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ORIGINAL SCIENTIFIC ARTICLE

CORRECTION OF POSTURAL DISORDERS OF MATURE AGE WOMEN IN THE PROCESS OF AQUA FITNESS TAKING INTO ACCOUNT THE BODY TYPE

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Abstract

The purpose of the article is to develop and test the effectiveness of aqua fitness exercise program for the posture improvement of women of the first period of a mature age with different body types.

Materials and methods. The pedagogical experiment involved 46 women of the first period of a mature age who had previously consented to participate in the study. The used methods include the analysis and generalization of scientific and methodological literature, Internet data, and mathematical statistics methods, including Fisher's angular criterion, which allows sampling by distribution of the trait (Byshevets et al., 2019). The research included the assessment of the posture condition of women based on the method of visual screening of posture with determination of the total score (Kashuba et al., 2016). A surgeon was also involved in assessing the posture of women. In the process of factor analysis, the data of anthropometric studies, physical fitness assessments, and motor activity level were analyzed.

Results. The distribution of women of the first period of a mature age by types of postural disorders and its changes under the influence of aqua fitness classes taking into account the body type has been established. The study involved 46 women of the mentioned category; 73.9% of them were women of normosthenic body type, 15.2% – of asthenic type, and 10.9% – of hypersthenic type. The research has established that women who were engaged in aqua fitness with regard to body type had positive changes in posture. The proportion of women of asthenic body type with a normal posture increased by 28.6%, of normosthenic type – by 20.6%, and of hypersthenic type – by 20.0%. Changes occurred in the level of the bio-geometric profile of the posture.

Conclusions. The study confirms the effectiveness of the use of aqua fitness in the process of health-promoting classes to prevent and correct postural disorders.

Keywords: women, aqua fitness, posture.

Introduction

The demographic situation in European countries, including Ukraine, is characterized by the presence of persistent crisis tendencies: decrease in population, aging, worsening of the health status, and decline of the birthrate (Afanasiyeva, 2016; Volovyk, 2017; Andrieieva, Hakman, Kashuba, Vasylenko, Patsaliuk, Koshura, & Istyniuk, 2019).

At the same time, researchers state the deterioration of the physical condition and the decline in the level of health of women of reproductive age caused by a sedentary lifestyle,

poor nutrition, adverse social, economic, and environmental factors, which negatively affects the demographic processes in the society (Martyniuk, 2016; Ivanchykova, Saienko, Goncharova, Tolchieva, & Poluliashchenko, 2018; Tkachova, Dutchak, Kashuba, Goncharova, Lytvynenko, Vako, Kolos, & Lopatskyi, 2020).

Considering the health of women of the first period of a mature age as the most important value of the society in the reproduction of the population, experts in physical education and sports are trying to find the most effective means to improve women's health and to develop measures that can motivate them to increase motor activity (Ivchatova, 2010; Bibik, 2013; Sadovnikova, 2018).

One of the most important indicators of health is the condition of the posture, the disorders of which lead to a

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number of diseases (Kashuba, Lopatskyi, & Khabinets, 2017; Kashuba, Goncharova, Tkachova, & Prylutska, 2019). The degree of influence of posture indicators on the functioning of organs and organism systems is described in the studies of other authors (Byshevets, Denysova, & Serhiyenko, 2018; Drozdovska, Andrieieva, Yarmak, & Blagii, 2020; Hakman, Andrieieva, Kashuba, Nakonechnyi, Cherednichenko, Khrypko, Tomilina, & Filak, 2020), who have the common opinion of relatively significant pathological changes in the human body against the background of existing disorders of the posture. Conversely, proper posture has a positive effect on women's vitality, gives them self-confidence, and improves their appearance, and therefore their well-being and mood. However, unfortunately, nowadays, an increasing proportion of women of the first period of a mature age are characterized by impaired posture, which provokes backpain (Tomilina & Bishevets, 2018).

The state of human posture, which determines the distribution of individual bio-links of the human body in space, depends on the type of physique (Ivchatova, 2010; Shankovsky, 2018). According to (Ivchatova, 2010; Shankovsky, 2018) pedagogical means of influence in the process of health fitness should be differentiated by body type, taking into account the state of posture.

The issue of correction of postural disorders of different population groups by means of health fitness has been repeatedly raised in scientific circles (Kashuba, Tomilina, Byshevets, Khrypko, Stepanenko, Grygus, Smoleńska, & Savliuk, 2020).

The experts indicate a special role of aquatic exercise for the prevention and correction of postural disorders and state its positive impact on the joints and spine (Shutova, Rybakova, & Sharaveva, 2015). Nowadays, aqua aerobics has gained considerable popularity among women. It is a system of water physical exercises borrowed from gymnastics, choreography, aerobics, sports and artistic swimming, performed to the rhythmic and intense music, and conducted in shallow, medium, and deep-water pools, which promotes the fitness of those involved (Lutsenko, Shepelenko, & Luchko, 2014).

However, despite the widespread discussion by health professionals about the health effects of recreational exercising in water on the musculoskeletal system of the population, the vast majority of research is aimed at establishing the effectiveness of training for the physical education of student youth (Balamutova, Polozhiy, & Kyselev, 2011; Usova, Romanyuk, & Kopitina, 2014). Therefore, in our opinion, studies aimed at establishing the impact of aqua fitness on the posture of women of the first period of a mature age taking into account the body type require further research.

The purpose of the research is to develop and test the effectiveness of aqua fitness exercise program for the posture improvement of women of the first period of a mature age with different body types.

Material and methods

Study participants

The research involved 46 women of the first period of a mature age, who gave their written consent to participate. The distribution of participants by age showed that the majority of women involved in the pedagogical experiment were aged 26 to 30 years, which amounted to 58.7% ($n = 27$). At

the same time, there were 23.9% ($n = 11$) participants up to 25 years, and 17.4% ($n = 8$) older than 30. 15.2% of them had asthenic (ectomorphic), 73.9% – regular (mesomorphic), and 10.9% – hypersthenic (endomorph) body type. At the beginning of the study, 23.9% of participants had normal posture, 23.9% had round back, and 19.6% had round-concave back, and scoliotic posture – 32.6%.

Considering the mathematical rules of setting up and conducting a pedagogical experiment (Borisova, 2019), a sample of women of the first period of a mature age engaged in aqua fitness was made in a simple random way, i.e. each of the subjects had the same probability to participate in the experiment. This selection of subjects ensured the representativeness of the sample taking into account the nature of social objects (Tulebaeva, 2010). On the other hand, the further distribution of women by body type, taking into account the natural variability that characterizes this contingent of women (Adler, 2016), confirmed that the proportion of women by body type generally corresponds to scientists' views about the body type of women of the first period of a mature age.

All women had previously consented to participate in the study. The pedagogical experiment was conducted in fitness club "Yunist" in Kyiv.

Research methodology

To achieve the goal of the research, the following methods were applied: analysis and generalization of data of scientific and methodological literature, data of the Internet, anthropometry, pedagogical methods of research, the method of visual screening of posture with determination of the total score (Kashuba, Bondar, Goncharova, & Nosova, 2016), and estimation of the level of motor activity by the method of Framingham study (Krutsevich, Vorobyov, & Bezverkhnya, 2011).

The research involved three stages of implementation. At the first stage, we analyzed scientific and methodological literature in the field of physical fitness of women of the first period of a mature age; also, we made the research of the level of physical development, physical fitness, and level of motor activity of 46 women of the first period of a mature age.

Anthropometric studies included the determination of body weight (kg), longitudinal body sizes (cm), circumferential body sizes (cm), body diameters (cm), size of skin and fat folds (mm) by conventional methods, with subsequent determination of body type (Martirosov, Nikolaev, & Rudnev, 2006).

The posture of women was assessed using an improved map of express control of the bio-geometric profile of posture (Kashuba et al., 2016). The distribution of the studied by the levels of the bio-geometric profile of the posture was carried out taking into account 11 indicators in the frontal (5) and sagittal (6) planes. The evaluation of each indicator was performed according to a three-point scale by comparing the individual posture in the photo and the standard graphical options. Score "1" corresponded to the grade "bad", "2" – "satisfactory", "3" – "good". The maximum amount of points that corresponds to the normal state of posture is 33 points.

The study of the level of motor activity of women involved fixing the time to perform motor activity of different levels (high, medium, low, sedentary, basic) (Krutsevich et al., 2011).

