of these muscle groups' developments. Thus, the mass indices and conditional moments of the limb segments strength reflect the main factors important for success in armwrestling.

5. Conclusions

Thus, the obtained results confirmed the effectiveness of a comparative analysis of the athletes' physical development of armwrestling with different levels of sports mastery applying the index method. Athletes with a high level of sports mastery are characterized by higher values of indices demonstrated the development of muscles, reflecting a strong body builds. These include body mass index, Erisman index, shoulder width index, Livi and Vervek indices, power index, body surface indices. The lower value of Pignet index in group 2 demonstrates the increased body strength of qualified athletes.

The specificity of the sport influence on the athletes' body is confirmed by the results of the vital index. Low values of this indicator reflect the insignificant influence of the functional condition of the respiratory system on success in arm wrestling.

The value of the mass indices and conditional moments of the limb segments strength demonstrates the main factors important for success in armwrestling.

The simplicity and informativeness of the applied range of indices allow recommending its application in monitoring the functional condition of athletes' armwrestling.

References

- Agata, K., & Monyeki, M. A. (2018). Association Between Sport Participation, Body Composition, Physical Fitness, and Social Correlates Among Adolescents: The PAHL Study. *International Journal of Environmental Research and Public Health*, 15(12) <https://doi.org/10.3390/ijerph15122793>
- Akpina, S., Zileli, R., Senyüzü, E., & Tunca, S. A. (2013). Anthropological and Perceptual Predictors Affecting the Ranking in Arm Wrestling Competition. *International Journal of Morphology*, 31(3), 832–838. <https://doi.org/10.4067/S0717-95022013000300009>
- Andres, A. (2017). Physical education of students, considering their physical fitness level. *Physical Education of Students*, 21(3), 103-107. <https://doi.org/10.15561/20755279.2017.0301>
- Burdukiewicz, A., Pietraszewska, J., Stachoń, A., & Andrzejewska, J. (2018). Anthropometric profile of combat athletes via multivariate analysis. *The Journal of Sports Medicine and Physical Fitness*, 58(11), 1657-1665. <https://doi.org/10.23736/S0022-4707.17.07999-3>
- Epyphanov, V.A. (1999). *Medical physical culture and sports medicine*. Moscow, Medicine.
- Ersoy, N., Kalkan, I., & Ersoy, G. (2019). Assessment of nutrition status of Turkish elite young male soccer players in the pre-competition period. *Progress in Nutrition*, 21(1), 12-18.
- Harcarik, G. (2013). Development of the Strength Abilities in Armwrestling with the Help of Different Training Programs. *4th International Conference on Education and Sports Education (ESE 2013)*, pp. 11-12.
- International Standards for Anthropometric Assessment*, (2001), ISAK.
- Ishihara, T., Kuroda, Y., & Mizuno, M. (2019). Competitive achievement may be predicted by executive functions in junior tennis players: An 18-month follow-up study. *Journal of Sports Sciences*, 37(7), 755-761. <https://doi.org/10.1080/02640414.2018.1524738>

- Kolokoltsev, M.M., Iermakov, S.S., & Jagiello, M. (2018). Comparative analysis of the functional characteristics and motor qualities of students of different generations and body types. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 22(6), 287-294. <https://doi.org/10.15561/18189172.2018.0602>
- Konstantinova, L.I., Semyenova, E.I., & Okhlopkova, E.D. (2019). Morphofunctional Indicators of Organism of the Athletes-wrestlers of Yakutia. *Yakut Medical Journal*, 1, 23-26.
- Korobeynikov, G.V., Korobeynikova, L.G., Romanyuk, L.V., Dakal, N.A., & Danko, G.V. (2017). 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*, 21(6), 272–278. <https://doi.org/10.15561/18189172.2017.0603>
- Krivoruchko, N., Masliak, I., Bala, T., Skripka, I., & Honcharenko, V. (2018). The influence of cheerleading exercises on the demonstration of strength and endurance of 15-17-year-olds girls. *Physical Education of Students*, 22(3), 127-133. <https://doi.org/10.15561/20755279.2018.0303>
- Masanovic, B., Bavcevic, T., & Prskalo, I. (2019). Comparative study of anthropometric measurement and body composition between junior handball and basketball players from the Serbian national league. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 23(2), 90-95. <https://doi.org/10.15561/18189172.2019.0206>
- Masliak, I.P., & Mameshina, M.A. (2018). Physical health of schoolchildren aged 14-15 years old under the influence of differentiated education, *Pedagogics, psychology, medical-biological problems of physical training and sports*, 22(2), 92–98. <https://doi.org/10.15561/18189172.2018.0205>
- Mata-Ordenez, F., Sanchez-Oliver, A., & Dominguez-Herrera, R. (2018). Importance of Nutrition in Weight Loss Strategies in Combat Sports. *Journal of Sport and Health Research*, 10(1), 1-12.
- Pearce, L.A., Sinclair, W.H., Leicht, A.S., & Woods, C.T. (2018). Physical, Anthropometric, and Athletic Movement Qualities Discriminate Development Level in a Rugby League Talent Pathway: *Journal of Strength and Conditioning Research*, 32(11), 3169–3176. <https://doi.org/10.1519/JSC.0000000000002350>
- Podrigalo, L., Iermakov, S., Romanenko, V., Rovnaya, O., Tropin, Y., Goloha, V., & Halashko, O. (2019a). Psychophysiological features of athletes practicing different styles of martial arts - the comparative analysis. *International Journal of Applied Exercise Physiology*, 8(1), 84-91. <https://doi.org/10.30472/ijaep.v8i1.299>
- Podrigalo, L., Artemieva, H., Rovnaya, O., Panshyna, A., Ruban, L., Merkulova, T., Galashko, M., & Chernukha, O. (2019b). Analysis of the physical

