

Adaptation to endurance load in youths

GEORGIY KOROBAYNIKOV¹, IVAN GLAZYRIN², VLADIMIR POTOP³, VOLODYMYR ARCHIPENKO⁴,
VALENTINA GLAZYRINA⁵, OLEKSANDR DUDNYK⁶, LESIA KOROBAYNIKOVA⁷, NATALIYA DAKAL⁸

^{1,7}National University of Physical Education and Sport, Kiev, UKRAINE

^{2,4}Cherkasy Institute of Fire Safety named after Chornobyl Heroes, Cherkasy, UKRAINE

³Ecological University of Bucharest, ROMANIA

⁵Bohdan Khmelnytsky National University, Cherkasy, UKRAINE

⁶Bila Tserkva National Agrarian University, Bila Tserkva, UKRAINE

⁸National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute», Kiev, UKRAINE

Published online: May 31, 2019

(Accepted for publication April 30, 2019)

DOI:10.7752/jpes.2019.s3149

Abstract.

Purpose: the study of peculiarities of adaptation to endurance load in youths 15-17.

Material: Material: 90 youths age 15-17 were examined. All of persons divided into three age groups: 15 age (30 youths), 16 age (30 youths), 17 age (30 youths). All of youths were separated on three groups by morphological development. The first group related with Accelerated of Physical Development (APD). The second group associated with Moderate Physical Development (MPD). The third group corresponded with Retarded Physical Development (RPD). The Cooper's 12-minute test, used a 15-minute run of fixed distance covered during this interval of time were used. *Results:* The complex evaluation of tempos of morpho-functional adaptation of organism in youths was studied. In results of this data the programs of the training of the main physical abilities were elaborated. As a result of this work were differentiated the separated the groups of youth on different types. Individual typological peculiarities of the physical development, puberty, the type of physique, the activity of the respiratory and cardiovascular systems of youths were studied. The individual indicants of the body exertions were identified; the ways of training of main motional abilities by the successions of exercise and their relation to the endurance development were clarified. *Conclusions:* The streaming of the 15-17 youths into several groups according to the rate of development shows the differences not only in the morphofunctional indicants, but also in the reaction of the organism to the single-action exertions and adaptation for them in the exercise system. As a result, it increases the effectiveness of the process of the physical preparedness. The selection of the physical exertions, that are relevant to according the peculiarities of age groups leads to improve of adaptation process to physical load. It result in growth of the efficiency and specified the sensitive periods of the development of endurance in youths.

Key words: adaptation, youths, endurance load, morpho-functional development.

Introduction

The adaptation criteria are those indicators of activity of the whole organism or its physiological systems that determine the new level of functioning. When changing the stimulus force, the physiological systems correspond to an increase or a decrease of adaptation level [1,2]. Therefore, it is important to study the adaptive changes that occur in the physiological systems in the process of adaptation to physical load, and the ones that characterize the completion of this process at a certain stage of interaction of an organism and an environmental factor [3].

It is known that certain types of constitution are characterized by certain paces of development [4], for example: astenoid-thoracic is characterized by the late maturity; digestive-muscular by to early one. Therefore, the representatives of the digestive and digestive-muscular type of the constitution are placed in group I. Group II includes muscular, muscular-thoracic and muscular-digestive types; group III embraces asteroid and astenoid-thoracic types of constitution.

The level of physical development is considered to be an integral indicator of puberty, somatotype and physical fitness [5,6]. Physical development is not only an integral manifestation of human capabilities, but it is a component of the concept of person's health and it is characterized by a number of objective factors such as: anthropometric indicators, power, capacity and efficiency of energy production mechanisms, muscles strength and endurance and neuro-muscular coordination. Therefore, when evaluating individual paces of males' development, the preference was given to their physical development. As a result of the coincidence of evaluation of three or

two indicators, on the ground that one of them is the physical development, the typological groups of males were determined [7].

Practically every physiological indicator can be a criterion of the physical activity dosage. In the case of a short-term adaptation, it is very important the number of repetitions of an exercise, rest intervals and adequacy of the action on vegetative system. With long-term adaptation the dosage can mean setting of the limits in the development of physical qualities, the degree of fitness and economization to physical activities [8].