Assessment of physical fitness of women included determination of static force endurance of muscles while maintaining static postures, and spine flexibility and elasticity of hamstrings (Earl & Baechle, 2012).

Also at the second stage of the research, we performed the analysis of the obtained data using the methods of mathematical statistics with the determination of the most informative indicators. The significant influence of indicators of body composition and condition of musculoskeletal system in the factor structure of indicators of physical development, physical activity and physical fitness of women of the first period of a mature age. They were defined as the criteria for the effectiveness of aqua fitness activities. At this stage, a program of aqua fitness for women of the first period of a mature age was developed.

At the third stage of the research, the influence of the developed training program on the posture of women of the first period of a mature age with different body types was determined. The study involved 46 women of this age. The duration of the training program was nine months.

Statistical analysis

In the course of the research, mathematical statistics methods were applied, including Fisher's angular criterion, which allows sampling by distribution of the trait (Byshevets, Denysova, Shynkaruk, Serhiyenko, Usychenko, Stepanenko, & Syvash, 2019). If the conditions of application of Fisher's angular criterion were not met when comparing the shares of women according to the level of the state of the bio-geometric profile of posture before and after the pedagogical experiment, Fisher's exact test was used. To compare the overall assessment of the bio-geometric profile of the posture of the

subjects before and after the experiment, Student's t-test was used for dependent samples in the case when according to the Shapiro-Wilk test the initial data were subject to the normal distribution law and Wilcoxon test in the opposite case.

In the process of factor analysis by the method of principal components with varimax rotation, the data of anthropometric studies, physical fitness assessments, and motor activity level were analyzed. The total number of indicators for factor analysis was 56 variables, which allowed identifying six factors (60.03% of the total variance) in the structure of the studied indicators. Data processing was performed using programs MS Excel (Microsoft, USA), Statistica 8.0 (StatSoft, USA).

Results

The results of factor analysis of indicators of physical development, physical fitness and physical activity allowed defining the factor structure of six factors. The first factor is "Physical fitness" with 20.32% of the total variance, the second factor is "Fat component of body composition" – 12.56%, the third factor is "Chest development" – 8.34%, the fourth factor is "Posture condition" – 7.80%, the fifth and sixth factors respectively were the "Posture type" (5.56%) and the "Body type" (5.46%).

These factors include indicators that are the most informative in relation to the physical development, physical activity, and physical fitness of women. The factor analysis was further refined by differentiation of the factor structure depending on the body type (Table 1).

For example, analyzing the results of factor analysis, the factor structure of women of the first period of a mature age with regular body type was detailed as the most representative of the studied contingent.

Table 1. Eigenvalues in the factor structure of the studied indicators of women of the first period of a mature age depending on the body type, (n = 46)

Body type	Separate factors	Calculation of eigenvalues			
		Eigenvalues	Total variance, %	Total eigenvalues, %	Accumulated frequencies, %
Asthenic	1. Physical development and sedentary motor activity	16.23	31.21	16.23	31.21
	2. Diameters and circumferential body sizes	10.14	19.49	26.36	50.70
	3. Equilibrium state and basic motor activity	8.90	17.11	35.26	67.81
	4. Posture condition and physical fitness	6.97	13.40	42.23	81.21
	5. Diameter of the forearm, skin and fat folds on the thigh and physical fitness	5.96	11.47	48.19	92.68
	6. Flexibility and mid-level motor activity	3.81	7.32	52.00	99.99
Regular	1. Physical fitness and basic motor activity	12.15	23.37	12.15	23.37
	2. Skin and fat folds	7.52	14.47	19.68	37.84
	3. Longitudinal body sizes	4.33	8.34	24.01	46.18
	4. Body diameters	3.38	6.51	27.39	52.68
	5. Posture condition	3.17	6.09	30.56	58.77
Hypersthenic	1. Anthropometric indicators and physical fitness	23.41	45.03	23.41	45.03
	2. Longitudinal body sizes and posture condition	16.69	32.09	40.10	77.12
	4. Physical fitness and motor activity	7.82	15.03	47.92	92.15
	5. Knees breadth, physical fitness and motor activity	4.08	7.85	52.00	99.99

It has been established that the structure of physical development, motor activity and motor abilities of women of the first period of a mature age of regular type includes 5 factors, which describe 58.77% of the total variance. The general factor "Physical fitness and basic motor activity" with a share in the total variance of 23.37% was made up of flexibility indicators, such as the magnitude of maximum bending ($r = 0.86$; $p < 0.05$) and the value of forward bending with folded leg ($r = 0.78$; $p < 0.05$), which has an inverse correlation with the duration of holding the shoulders up lying on the abdomen ($r = -0.81$; $p < 0.05$), holding the legs up lying on the abdomen ($r = -0.83$; $p < 0.05$), holding the torso lying on the back ($r = -0.81$; $p < 0.05$), holding the torso lying on the back with bent knees at an angle of 90 ($r = -0.85$; $p < 0.05$); lifting the shoulders lying on the abdomen, arms near the chest ($r = -0.81$; $p < 0.05$), equilibrium ($r = -0.89$; $p < 0.05$) and basic physical activity index ($r = -0.73$; $p < 0.05$), as well as sitting body length ($r = -0.80$; $p < 0.05$) and shoulder width ($r = -0.78$; $p < 0.05$). The unipolar factor two "Skin and fat folds" with 14.47% in the total variance includes the size of skin and fat folds on the shoulders' back ($r = 0.78$; $p < 0.05$), on the thighs ($r = 0.77$; $p < 0.05$) and on the back under the shoulder blade ($r = 0.77$; $p < 0.05$) and indicate an increase in the size of the folds on the thighs and on the back as they increase on the shoulders. The factor "Longitudinal body sizes" includes body length ($r = 0.71$; $p < 0.05$, ridge body diameter ($r = 0.71$; $p < 0.05$) and chest circumference with maximal inhalation ($r = 0.74$; $p < 0.05$) and explains 8.34% of the total variance. The fourth factor "Body diameters" with 6.51% includes the transverse diameter of the distal part of the thigh ($r = 0.77$; $p < 0.05$) and the shin ($r = 0.75$; $p < 0.05$) indicating an increase in one indicator along with an increase in another. Factor five "Posture condition" includes independent indicators of the state of bio-geometric profile of women in the frontal ($r = 0.77$; $p < 0.05$) and sagittal ($r = 0.70$; $p < 0.05$) planes and explains 6.09% of the total variance.

In the defined factor structure of women of the first period of a mature age with different body types, there are general patterns of separation of informative indicators. Among the studied groups of women of asthenic and hypersthenic body types, the first two factors separate the indicators of physical development, as those with the greatest impact. Instead, among women of regular body type, physical fitness and physical development have a leading position. Factors that make a significant contribution to the overall sample variance include indicators of women's posture.

The study of the factor structure of indicators of physical development, motor activity and physical fitness of women of the first period of a mature age revealed the leading directions of intended influence on the body of women. The observed patterns were taken into account when developing the structure of the means of influence in the process of health-improving activities for women of the first period of a mature age.

The shift of the accents of the content of aqua fitness exercise towards the means of prevention and correction of postural disorders is conditioned by the inherent motor regime of modern women of a mature age, working conditions and peculiarities. The studied contingent is characterized by a large number of women with manifestations of functional disorders of the musculoskeletal system, especially among the representatives of the asthenic body type.

The training program included a combination of distance swimming, aqua fitness, and performing special tasks, conducting theoretical lessons on a healthy lifestyle, and enhancing motivation. The training program was implemented over a period of nine months.

The structure of the training program included three sessions per week, lasting forty-five minutes, with variant modeling of physical activity and the ratio of physical education means. Methodological features of the classes were determined for women with different types of posture disorders and included different ratio of aqua fitness and distance swimming, exercising in different conditions (near the pool side, without fixation, in deep and shallow water).

The key provisions of the training program included taking into account the functional imperfection of the trunk muscles as a whole and the violation of the symmetry of the tone of the muscles of the individual groups. For example, the women with round shoulders and round back are characterized by the weakened muscles of the torso and a slightly reduced tone of the muscles of the shoulder girdle. The women with round concave back have weak gluteal and back thigh muscles, and general functional imperfection of the muscles of the abdomen. The women with flat back are characterized by low muscle tone of the back and shoulder girdle. The women with functional disorders of the posture in the front plane have unequal muscle tone on the right and left side of the torso (Swede, 2018).