- development and somatotype of girls and females involved into dancing and gymnastic sports, *Physical Education of Students*, 23(2), 75-81. <https://doi.org/10.15561/20755279.2019.0204>
- Podrigalo, L.V., Iermakov, S.S., Jagiello, W. (2017). Special indices of body composition as a criterion of somatic development of martial arts practitioners. *Arch Budo Sci Martial Art Extreme Sport*; 13: 5-12.
- Podrigalo, L.V., Galashko, M.N., Iermakov, S.S., Rovnaya, O.A., & Bulashev, A.Y. (2017). Prognostication of successfulness in arm-wrestling on the base of morphological functional indicators' analysis. *Physical education of students*, 21(1), 46. <https://doi.org/10.15561/20755279.2017.0108>
- Podrigalo, L.V., Istomin, A.G., & Galashko N.I. (2010). *Monitoring of the functional state of the athletes in arm sport*. Kharkov: KNMU Publ. [in Russian]
- Priymak, S.G., & Terentieva, N.O. (2017). Somatologic characteristics of biathlon students' body constitution in predicting of their successfulness. *Pedagogics, psychology, medical-biological problems of physical training and sports*, 21(4), 192-199. <https://doi.org/10.15561/18189172.2017.0408>
- Romanenko, V., Podrigalo, L., Iermakov, S., Rovnaya, O., Tolstoplet, E., Tropin, Y., & Goloha, V. (2018). Functional state of martial arts athletes during implementation process of controlled activity - comparative analysis. *Physical Activity Review*, 6, 87-93. <https://doi.org/10.16926/par.2018.06.12>.
- Rovnaya, O.A., Podrigalo, L.V., Aghyppo, O.Y., Cieslicka, M., & Stankiewicz, B. (2016). Study of Functional Potentials of Different Portsmanship Level Synchronous Swimming Sportswomen under Impact of Hypoxia. *Research Journal of Pharmaceutical Biological and Chemical Sciences*, 7(4), 1210-1219.
- Sandercock, G.R.H., & Cohen, D.D. (2019). Temporal trends in muscular fitness of English 10-year-olds 1998-2014: An allometric approach. *Journal of Science and Medicine in Sport*, 22(2), 201-205. <https://doi.org/10.1016/j.jsams.2018.07.020>
- Silva, D. C. de O., Silva, Z., Sousa, G. da C., Silva, L. F. G. e, Marques, K. do V., Soares, A. B., ... Bérzin, F. (2009). Electromyographic evaluation of upper limb muscles involved in armwrestling sport simulation during dynamic and static conditions. *Journal of Electromyography and Kinesiology*, 19(6), e448-e457. <https://doi.org/10.1016/j.jelekin.2008.09.014>
- Tumanian, G.S., & Martirosov, E.G. (1976). *Constitution and sport*. Moscow: Physical Culture and Sport.
- Turgut, M., Bağır, S., Sarıkaya, M., & Tinaz, Ü. (2019). The effect of 8 week resistance exercise on some anthropometric measurements and body composition to Sedentary Women. *Physical Education of Students*, 23(2), 93-97. <https://doi.org/10.15561/20755279.2019.0207>
- Volodchenko, O.A., Podrigalo, L.V., Iermakov, S.S., Zychowska, M.T., & Jagiello, W. (2019). The Usefulness of Performing Biochemical Tests in the Saliva

- of Kickboxing Athletes in the Dynamic of Training. *Biomed Research International*, 2019, 7. <https://doi.org/10.1155/2019/2014347>
- Wyss, T., Roos, L., Studer, F., Mäder, U., Beuchat, C., & Staub, K. (2019). Development of physical fitness performance in young Swiss men from 2006 to 2015. *Scandinavian Journal of Medicine & Science in Sports*, 29(4), 586–596. <https://doi.org/10.1111/sms.13376>