Materials and methods

90 youths age 15-17 were examined. All of persons divided into three age groups: 15 age (30 youths), 16 age (30 youths), 17 age (30 youths). The nature of the relationships between the main morph-functional characteristics in youths of 15-17 was studied. But for the complex method of determining the paces of their development we used only the level and the pace of physical, sexual and somatic development. Limited use of morph functional indicators in our methods is the possibility of its wide application in the practice of physical education [9]. A physical education specialist can easily determine these indicators in the field conditions but others need to be done in the laboratory. To study the pace of morph functional development in youths of 15-17, the obtained data are included in the table of comprehensive assessment. It includes the following components: the body length, the body weight, the chest girth, the assessment of physical development, the index of harmonic morphological development (IHMD), evaluation of puberty paces and the typological group. All of youths were separated on three groups by morphological development.

The first group (I) related with Accelerated of Physical Development (APD). The pace of development of this group is surpasses the passport age. The tempo of developed in youths are accelerated, characterized by high or above average physical development, accelerated puberty which corresponds to muscle, digestive and combined types of constitution. The second group (II) associated with Moderate Physical Development (MPD). The pace of development corresponded of the passport age. They are normostenics, who are characterized by the average physical development, the pace of puberty corresponds to their age which is typical of the thoracic, thoracic-muscular and muscular-thoracic type of the constitution. The third group (III) corresponded with Retarded Physical Development (RPD). The pace of development is lagging behind the passport age. They are have delayed tempo of physical developed, who are characterized by low or below average physical development, slowed puberty rate, which corresponds to the asthenoid constitution type.

Results

To improve body endurance of the males, we, by analogy with K. Cooper's (1970) 12-minute test, used a 15-minute run of fixed distance covered during this interval of time. This choice is predetermined by a three-kilometer norm of endurance at school Physical Education curriculum. The 3000 m-run in 15 minutes brings positive result in this test type. The circle racetrack of 200-400 m was equipped with information boards placed at every 50 m. Measurement of the covered distance in 15 minutes was done by counting the number of circles and meters in the last circle for each persons. Furthermore, at the beginning and at the end of the study heart rate and frequency of breathing at rest and lung vital capacity at rest and after the exercise were recorded. The maximum oxygen consumption (MOC) was studied on the basis of the submaximal step-test if Astrand-Rhyming nomogram.

One of the aims of the study was to examine the process of efficiency increase in youths of 15-17 of different typological groups under physical activity which aimed at endurance development (table 1).

Table 1 Endurance development in youths of 15-17 from different typological groups (M±m)

Age	Group	Development of endurance (distance in meters covered in a 15-minute- run at each lesson)											
		1	2	3	4	5	6	7	8	9	10	11	12
15	I	2733± 20,6	2748± 22,7	2775± 23,3	2808± 23,2	2844± 25,0	2872± 24,1	2887± 26,9	2919± 25,9	2927± 24,8	2964± 20,8	2983± 27,2	3012± 30,4
	II	2763± 27,6	2808± 32,8	2844± 23,3	2859± 36,7	2866± 43,5	2873± 47,8	2876± 57,0	2923± 31,2	2947± 42,8	2970± 40,8	2990± 37,1	3018± 33,3
	III	2711± 7,5	2740± 30,5	2778± 31,8	2788± 20,4	2843± 30,5	2854± 20,7	2889± 33,5	2897± 38,0	2934± 30,1	2977± 47,1	3023± 32,1	3034± 40,7
16	I	2705± 28,7	2734± 27,9	2765± 28,9	2792± 28,8	2794± 25,4	2827± 26,1	2881± 24,8	2889± 23,2	2912± 21,5	2990± 21,2	2947± 20,4	3000± 27,1
	II	2822± 16,5	2869± 16,2	2913± 18,2	2928± 20,2	2954± 20,2	2990± 16,9	3017± 19,7	3040± 23,0	3054± 22,1	3072± 29,9	3101± 32,5	3121± 24,1
	III	2738± 22,1	2798± 20,1	2848± 19,8	2874± 21,0	2901± 20,0	2933± 20,1	2954± 21,7	2960± 28,8	2970± 17,0	2994± 24,7	3030± 20,2	3053± 24,8
17	I	2661± 31,8	2702± 32,6	2762± 31,9	2802± 30,2	2826± 27,7	2878± 28,0	2916± 19,0	2933± 18,5	2980± 17,0	2987± 13,3	3008± 12,9	3027± 14,9
	II	2769± 20,0	2824± 19,3	2854± 24,2	2905± 26,7	2921± 28,0	2903± 38,	2977± 20,1	2993± 27,3	3012± 30,0	3040± 24,1	3052± 27,1	3058± 30,4
	III	2752± 20,3	2810± 20,7	2863± 24,1	2883± 27,5	2888± 26,8	2914± 21,6	2926± 12,9	2971± 12,0	2987± 21,0	3007± 22,2	3011± 19,7	3034± 20,1