The structure of motor activities for women of the first period of a mature age in the aquatic environment was determined in regard to the type of postural disorders and in accordance with the peculiarities of the location of individual body bio-links under the influence of functional disorders of the musculoskeletal system. For women with round shoulders and round back, backstroke was used; for women with flat and concave backs – crawl and butterfly strokes. For the contingent of women with scoliotic posture, the content of the classes was supplemented by swimming with symmetrical motor actions (breaststroke, butterfly stroke). In the case of excessive lumbar lordosis in women of the first period of a mature age, a swimming board was placed under the abdomen.

Aqua fitness exercises were implemented in the training program according to the type of postural disorders and individual characteristics of women's physical development, and were determined by the body type (Table 2).

Namely, within one session, the means directed on the development of no more than two motor qualities were used. According to these principles, the following combinations were proposed: exercises for the development of strength and flexibility; coordination and power exercises; exercises for the development of endurance only, power and speed-power exercises.

In the course of the research, we examined the posture of women of the first period of a mature age under the influence of aqua fitness, taking into account the body type.

Thus, according to the obtained data, before the experiment, 23.9% of the participants had normal posture, 23.9% had round back, 19.6% had round-concave back, and scoliotic posture prevailed with the share of 32.6%. After the experiment, the distribution changed as follows: normal posture – 45.7%, round back – 19.6%, round-concave back – 15.2%, scoliotic posture – 19.6%. Additional calculations using the

Table 2. Distribution of aqua fitness exercises according to the body type of women of the first period of a mature age

Posture type	Aqua-fitness exercises (effects on women's body)
Asthenic	Aqua building, aqua forming (development of maximum muscle strength of major muscle groups and their endurance)
	Aqua stretch, hydro relaxation (development of flexibility and mobility in the joints, regulation of muscle tone, stimulation of recovery processes)
	Aqua gym, aqua dynamics (development of strength abilities and coordination of movements)
Regular	Aqua tonics (support of the muscle tone)
	Aqua gym (development of strength endurance and coordination of movements)
	Aqua karate (exercises for the development of strength, coordination and speed of movement)
	Aqua stretch, hydro relaxation (development of flexibility and mobility in the joints, regulation of muscle tone, stimulation of recovery processes)
Hypersthenic	Aqua step (development of aerobic and strength endurance, flexibility and coordination of movements)
	Aqua jogging, aqua dance, aqua rhythmic (development of aerobic and strength endurance, flexibility and coordination of movements)
	Aqua gym (development of strength endurance and coordination of movements)
	Aqua stretch, hydro relaxation (development of flexibility and mobility in the joints, regulation of muscle tone, stimulation of recovery processes)
	Aqua flipper, aqua motion (development of general endurance, strength endurance)

Fisher's angular test made it possible to prove that the proportion of women with normal posture under the influence of aqua fitness training, taking into account the body type, increased statistically significantly ($p < 0.05$).

A more detailed study of medical cards data allowed to determine the peculiarities of posture of women of the first period of mature age, depending on their body type before and after the experiment, and to evaluate the impact of aqua fitness on the posture of the subjects.

The research has established that both before and after the introduction of the authors' aqua-fitness program, the type of posture without violations prevailed among women of regular type. Before the experiment, their share was 26.5% and after the experiment – 47,1%.

It has been found that by the start of the experiment, asthenic-type women were 6.5% ($p > 0.05$) less likely to have a normal posture type and hypersthenic-type women 12.2% ($p > 0.05$) less than regular-type women were. However, the highest proportion of women with round back was found among women with hypersthenic type: it was 40%, and the smallest proportion, which was 14.3%, was recorded among women of asthenic type. These changes had a favorable trend but were not statistically significant.

The majority of women with round-concave back (28.6%) ($p > 0.05$) were women of hypersthenic type. At the same time, the proportion of asthenic-type women with such postural impairment was 8.6% ($p > 0.05$) less, and of regular type – 11% ($p > 0.05$) less.

In addition, among women of hypersthenic type, the largest proportion, amounting to 42.9%, was characterized by scoliotic posture. At the same time among women of asthenic type this disorder was found in 20%, and among women of regular type – in 32,4%, and statistically significant ($p > 0.05$) proportions of women with this type of disorder did not differ.

The study has showed the positive impact of aqua fitness on the posture of women of the first period of a mature age, regardless of the type of body.

Thus, the proportion of asthenic-type women with normal posture increased by 28.6% ($p > 0.05$), regular – by 20.6% ($p > 0.05$), and hypersthenic – by 20.0% ($p > 0.05$). Therefore, taking into account the body type, aqua fitness has the maximum impact on women of the first period of a mature age of asthenic type.

In addition, the study has showed that after the introduction of the authors' program among the participants of the experiment, the proportion of hypersthenic-type women with round back, regular-type women with scoliotic posture, as well as asthenic-type women with round back and scoliotic posture decreased the most. Their shares were 20.0%, 14.8% and 14.3% respectively ($p > 0.05$). However, the proportion of women of asthenic and hypersthenic type with round-concave back did not change.

The obtained data make it possible to testify to the positive dynamics that occurred in the posture of women of the first period of a mature age under the influence of the authors' aqua fitness program.

The further analysis of changes in posture of women of the first period of a mature age under the influence of the proposed means of aqua fitness was carried out through the distribution of the studied contingent by levels of posture and direct scoring of visual screening of the posture by the method (Kashuba et al., 2016).

Statistical processing of the experimental material allowed establishing the following changes:

asthenic body type

- assessment of the level of the bio-geometric profile of the posture in the frontal plane statistically significantly ($p < 0.05$) increased by 26.9% from (7.43; 1.62) points to (9.43; 2.07) points;

- an increase in the sagittal plane by 10.5% from (8.14; 2.79) points to (9.00; 2.71) points, however, no statistically significant ($p > 0.05$) differences were detected;
- overall assessment of the posture bio-geometric profile statistically significantly ($p < 0.05$) increased from (15.57; 4.39) points to (18.43; 4.65) points;

regular body type

- with respect to the frontal plane, the indicator of the level of the posture bio-geometric profile after the experiment was statistically significantly ($p < 0.05$) higher by 24.7% than at the beginning ((10.09; 1.90) against (8.09; 1.58) points);
- a statistically significant ($p < 0.05$) increase of 10.4% (10.03; 2.34) points to (9.09; 2.59) points was registered in the sagittal plane;
- a statistically significant ($p < 0.05$) increase from (17.18; 4.06) points to (20.12; 4.06) points in the overall assessment of the bio-geometric profile of the posture was recorded;

hypersthenic body type

- the indicator of the level of the bio-geometric profile of the posture in the frontal plane statistically significantly ($p < 0.05$) increased (by 27.0% from (7.40; 1.52) points to (9.40; 2.07) points);
- notwithstanding the absence of statistically significant ($p > 0.05$) differences between the index in the sagittal plane, there was a positive tendency for its growth, where the increase was 17.1%, and the indicator increased from (8.20; 3.27) points to (9.60; 2.07) points;
- overall assessment of posture bio-geometric profile statistically significantly ($p < 0.05$) increased from (15.60; 4.56) points to (19.00; 4.06) points.

The research has established that the proportion of women with average level increased by 5.88% and the proportion of women characterized by a high level of bio-geometric profile of posture increased by 17.65% women regular body type. This increase was due to the changes among women with low posture bio-geometric profile, the proportion of whom

decreased by 23.53%. At the same time, among the surveyed asthenic body type, there was an increase by 28.57% in the proportion of women with a high level of posture bio-geometric profile due to a decrease by 14.29% in the proportion of women with average and low levels in each case (Fig. 1).

During the experiment, asthenic-type women underwent changes in the distribution of the bio-geometric profile of the posture:

- the proportion of women with low and average levels decreased by 14.29%, respectively;
- the proportion of women with high levels increased by 28.57%.

For women of regular body type, such changes in the distribution of the bio-geometric profile of the posture were characteristic:

- the proportion of women with low level decreased by 23.53%;
- the proportion of women with average level increased by 5.88%;
- the proportion of women with high level increased by 17.65%.

The following positive changes in the distribution of the bio-geometric profile of the posture occurred among women of the hypersthenic body type:

- the proportion of women with low level decreased by 40%;
- the proportion of women with average level increased by 20%;
- the proportion of women with high level increased by 20%.

Discussion

The results of the analysis of scientific and methodological literature (Tomilina et al., 2018; Kashuba, Andrieieva, Goncharova, Kyrychenko, Karp, Lopatskyi, & Kolos, 2019b, Kashuba et al., 2020) indicate a significant number of posture disorders in adults, which is confirmed by the results of this research, in which 76.1% of women in the first period of a mature age had posture disorders. In addition, the results ob-

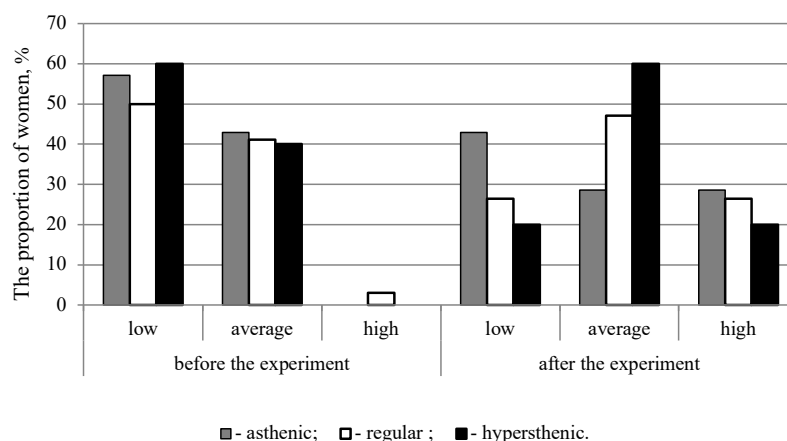


Fig. 1. Distribution of women of the first period of a mature age according to the bio-geometric profile of the posture

tained during the study are consistent with the results Bibik (2013), according to which only about 25 % of women of the first period of a mature age have normal posture, and the most common violation of posture among this contingent is a violation in the frontal plane – scoliotic posture.

Regular posture is an indicator that affects the activity of other organs and systems of the body (Ivchatova, 2010), which is confirmed by the results of factor analysis of physical development, physical fitness and motor activity of women in this study, where “Posture status” is 7.80% of the total variance of the sample.

However, scientists agree that, unfortunately, already during the first period of a mature age, women experience deterioration of well-being, pain in the cervical, thoracic and lumbar parts of the spine, which gradually becomes further deteriorated (Samoshkin, Liadska, Denisenko, & Riapasova, 2014; Tomilina et al., 2018; Hakman, Andrieieva, Kashuba, Omelchenko, Ion, Danylchenko, & Levinskaia, 2019), which requires the development of the means of influence.

In the course of the research the peculiarities of posture disorders in women with different body type were clarified, the largest number of posture disorders was observed in women with asthenic body type. These results confirm the research of other scientists (Ivchatova, 2010).

The analysis of scientific and methodological literature (Ivchatova, 2010; Ivanchykova et al., 2018; Hakman et al., 2020) allowed defining means of physical education, which are applied in the course of physical fitness for the contingent of women of the first period of a mature age for the purpose of prevention and correction of posture disorders. Aqua fitness occupies a special place among these means.

In particular, there is evidence of the effective use of aqua fitness in the physical education of students (Zhuravlev & Malikov, 2019). For example, Usova et al. (2014) states that aqua fitness exercises not only provide a higher health effect than other types of fitness, promotes the resistance of female students to the effects of temperature fluctuations, but also have significant health and strengthening effect in preventing spine distortions and forming the correct posture. Considering health-promoting aqua aerobics as a means of hydro rehabilitation for students of special medical groups, Balamutova et al. (2011) draws attention to the effectiveness of its use in order to strengthen virtually all muscle groups and correct posture without the risk of injury. The peculiarity of the proposed authors' approach to the aqua fitness classes is the differentiation of means depending on the posture of women of the first period of a mature age and their body type, the effectiveness of which has been proven in the process of pedagogical experiment.

Conclusions and perspectives of further research

The results of factor analysis of the factor structure of physical development, physical fitness, and motor activity of women of the first period of a mature age indicate the presence of six factors (60.03% of the total variance). The “Posture status” of women (7.8%) and “Body type” (5.46%) make a significant contribution to the content of the factor structure, which determines the directions of influence during the programming of physical fitness activities for this contingent.

The research has proposed the program of aqua fitness classes, the content of which is differentiated in accordance

with the peculiarities of posture and body type of women of the first period of a mature age.

The study of the effectiveness of an aqua fitness program based on the body type of women of the first period of a mature age shows that women had positive changes in posture. If, at the beginning of the experiment, only 23.9% woman had normal posture, then after the experiment their proportion increased statistically significantly ($p < 0.05$) to 45.7%.

It should be noted that both before and after the experiment, the proportion of women with normal posture was the highest among women of regular body type, namely 26.5% at the beginning and 47.1% at the end of the pedagogical experiment. Moreover, the most common violation recorded in the examined women was scoliotic posture, 32.6% among all study participants.

The aqua fitness program had the greatest effect on asthenic-type women with round back (the number of women decreased by 14.3%; $p > 0.05$) and scoliotic posture (decreased by 14.3 %; $p > 0.05$), regular-type women with scoliotic posture (decreased from 32.4 % to 17.6 %; $p < 0.05$), and hypersthenic-type women with round back (decreased from 40 % to 20 %; $p > 0.05$).

This study has shown that the proportion of subjects with normal posture in the total sample significantly increased at the end of the experiment ($p < 0.05$), however this changes in each of the groups of women with different body types were statistically insignificant ($p > 0.05$).

The analysis of the dynamics of the bio-geometric profile of posture confirms the improvement of posture in representatives of different somatotypes: for women of asthenic type, the assessment of the bio-geometric profile of posture increased statistically significantly ($p < 0.05$) from (15.57; 4.39) to (18, 43; 4.65) points, for women of regular type there was a statistically significant ($p < 0.05$) increase in the indicator from (17,18; 4,06) to (20,12; 4,06) points, and in representatives of hypersthenic type, a statistically significant ($p < 0.05$) increase from (15.60; 4.56) to (19.00; 4.06) points.

Therefore, it can be argued that aqua fitness has a positive effect on the posture of women of the first period of a mature age, regardless of their body type.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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КОРЕКЦІЯ ПОРУШЕНЬ ПОСТАВИ ЖІНОК ЗРІЛОГО ВІКУ З УРАХУВАННЯМ ТИПУ ТІЛОБУДОВИ В ПРОЦЕСІ ЗАНЯТЬ АКВАФІТНЕСОМ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 10 с., 2 табл., 1 рис., 34 джерела.

Мета роботи розробка та перевірка ефективності програми занять аквафітнесом для жінок першого зрілого віку із різним типом тілобудови з метою покращення стану їх постави.

Матеріали та методи. В педагогічному експерименті брали участь 46 жінок першого періоду зрілого віку, які попередньо надали згоду на участь у дослідженні. Методи дослідження передбачали аналіз та узагальнення науково-методичної літератури, даних мережі Internet та методів математичної статистики із застосуванням кутового критерію Фішера, який дозволяє здійснювати співставлення вибірок за розподілом ознаки (за Byshevets et

al., 2019), проводилась оцінка стану постави жінок на основі методики візуального скринінгу постави із визначенням сумарної бальної оцінки (за Kashuba et al., 2016). До проведення оцінки стану постави жінок також було залучено лікаря хірурга. У процесі здійснення факторного аналізу були проаналізовані дані антропометричних досліджень, оцінки фізичної підготовленості, рівня рухової активності.

Результати. Встановлено розподіл жінок першого зрілого віку за типами порушень постави та його зміни під впливом занять аквафітнесом з урахуванням типу тілобудови. У дослідженні прийняло участь 46 жінок за-

значеної категорії, причому 73,9 % з них склали жінки нормостенічного, 15,2 % – астенічного, а 10,9 % – гіперстенічного типу тілобудови. Встановлено, що у жінок, які займалися аквафітнесом з урахуванням типу тілобудови, відбулися позитивні зрушення у стані постави. Частка жінок з астенічним типом тілобудови, які характеризуються нормальною поставою, зросла на 28,6%, з нормостенічним типом – на 20,6%, а гіперстенічним

типом – на 20,0 %. Відбулись зміни у рівні стану біогеометричного профілю постави.