The general analysis of the data showed, at first glance, even or wavelike results growth of a fifteen-minute run in all age groups (Table 1). But a more detailed comparison of their gains with the usage of Student's criterion showed that youths of 15-17 from different typological groups did not equally adapted to the physical load aimed at the endurance development.

The 15-year-olds of the APD achieved significant incremental results ($p < 0.05$) at lessons 4, 7 and 10. Consequently, three stages of significant increases in efficiency of endurance were obtained. For the 15-year-olds of MPD three stages of significant increases in endurance indices were determined, but their results differed, as a substantial increase ($p < 0.05$) was obtained at lessons 3, 8 and 12 (Table 1). Retardants had the highest rates of endurance growth among persons of this age category. They had 4 stages of significant increases of efficiency at lessons 4, 6, 9 and 11 (Table 1). Among youth of 16 of 1 typological group have analogical dynamics to the physical exertions endurance in the same way as their predecessors of the same group, excluding the last stage results, which they got not at lessons 10, but at lessons 11 (Table 1).

Among persons of typological groups II and III of this age category are the most adapted to long-term loads of moderate intensity. During the study period, they demonstrated five stages of endurance growth, and every two or three lessons brought significant increments in results ($p \leq 0.05$). It should be noted, that the first four stages are identical. They are lessons of 2, 4, 6 and 9. The final period of endurance increase occurred in the group II at lesson 12, in group III - at lesson 11. Experimental studies in all typological groups between youths of 17 showed four stages in the development of endurance. In group I, essential increases were demonstrated at every three classes – at lessons 3, 6, 9 and 12. In group II it happened at lessons 2, 4 and 10, and in group of retardants increase was exposed initially at lessons 2 and 14, but then at lessons 8 and 12 (Table 1).

The results of analysis show that every typological age group of youths 15-17 had its own, inherent only to the period of significant improvement in endurance power at lessons 2 and 4, at lessons 4 and 6, at lessons 8 and 9 and at lessons 10 and 12 (Table 1). The grading, quantity, number, duration and amplitude of the stages of endurance increase in the investigated contingent of males are shown in Figure 1.