Висновки. Дослідження підтверджує ефективність застосування засобів аквафітнесу в процесі оздоровчих занять з метою профілактики та корекції порушень постави.

Ключові слова: жінки, аквафітнес, постава.

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ORIGINAL SCIENTIFIC ARTICLE

TRAINING EFFECT OF SPECIAL BASKETBALL EXERCISES

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Abstract

The study objective is to evaluate the immediate training effect under the influence of changes in the parameters of physical activity in special exercises on the basis of physiological changes in the body of basketball players.

Materials and methods. The study used empirical methods of measuring heart rate during competitions, pulmonary ventilation values, O₂ consumption during physical work, O₂-debt, "excess" CO₂, methods of mathematical statistics.

Results. An empirical study has shown that the exercises used in the preparation of basketball players differ significantly in the nature of physiological action. The greatest physiological shifts in the body of basketball players determine the exercise, which is performed intensively or repeatedly with maximum intensity. The smallest physiological shifts were found when performing free throws.

Conclusions. The magnitude and orientation of the immediate training effect of special exercises in basketball depend on the combination of the effects of all the main indicators of physical activity – the type of exercises used, their intensity and duration, duration of rest, the number of repetitions.

Keywords: basketball, special exercises, immediate training effect, physiological changes.

Introduction

Problem statement. The increase in sports scores in basketball is driven by scientifically sound management of the training process (Fort-Vanmeerhaeghe, Montalvo, Latinjak, & Unnithan, 2016). Effective management of the training process of training basketball players can be implemented if a number of key tasks are solved (Koryagin, Blavt, & Grebinca, 2016). Understanding this determines the direction of research that is constantly being undertaken to improve the training of athletes in various sports, including basketball, for many years.

At the present level of basketball development, as competition in the international and domestic sports arenas is increasing, the skill requirements of the athlete are increasing (Asadi, Saez de Villarreal, & Arazi, 2015). The problem of streamlining the structure of the training process in basketball requires analysis of the sports training system, research

and selection of training facilities, as well as management of athletes' fitness condition (Anastasiadis, 2006; Gonzalo-Skok, Sánchez-Sabaté, Izquierdo-Lupón, & Sáez de Villar, 2019). All kinds of training tools should be combined as much as possible to provide integrated training (Tyshchenko, Hnatchuk, Pasichnyk, Bubela, & Semeryak, 2018). More than ever, the challenge is to limit the mobilization of functional reserves and maximize their mobilization to demonstrate the highest level of sporting capabilities.

Streamlining the structure of the training process will solve the problem of improving the process of training basketball teams masters and managing their activities in responsible games. Therefore, the issue of comprehensive training for highly skilled basketball players determines the importance of research aimed at ensuring the effectiveness of the training process.

Analysis of recent research and publications. In today's sports science, a vast amount of objective knowledge has been accumulated concerning the selection of the most effective training tools and methods aimed at enhancing athletes' functionality (Ben Abdelkrim, Castagna, El Fazaa, & El

Ati, 2010; Hoare, 2000; Webster, Horne, Wheelans, & Bell, 2009). It is believed that this process is based on knowledge of the demands placed on the body by certain sports (Bosco, Luhtanen, & Komi, 1983; Gonzalo-Skok et al., 2017; Ingebrigtsen, Jeffreys, & Rodahl, 2013). The most pressing issue is the definition of requirements for the physical and especially functional fitness of athletes in sports games (Kozina, Iermakov, Cretu, Kadutskaya, & Sobyagin, 2017; Koryagin & Blavt, 2018; Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005).

In the modern system of sports training, the functional training section occupies one of the leading places (Anastasiadis, 2006; Ben Abdelkrim, El Fazaa, & El Ati, 2007; Khudolii, 2019). The literature has intensified the scientific search for alternative approaches to assessing the functional preparedness of basketball players as a basis for managing the training process (Asadi et al., 2015; Montgomery, Pyne, & Minahan, 2010).

Nowadays in basketball, the question of evaluating the training effect of special exercises of basketball players is mainly solved on the basis of the experience and intuition of the coach. In finding new tools and methods to improve the training process of skilled basketball players, it is of paramount importance to establish the immediate training effect of special basketball exercises (Ramos, Rubio, Martínez, Esteban, & Jiménez, 2010). It has been suggested (Ben Abdelkrim, El Fazaa, & El Ati, 2007) that physiological indicators that are highly informative (Green, Hughson, Orr, & Ranney, 1983).

The available scientific research, conclusions and recommendations are of great value for solving the problem of training high-end basketball players. Based on the current interpretation of sports training (Asadi et al., 2015; Fort-Vanmeerhaeghe et al., 2016), the choice of methodology in the planning and planning process should be maximally considered, availability of evaluation of the training process as a basis for its management.

In the theory and practice of basketball, the issues of planning and managing the modern training process have not been sufficiently studied and do not have adequate scientific substantiation. In the modern scientific and practical literature there are no works that would systematically and comprehensively cover the theory, methodology and practice of establishing the immediate training effect of special exercises of basketball players.

Given that physical training affects all components of basketball players' training and in order to gain knowledge of their performance it is necessary to have information on the impact of specific exercises used in the training process (Marchenko & Dykhanova, 2019; Matthew & Delextrat, 2009).

Purpose of the research: on the basis of physiological changes in the body of basketball players, to evaluate the immediate training effect under the influence of changes in the parameters of physical activity in special exercises.

Materials and methods

The study of the heart rate during competitions was conducted by means of the method of continuous automatic registration using the multichannel system (Koryagin & Blavt, 2019). This allowed determine the maximum mean pulse rate during the game, as well as the maximum pulse rate total during the game and during the recovery.

The level of pulmonary ventilation was determined by way of collecting expired air into Douglas bags with the sub-

sequent measurement of the volume of the air contained in the bag using a laboratory gas meter (Beaver, Wasserman, & Whipp, 1986).

The percent composition was determined by way of analyzing the samples using the gas analyzers Spirolit and ME-TAMAX that are capable of recording the concentration of O₂ and CO₂ in expired air.

All the indicators of the heart rate, as well as the level of O₂ consumption, total O₂, the level of CO₂ release and oxygen pulse rate were calculated according to the method described in the works (Volkov, 1986; Zankovets, 2016).

Results

Studies have shown that special exercises used in the preparation of basketball players differ significantly in the nature of physiological effects on the body (Tab. 1).

It was found that the smallest physiological shifts were detected when performing free throws. The average heart rate was 128 ± 2.24 bpm. Oxygen consumption level – 31% of the maximum carbon dioxide value is 0.18 ± 0.17 l/min. When performing other special exercises with moderate intensity, the heart rate is in the range of 140-150 beats per minute (in tall players within the range of 160 beats per minute), the level of oxygen consumption varies from 53.7 to 55.1 % of the maximum value (2.3 l/min on average), carbon dioxide evolution reaches 0.5 l/min, pulmonary ventilation 45 l/min.

The training effect of these exercises is predominantly aerobic. Physiological indicators, when performed by basketball players special exercises, belong to different ranges of training loads. The results of the studies that led to these conclusions are presented in Table 1.

The greatest physiological shifts in the body of the basketball players cause exercises that are performed in an intense or repeated mode with the maximum intensity and duration of each repetition of the exercise from 20-30 s to 2 min.

The amount of oxygen consumption when performing such exercises reaches the maximum possible values of oxygen debt – increases to 10 liters.

Somewhat less pronounced physiological shifts are observed when performing game exercises (1x1 with the ball and without the ball, 2x2, 3x3, 5x5 on one shield). Here, the oxygen consumption is 65.2 to 82.4 % of the maximum, the average heart rate is 172-187.5 bpm. The value of the oxygen debt is in the range from 5.8 to 7.2 l, carbon dioxide emission is 0.67-0.89 l/min. These exercises are characterized by a complex effect on the body of athletes, that is, they contribute to the development of speed-power qualities and endurance.

When performing short-term exercises of 5-15 duration with an intensive or repeated method, the value of physiological shifts is negligible: the level of oxygen consumption was 68.1 % of the maximum value. These exercises are characterized by the highest rate of formation of alactate oxygen debt – 68.5 ± 17.5 ml/min.

As can be seen from the results in the table, performing the same exercise with different combinations of physical activity indicators can cause different physiological shifts in the body.

Thus, it was found that the physiological indicators, which can serve to evaluate the immediate training effect of the exercises, have different informativeness. With the change of physical activity parameters, each indicator changes in a specific way. These changes occur until it reaches the limit

Table 1. The value of physiological indicators when basketball players perform special exercises in various ranges of training loads

The focus of the trainer	Level O ₂ consumption l/min	Alactate O ₂ -debt, l	Lactate O ₂ -debt, l	Total O ₂ -debt, l	"Non-metabolic surplus" CO ₂ , l/min	Level of pulmonary ventilation, l/min	Heart rate, bpm	Pulse amount of recovery, beats	Average heart rate bpm
Mostly aerobic	0.9-2.3 1.6	0.5-1.5 0.75	1.3-3.3 2.3	1.8-4.8 3.2	0.14-0.5 0.32	16-45 20	120-160 140	300-900 600	50-90 70
Mixed aerobic-anaerobic	2.3-3.6 2.95	1.5-2.0 1.75	3.3-6.0 4.65	4.8-7.5 6.15	0.5-1.2 0.85	45-80 62	100-190 175	900-1900 1400	90-115 102
Anaerobic glycolytic	3.6-4.3 3.95	2.0-2.6 2.3	6.0-6.8 6.4	7.5-9.5 8.5	1.2-1.8 1.5	80-140 110	180-190 185	1900-2300 2115	90-110 100
Anaerobic alactate	2.3-3.1 2.7	1.3-1.9 1.6	2.3-4.4 3.35	5.1-6.2 5.65	0.35-0.8 0.55	50-75 62	170-190 180	730-1500 1100	94-103 98.5

values above which it becomes insensitive to the increasing impact of the load.

Duscussion

The basis of our study is based on the study of the immediate training effect of special exercises basketball players on the nature of physiological action on the body of athletes, as the basis for effective planning of the training process. The results of the empirical study complement the ideas of managing the training process based on the control of the impact of the means used in the training of qualified athletes (Fort-Vanmeerhaeghe et al., 2016; Gonzalo-Skok, Tous-Fajardo, Valero-Campo, Berzosa, Bataller, Arjol-Serrano, & Mendez-Villanueva, 2017).

Better to understand the data obtained changes in the physiological functions of basketball players in the course of performing special exercises, allows their interpretation. The results of the study of physiological shifts in the body of basketball players in the performance of special exercises were consistent with the information that the parameters of physiological changes are correlated with the influence of different exercises (Cormery, 2008; Robert, McGown, Fisher, Dalsky, & Robinson, 2017; Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005). Therefore, this allows them to be correlated by changing the parameters of the exercises (McArdle, Katch, & Katch, 1991; Koryagin & Blavt, 2018).

Considering that, based on the study of the immediate training effects of special exercises of basketball players, it is possible to systematize the exercises used in the training process of basketball players, the conducted research integrates the existing ideas in this direction. Therefore, information on improving the training system for skilled basketball players has been supplemented (Asadi et al., 2015; Fort-Vanmeerhaeghe et al., 2016; Gonzalo-Skok et al., 2019).

The obtained results expand and supplement the data on the effectiveness of the use of scientifically-based planning in the training of highly skilled basketball players, which involves the management of sports uniforms, the search for new rational means of special training (Aiken, Fairbrother, & Post, 2012; Kozina et al., 2017; Scanlan, Fox, Borges, Tucker, & Dalbo, 2018).

The researchers note the potential of using information on the impact of special exercises on the effectiveness of the training process in sports games in general (Backman & Danielson, 2011; Ciuti, Marcello, Macis, Onnis, Solinas, & Lai, 2009; Ingebrigtsen, Jeffreys, & Rodahl, 2013). Thus, the study provides a further understanding of the factors that influence

the effectiveness of training activities in training players. We have expanded the available data on the use of physiological control in the planning of the training process. Proper planning of the training process with the use of the data obtained from the study will allow rational use of training time, reaching a high level of basketball players.

The obtained results extend and supplement the data that increase of efficiency of a training process is possible on the basis of deep analysis of influence of physical activity on an organism of athletes (Karpowicz & Karpowicz, 2013; Bosco et al., 1983; Robert et al., 2017).

The study results complement the information on pedagogical control of basketball players' training activities, which is the basis for appropriate regulation of planning and management of training of highly qualified basketball players to ensure its effectiveness (Asadi et al., 2015; Erčulj, Blas, & Bračić, 2010; Vaquera, Santiago, Villa José, Morante, & García-Tormo, 2015).

Conclusions

The first step in the creation of an effective system for managing the training process of basketball players is to establish an immediate training effect of special exercises. The most acceptable in assessing the immediate training effect of exercise may be physiological indicators that are highly informative.

Exercises used in the preparation of basketball players differ significantly in the nature of physiological effects. The magnitude and direction of the immediate training effect of special exercises in basketball depend on the combination of the effects of all the main indicators of physical activity – the type of exercises used, their intensity and duration of the amount of rest breaks, the number of repetitions.

The practical implementation of the formulated provisions will allow coaches and athletes to rationally and effectively build a multi-year process aimed at training skilled basketball players.

Conflict of interest

The authors state no conflict of interest.

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ТРЕНУВАЛЬНИЙ ЕФЕКТ СПЕЦІАЛЬНИХ ВПРАВ БАСКЕТБОЛІСТІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

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Мета дослідження – на основі фізіологічних змін в організмі баскетболістів здійснити оцінку термінового тренувального ефекту під впливом змін параметрів фізичного навантаження у спеціальних вправах.

Матеріали та методи. У дослідженні було використано емпіричні методи вимірювання частоти серцевих скорочень під час змагань, величини легеневої вентиляції, O₂-споживання під час фізичної роботи, O₂-боргу, «надлишку» виділення CO₂, методи математичної статистики.

Результати. Проведене емпіричне дослідження показало, що вправи, які застосовуються при підготовці баскетболістів, істотно розрізняються за характером

фізіологічної дії. Найбільші фізіологічні зрушення в організмі баскетболістів зумовлюють вправи, що виконуються в інтенсивному або повторному режимі з максимальною інтенсивністю. Найменші фізіологічні зрушення виявлені при виконанні штрафних кидків.

Висновки. Величина і спрямованість термінового тренувального ефекту спеціальних вправ в баскетболі залежать від поєднання впливів всіх основних показників фізичного навантаження – виду застосовуваних вправ, їхньої інтенсивності та тривалості, тривалості відпочинку, числа повторень.

Ключові слова: баскетбол, спеціальні вправи, терміновий тренувальний ефект, фізіологічні зміни.

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ORIGINAL SCIENTIFIC ARTICLE

A METHOD TO PROMOTE THE DEVELOPMENT OF INTELLIGENCE AND GAME SKILLS IN YOUTH FOOTBALL

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Abstract

Research purpose. The aim of the study is to evaluate the playing skills of the young players under investigation in a global context. Specifically, it is intended to test whether the proposed training methodology favorably influenced the development of game skills, increasing the efficiency of game performance.

Materials and methods. The study participants are 24 young players, aged between 13 and 14. To achieve the tasks set, the study relied on the following methods: analysis of scientific literature, field testing and methods of mathematical statistics. The experimental group performed a specific training mesocycle (that of the Brain Kinetic), while the control group performed a traditional working mesocycle. To detect the effects of the training methodologies, field tests were used both before and after the training period, respecting the execution protocols described by H. Wein. The study materials were processed by the statistical analysis software-IBM SPSS 22. A paired sample t-test was used to compare the results of the two groups.

Results. The t-test analysis indicates statistically significant changes in the training effect of the experimental group. A better performance index found in the experimental group in the execution of skills, compared to the control group, is due to the diversification of the methodology to which they were subjected. Therefore, the changes after training at each skill index are amplified by the subsequent repetition of the tests. Differences between test indicators are statistically significant.

Conclusions. The study, through the use of field tests, has confirmed the hypothesis that the use of the Brain Kinetic training method determines a positive training effect in skill exercises. This method allowed the players involved in the experimental group to take personal, individual and group actions that had a real impact on the outcome of the game.

Keywords: youth football, decision-making skills, simplified game.