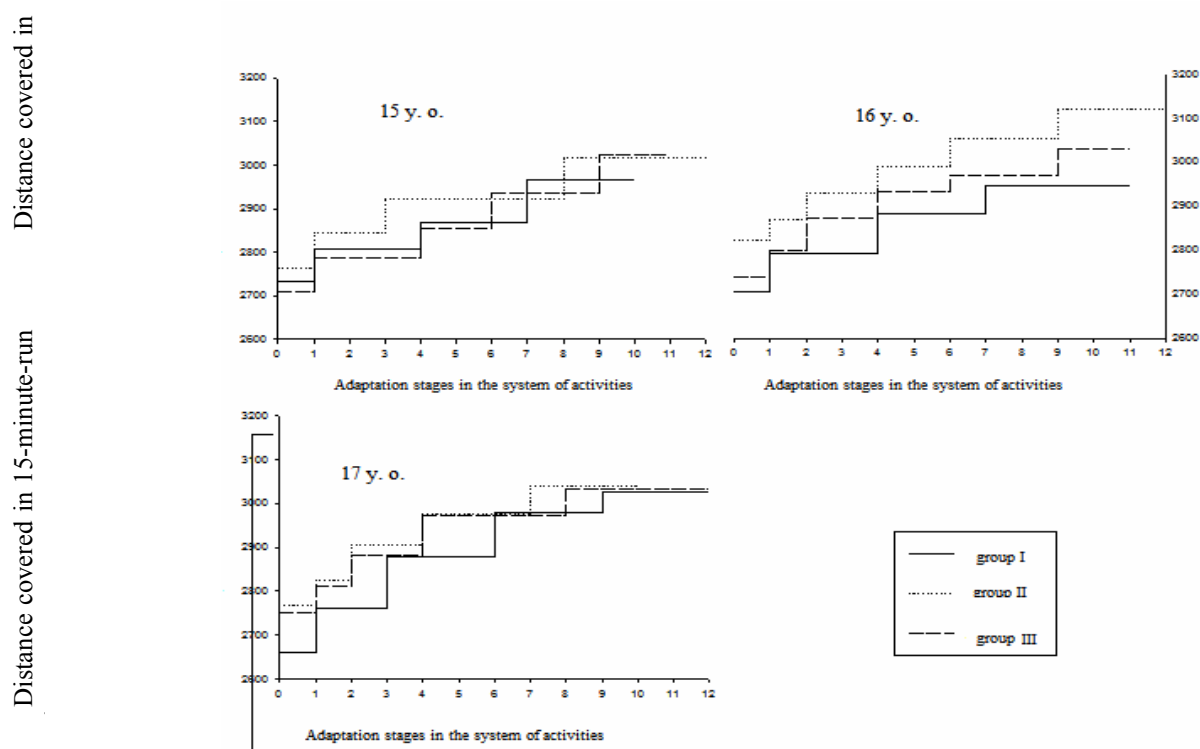


Figure 1. The dynamics of adaptation in youths of 15-17 of different typological groups to a series of physical activities aimed at the endurance development.

Analysis of the average data of the increase in the results of a fifteen-minute running during the series of 12 lessons and one lesson showed the differences in the dynamics of growth in the indices of endurance (fig. 2). Thus, those with accelerated rates of development demonstrated a clear tendency to the increased rates of growth with the indicators from 15 to 16, and it is especially typical of 16 - 17.

Among the youths who demonstrated slower rates of development, the back dynamics was observed – the growth of the results of running decreased from 15 to 17. Youths who had normal pace of development, in the

period from 15 to 16, demonstrated an active result increase, but at the age of 16 - 17 this process slowed down significantly.

It can be concluded that endurance in youths was trained hardest at the age of 15 and there was a tendency of improving conditions for its perfection in the period approaching 16 years and especially 17 years, when there was an intense increase in this physical characteristic. People of average height and weight revealed endurance that was somewhat harder, especially in youths of 15 who had the lowest increase in the growth of power movement. The rates were intensively growing by the age of 16, but then they slowed down again at the age of 17.

Fifteen-year-old retardants are characterized by rather intensive growth processes of endurance indices, but with age growing this typological group showed significant decrease in endurance development.

Therefore, due to the fact that the seventeen-year-old youths with accelerated paces of development revealed significant endurance growth it can be assumed that this category of the studied persons is the most susceptible to the development of this physical characteristic.

It is necessary to mention that 15-16-year-old retardants recorded relatively significant growth in endurance run results. Less favorable conditions for endurance improving were demonstrated by seventeen-year-old retardants, fifteen-year-old with accelerated physical developed, and especially with the moderate developed of this age category.

It is noteworthy that youths of 15–17 confirmed not only the difference in the periods of long-term adaptation to physical loads, aimed at endurance development, but there were differences in its dynamics in the age typological aspect and various sensitive periods with improving of motorical quality.

In the result of physical activities aimed at the endurance development some adaptive changes in the functioning of body systems limiting such activity occurred: cardiovascular system and respiratory system (Table 2).