Introduction

Talent is a somewhat difficult concept to understand, precisely because it is possible to experience it in many different forms (Battisti, 2018). The task of a coach within a football team, or any other sports discipline, is precisely to identify this talent and place it in an existing context, the team (Accame, 2010). Since there is no exact science to accurately quantify an athlete's talent, each coach uses various approaches to investigate what are the factors that determine performance (Invernizzi, Signorini, Bosio, Raiola & Scurati, 2020). According to several studies, through the functional evaluation and the use of specific tests, it is possible to measure certain variables in team sports, such as physical condition or technical-tactical performance (Ceruso, Esposito,

& D'Elia, 2019; Izzo, D'isanto, Raiola, Cejudo, Ponsano, & Varde'i, 2020). The trainer must be able to observe and understand the needs of the young players, improve their shortcomings, enhance their qualities, and subsequently help to define the purposes necessary to set up the training program (MacDougall, Wenger, & Green, 1991). To improve the technical level, it is necessary, among other things, to systematically stimulate the development of the player's technical and tactical thinking and behaviour, while improving perceptual and individual skills (Esposito, Ceruso, & D'Elia, 2019). Using these properly constructed experiences, allows to achieve correct behaviours in the various situations of life, as well as in football (Raiola, D'Elia, & Altavilla, 2018). The ability to quickly and effectively adapt a learned behaviour, can only be acquired when the player has been subjected to a systematic development of his intellectual abilities, from the beginning, and up to the high performance phase (Raiola, 2017). As

widely recognized, all young people should face simplified games as soon as possible during training, which are the ideal means of transmitting tactical knowledge and experience for the correct execution of technical and tactical skills (D'Isanto, D'Elia, Raiola, & Altavilla, 2019). The acquisition of knowledge and experience is the result of a well-studied pedagogical process in which the instructor, by means of clarifying questions and demonstrations to the boys, aims to make visible and clear all the knowledge and experiences learned by the boys themselves (Molinas & Argiolas, 2002; Rossi, Thrasou, & Vrontis, 2013). With a progressive games program, tactical thinking and behavior are developed as each player encounters and experiences the various solutions available to him (Williams & Reilly, 2000). It does not matter if the action on the field is the result of the repetitive practice of the same game situation in training, or if it is the correct solution to the problem resulting from the spontaneity of the player. What is important is that the player is able to read the game situation and solve problems successfully (Halouani, Chtourou, Dellal, Chaouachi, & Chamari, 2017).

Research purpose – in this study it was hypothesized the possibility of increasing the overall performance of a sample of young amateur footballers, through the use of the Brain Kinetic training methodology. The aim is to test the efficiency and impact of this training methodology through the use of field tests validated in the literature. These tests are useful not only to evaluate the level of technical qualification acquired, but also the ability to make decisions. In particular, it was intended to experiment if the proposed method favorably influenced the development of specialist knowledge in the experimental group, after two months, increasing the efficiency of the game performance.

Materials and methods

Study participants

Twenty-four U14 players (age: 14 ± 0.3 years; height: 166.4 cm; body mass: 62.92 kg; training experience: (3 ± 0.3) years) participated in this study. All participants were free from musculoskeletal injuries, participated in $\geq 95\%$ of training sessions per year, and were not early or late maturers. Experimental procedures and potential risks, discomforts, and benefits were fully explained to all boys and parents/guardians prior to participation. Signed informative consent forms were provided by subjects' parents and/or legal guardians.

Study organization

The group of players was divided into an experimental and a control group both characterized by 12 players. Both groups performed a different training method twice a week for a period of two months. The training method used to which the experimental group was subjected, involved a whole series of proprioception exercises associated with complex movement sequences, capable of inducing the activation of different cortical areas (motor, somatosensitive) and subcortical areas for the purpose of learning and correct execution of the required motor program (Pill, 2012, 2014; Capranica & Millard-Stafford, 2011). Some proposals consisted of dribbling regularly with the ball by simultaneously moving a ball on a racket without dropping it; conducting

ball exercises wearing a monocular bandage; quick and reasoned response exercises to unexpected events and exercises to improve the autonomy of the limbs and spatial sense. All these exercises were included in the training context, and proposed through sequences of variants, for a total of 46-60 minutes. They were performed 2 times a week. The control group, instead, took part in a traditional training mesocycle, carrying out in addition to the analytical part, also technique exercises and motor paths. They also performed games with defensive positioning in the first 2/3 of the field within 7 seconds, giving a limit of 3 ball touches. Both before and after the training period, all 24 players have carried out three different field tests, to evaluate in addition to the components of a technical nature, also other important skills such as game vision, creativity, advance and choice among the various possibilities were used in this study. The tests carried out followed the original test protocols proposed by H. Wein in the literature (Wein, 2007). Specifically, the three tests concerned: the number of consecutive passes made by evading the opposing pressure, a situation of attack with elements of psychokinetic and finally a 3vs3 game with 4 doors. The tests were carried out on different days.

The first test carried out concerned the number of consecutive passes useful to evade the opposing pressing (Fig.1). Both the control and experimental groups have been divided into four teams, each consisting of three players. The two opposing teams met on an 8×16 m or 10×20 m playing field. The test objectives concerned knowing how to pass the ball at the right time, not entering the defender's range of action with the ball, imparting sufficient power and pressure to the ball.

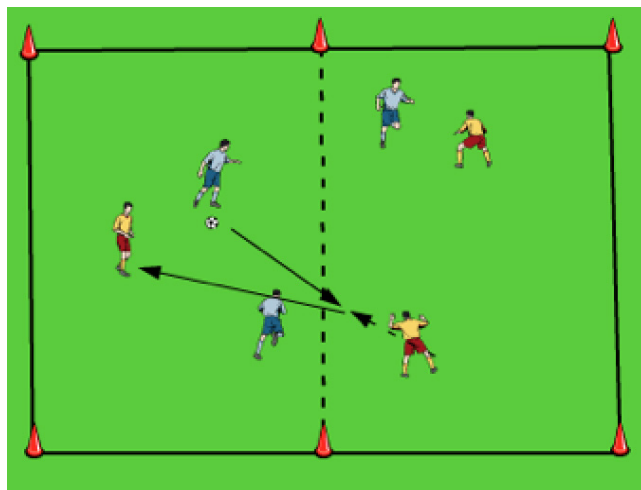


Fig. 1. Scheme of the first test: game of consecutive passes

A team had to place two players in the midfield (8×8 m), trying to make the maximum number of consecutive passes while an opponent tried to do everything possible to intercept the ball. When the defender was able to intercept the ball, he had to immediately pass it on the adjacent field, of the same size, where two of his teammates waiting for the passage. Thus, a new team of three attackers was formed who had to pass the ball, avoiding the intervention of one of the three opponents, keeping possession for 10-15 sec. Each player, after making a pass and then getting rid of the ball, always had to look for a position on the field that would allow him to re-

ceive the ball and pass it again without haste. The ball holder had two options: pass the ball to the less marked partner or lead the ball into an undefended space to gain time. In gaining space, the player always had to protect the ball with his body, placing himself between the ball and the opponent, and then turning around and leaving the corner. The defender had to be good at reducing the space and time available to the strikers, anticipating their actions, and forcing them to play the ball in the desired direction. When the ball left the field or when the attackers committed a foul, the defender took a free-throw, with the opponents positioned 5 m away. The game lasts 4 times of 5 minutes. What was evaluated was the number of consecutive passes that the team managed to make in the 4 game times.

The second test concerned the execution of a three-player attack situation (Fig. 2). In this case, two doors of different colours were needed for each team. The players of the two opposite teams were matched in an organized way (according to the scores of the first test) and competed in four games of 3vs3. Both the single selected actions (shots on goal, guiding the ball, dribbling / feints, advances on the opponent) and actions in collaboration with a partner (passes, receptions, position taking) were analysed.