The dynamics of indicators that are represented of changes under the influence of endurance loads could confirm higher training efficiency, increased parasympathetic effects on the respiratory (BR), cardiovascular systems (HR in a state of rest and after physical load), and improving the power of oxygen transport systems or aerobic power (MOK).

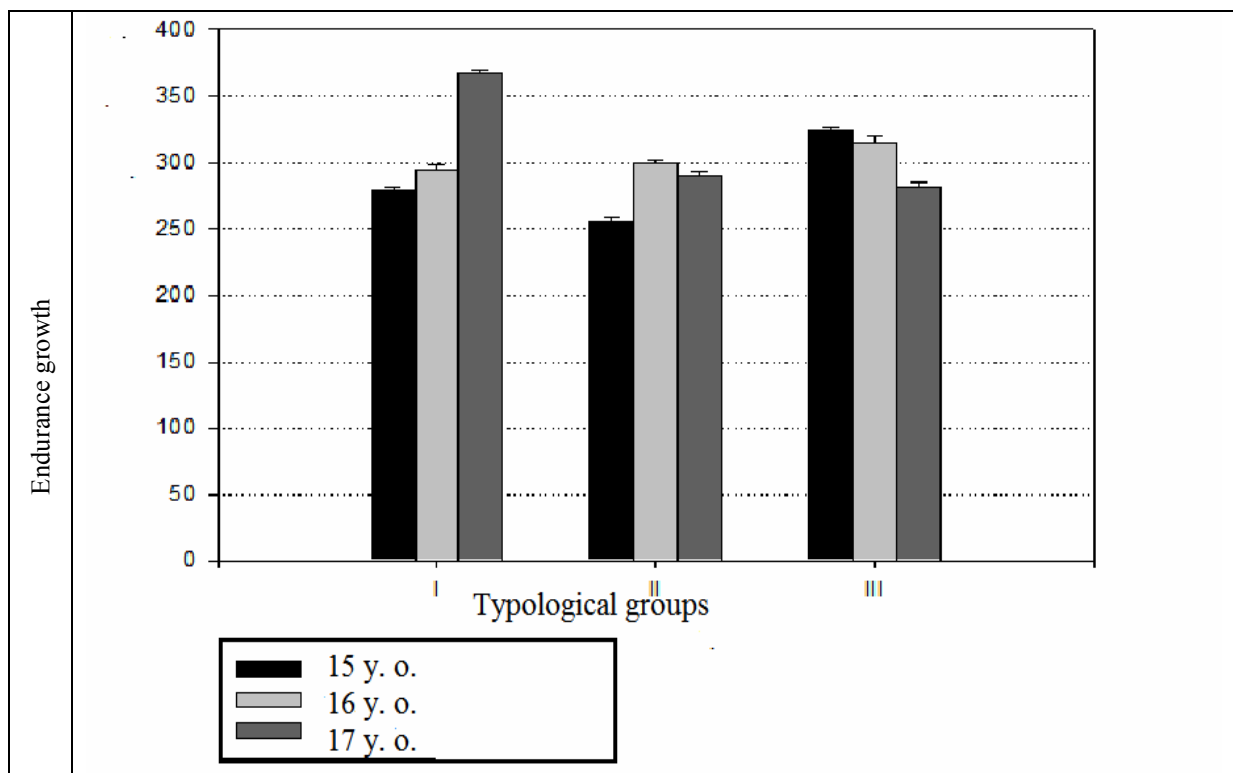


Figure 2. Dynamics of endurance growth

Furthermore, in all typological age groups of the studied contingent of youths the indicators of maximum oxygen consumption increased significantly ($p < 0.05$). The only exceptions are youths of 17 with accelerated physical developed.

Table 2 The influence of a series of prolonged moderate physical loads on the functional systems of the body of 15–17 year-old males from various typological groups (M±m)

Age	Group	Physiological parameters of loads									
		Breathing rhythm in the condition of calmness (BR) (per min)		Maximum oxygen consumption (MOC) (l/min)		Lung capacity (LC) (sm ³)		Resting heart rate per min(RHR)		Exercise heart rate per min	
		Before the study	After the study	Before the study	After the study	Before the study	After the study	Before the study	After the study	Before the study	After the study
15	I	19,04± 1,05	18,77± 0,84	3,36± 0,11	3,71± 0,07	2647,02± 43,40	2684,14± 46,92	72,37± 1,19	71,24± 2,14	153,21± 2,02	145,14± 2,91
	II	21,80± 0,97	20,01± 0,66	2,69± 0,07	3,04± 0,10	2523,16± 37,90	2617,43± 41,70	73,69± 1,02	71,01± 0,86	152,30± 3,15	148,52± 2,67
	III	22,43± 0,67	20,14± 0,59	2,38± 0,10	2,92± 0,13	2491,72± 40,08	2554,69± 43,84	75,31± 1,14	72,12± 1,03	159,91± 2,76	152,61± 3,90
16	I	18,19± 1,32	18,00± 1,05	3,64± 0,14	3,97± 0,09	3008,62± 34,91	3117,97± 30,18	70,23± 1,09	68,49± 0,71	147,74± 3,00	140,01± 2,22
	II	19,34± 0,83	18,78± 0,80	3,17± 0,09	3,64± 0,10	2826,00± 51,40	2974,00± 43,62	71,46± 1,19	69,04± 0,90	150,02± 2,84	148,14± 3,07
	III	20,11± 0,72	18,03± 0,67	2,47± 0,09	3,16± 0,19	2689,29± 34,11	2728,10± 37,92	75,08± 1,03	72,01± 1,07	152,94± 2,27	149,50± 2,91
17	I	17,04± 1,30	17,22± 0,92	3,74± 0,11	3,92± 0,08	3561,41± 62,30	3592,03± 60,07	69,68± 0,88	68,93± 0,67	151,3± 2,81	143,07± 2,90
	II	18,22± 1,47	17,83± 1,04	3,53± 0,09	3,83± 0,10	3319,77± 29,94	3422,84± 32,44	68,80± 0,95	68,01± 0,45	152,00± 2,74	145,73± 3,11
	III	18,94± 0,41	17,30± 0,59	2,85± 0,11	3,29± 0,09	3140,00± 61,00	3186,00± 66,18	70,75± 0,92	68,30± 0,67	148,22± 3,11	146,10± 3,00

Discussion

The further analysis of the physiological measurements, obtained at the beginning and at the end of the experiment, confirmed that the studied youths, of the typological group III of 15-17, demonstrated some similar adaptive changes which occurred as a reaction to the succession of physical exertions focused on the improving of endurance. Besides MOK, the indicants of HR and BR in the conditions of rest bettered too ($p < 0.05$). The same meaningful adaptive changes of maximum consuming of the oxygen and vital lung capacity occurred in group II of 16-17.

The adaptive reactions of the males from other age typological groups are more individual. For example, for youths of 15 from typological group I this values MOK and HR after the exertions. While in group II the important values of HR in rest and MOK. For the youths of 16 from group I, the indicants of MOK, LC and HR after the exertions acquire the significant changes ($p < 0.05$) changes. While for the youth of 17 from the same group the significant changes are observed only of the HR after the exertions. It can be concluded that during the process of the succession of the physical exertions typological age groups differed in terms of intensity and amount of the periods of durable adaptation, in the dynamics in the aspect of age and character of the adaptive change.

The complex evaluation of tempos of morpho-functional development of organism, grounded on the level of physical development and type of puberty were studied. These methods help group persons in relatively homogeneous typological groups. They are determination of the level of physical development [5], motional preparedness [10], the paces of puberty [11], somatotype, differentiation of the bone or teeth age, the type of higher nervous activity [12] and etc. But none of these methods can sufficiently explain the variety of the activity of the organism, especially in the process of the biological maturation. The study of the complex evaluation of tempos of morpho-functional development of the human organism, grounded on the level of physical development, type of puberty. In results of this data we can elaborate the programs of the training of the main physical abilities present significant practical value.

In this study, along with the consideration of the various methods of studying the individuality, there was an attempt to solve these tasks by studying characteristics of the morpho-functional development in youths of 15-17 with the help of the research of options of the physical development, the tempo of puberty and somatotype. As a result, we differentiated the separated the groups of youth on different types. Individual typological peculiarities of the physical development, puberty, the type of physique, the activity of the respiratory and cardiovascular systems of youths were studied. The individual indicants of the body exertions were identified; the ways of training of main motional abilities by the successions of exercise and their relation to the endurance development were clarified.

Conclusions

1. The streaming of the 15-17 youths into several groups according to the rate of development shows the differences not only in the morphofunctional indicators, but also in the reaction of the organism to the single-action exertions and adaptation for them in the exercise system. As a result, it increases the effectiveness of the process of the physical preparedness.
2. The selection of the physical exertions, that are relevant to according the peculiarities of age groups leads to improve of adaptation process to physical load. It result in growth of the efficiency and specified the sensitive periods of the development of endurance in youths.
3. As practice has shown, in the presence of these recommendations and personal interest, youths aged 15-17 can successfully complete their own physical activity. For individual classes we can recommend differentiated tasks. They should be considered not as separate lessons, but as part of the system of homework for physical education.

References

- Zinevych, I., Pastukhova, V., Nazymok Y., Korobeynikova L., Glazyrin I., Arhopenko, V., Korobeynikov G. (2017) Estimation of anthropometric parameters of track and field athletes at different stages of long-term preparation. *Journal of Physical Education and Sport*, 17(2), 643-647. doi:10.7752/jpes.2017.02096.
- Korobeynikov, G.V. (1995) Physiologic mechanisms of functional reserve mobilization in man during strenuous muscle activity. *Fiziologija cheloveka*, 21(3), 81-86.
- Loturco, I., Suchomel, T., Kopal, R., Arruda, A.S., Guerriero, A., Pereira, L.A., Pai, C.N. (2018). Force-Velocity Relationship in three Different Variations of Prone Row Exercises. *Journal of Strength and Conditioning Research*. doi: 10.1519/JSC.0000000000002543.
- Ivashchenko, O., Khudolii, O., Yermakova, T., Iermakov, S., Nosko, M., & Nosko, Y. (2016). Factorial and discriminant analysis as methodological basis of pedagogic control over motor and functional fitness of 14–16 year old girls. *Journal of Physical Education and Sport*, 16(2), 442-451. doi:10.7752/jpes.2016.02068.
- Korobeynikov, G., & Korobeynikova, L. (2002). Physical development and psychical function states in junior schoolchildren. *Bratislavské lekárske listy*, 104(3), 125-129.
- Kozina, Z., Shepelenko, T., Cieślicka, M., Prusik, K., Muszkietka, R., Osipov, A., et al. (2017). The teams' formation in sport aerobics on the basis of application of multidimensional analysis methods. *Phys Educ Students*; 21(6), 270–279. doi: 10.15561/20755279.2017.0603.
- Kozina Z., Sobko I., Bazilyuk T., Ryepko O., Lachno O, linitckaya A. (2015). The applying of the concept of individualization in sport. *Journal of Physical Education and Sport*, 15(2), 172. doi:10.7752/jpes.2015.02027.
- Chernozub, A.A. (2015). Features of adaptive reactions in humans under power fitness. *Fiziologichnyi zhurnal*, 61(5), 99-107.
- Henselmans, M., Schoenfeld, B.J. (2014). The effect of inter-set rest intervals on resistance exercise-induced muscle hypertrophy. *Sports Medicine*, 44(12), 1635-1643. doi: 10.1007/s40279-014-0228-0.
- Rovnaya, O., Podrigalo, L., Aghyppo, O., Cieślicka, 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.
- Altintas, A., Asci, F.H. (2008). Physical self-esteem of adolescents with regard to physical activity and pubertal status. *Pediatric Exercise Science*, 20, 142–156.
- Makarenko, N.V., Lizogub, V.S., Yukhimenko, L.I. (2006). Reactions of the autonomic nervous system of students with different characteristics of higher nervous activity in the situation of examination stress. *Human Physiology*, 3(2), 136–138. doi: 10.1134/S0362119706030182.