Specifically, each team attacked two diagonally opposite doors and defended the other two. By doing so, a situation of

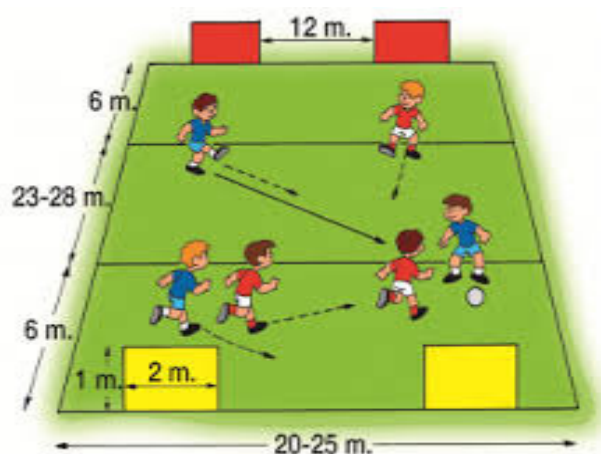


Fig. 2. Scheme of the second test: "3vs3 with elements of psychokinetic"

numerical superiority of 3vs2 and subsequently of 2vs1 was recreated that the team in possession of the ball had to try to capitalize to score a goal. The attack was to be conducted by passing the ball to speed up the game, with better exploitation of the free spaces. The introduction of frequent changes of direction when leading the ball could have created more space and induced more defensive errors. The coach and an assistant were able to change the color of the doors quickly and simultaneously on both sides. In fact, a frequent change of color of the doors during the game allowed to increase the attention, concentration, and peripheral vision of all the engaged players, since they had to keep an eye on all four doors simultaneously and read the game on the field. A goal could be scored either by shooting from within the 6m zone, or by leading the ball through the 7m goal of the designated color. The duration of the game is 3 times of 3 minutes. Table 2 shows a series of quantitative indices that reflect the perfor-

mance of each team. Specifically, these indices concern the number of scoring chances, the number of feints or dribbling, total passes, the number of balls stolen, the right maintenance of the position, the reception and the guide of the ball.

The last test involved a 3vs3 in confined spaces (Fig. 3). Each team had to defend two opposite doors and attack the other two; the doors were 7 to 10 meters wide, depending on the technical level of the players. Again, the team players, combined in an organized way, were evaluated in four games. In this case, the strikers in possession of the ball were not only required to assess the position, behaviour, and distance of the active defender, but also the position of the passive defender on the goal line. The assessment of the players' operational efficiency was aimed at limiting events that could adversely affect the course of the game.

The game started by throwing the ball in the midfield. When the ball went off the pitch it was put back into play by the other team, with the opponents at least 3 m away. To

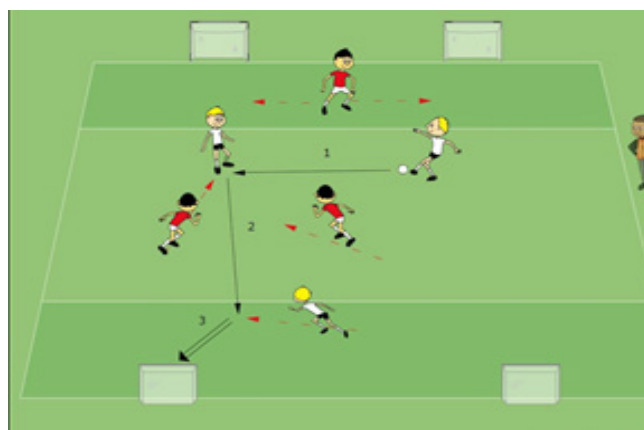


Fig. 3. Scheme of the third test: "3vs3 in small spaces"

score a goal, the teams had to lead the ball beyond the line of one of the two goals. To obtain a remarkable participation of all the players, it is recommended to make a two-minute rest after two goals (Joo, Hwang-Bo, & Jee, 2016). During this time both teams could discuss which strategy to apply later in the game. The aim of the test was to evaluate the quality of the game without the ball, the ability to break away and the understanding between the strikers. To create enough space and time to bring the next action to a successful conclusion, the player had to frequently make changes in direction and rhythm with or without the ball. When the game situation required it, even playing on the bank. The test involved 3 times of 5 min. of actual play. A series of indices that reflect the individual offensive performance have been reported in the table. Specifically, these concern 4 aspects:

- Ball control (advancing and maintaining position).
- The Passage (verticalizations and number of passages).
- The creation of offensive actions (by carrying the ball or through unmarked passages).
- The number of scoring chances (in and out of area).

Statistical analysis

The data obtained from the tests showed a normal distribution and were presented as mean and standard

deviation (SD). A t-test was conducted for independent samples to combine the results obtained from the tests before the experiment, and after the experiment. The t-test was selected as an analytical method to verify the presence or absence of a significant difference between two sets of data. The significant level was set at $p = 0.25$. Statistical analyzes were performed with the IBM SPSS Statistics 23 software.

Results

In the free trial, that of the “consecutive passages in reduced spaces” (Fig.1), the most frequent errors occurred in the hasty execution of the gesture, due to the opposing pressing which resulted in most cases, a defective control or a poorly calibrated first intention pass by the ball owner. In some cases, the difficulty in knowing how to dose the right strength to impart to the ball has also emerged. This often entailed the execution of high passages, slower and difficult to be controlled by the teammates compared to those carried out on the ground, facilitating the intervention of the defender. As can be seen from the results in the table, the number of steps carried out has increased considerably in both groups. The t-test shows a statistically significant variation between the two groups. Space is the variable that most influenced decision making and athletic performance.

In the second test, of the offensive situation with diagonally opposite doors (Fig. 2), the performance evaluation of the players was carried out with objective observation sheets. Effective and ineffective measures were considered, which provided a basis for calculating the reliability ratios (Table 2). Both teams recorded a better performance index in the rep-

Table 1. Results of the test of consecutive passes

Terms of registration	Experimental group (n = 12)		Control group (n = 12)		Δx	t	p
	X	s	X	s			
Until the experiment	7.1	2.44	5	1.53	1.75	2.09	.0175
After the experiment	9.4	2.76	6.6	1.91	2.50	2.10	.0124

etition of the test, but the team that showed overall a greater efficiency index was the experimental group with a score of 7.3 (until the experiment) and 7.5 (post the experiment). In a similar study (Kaczor & Duda, 2017) the players had reached an efficiency index of 6.18.

In the last test of 3vs3 with limited spaces (Fig. 3), what we wanted to investigate was the execution of the individual offensive strategy. The results of the evaluation (Table 3) show a significant increase in the individual involvement of the players and at the same time, a limited execution of slow actions in the game. The most frequent mistakes made by the attackers were playing too close, almost in line and not forming a triangle, thus facilitating the defense game. Even the passage, very often, was carried out on the partner and not on the run, thus slowing the execution of the shot. With the t-test, it has been observed that the main skills in which a significant improvement has occurred concern an increase in the number of steps performed, and greater offensive danger.

Table 2. Results of the test “3vs3 with elements of psychokinetic”

Index	Efficiency index		Inefficiency index		Activity index		Reliability index	
Experimental group	Until the experiment	After the experiment	Until the experiment	After the experiment	Until the experiment	After the experiment	Until the experiment	After the experiment
Goal shot	5	4	2	1	7	5	7.1	8
Lead the ball	8	8	4	3	12	11	6.6	7.2
Dribbling	6	6	1	1	7	7	8.5	8.5
Balls stolen	5	5	3	1	8	6	6.2	8.3
Total Passes	7	6	2	2	9	8	7.7	7.5
Receptions	6	4	1	2	7	6	8.5	6.6
Assuming position	5	3	2	1	7	3	7.1	6.6
Performance efficiency until the experiment: 7.3					Performance efficiency after the experiment: 7.5			
Control group	Until the experiment	After the experiment	Until the experiment	After the experiment	Until the experiment	After the experiment	Until the experiment	After the experiment
Goal shot	3	6	5	3	8	9	3.7	6.6
Lead the ball	6	3	5	2	11	5	5.4	6
Dribbling	3	4	2	2	5	6	6	6.6
Balls stolen	4	3	5	4	9	7	4.4	4.2
Total Passes	8	6	3	2	11	8	7.2	7.5
Receptions	6	4	2	2	8	6	7.5	6.6
Assuming position	4	3	3	2	7	5	5.7	6
Performance efficiency until the experiment: 5.7					Performance efficiency after the experiment: 6.2			

Note: Efficiency index = number of effective actions; Inefficiency index = number of ineffective actions; Activity index = effective + ineffective actions; Reliability index = (effective actions ÷ activity index) x10; Index of complex action efficiency = (sum of all reliability indices) ÷ 7.

Table 3. Results of the test “3vs3 in small spaces”

Variables considered	Terms of registration	Experimental group (n = 12)		Control group (n = 12)		Δx	t	p
		X	s	X	s			
Ball control	Until the experiment	3.8	0.9	2.9	0.8	.75	2.58	.017
	After the experiment	4.1	0.5	3.2	0.4	1.63	4.32	.000
Total Passes	Until the experiment	4.5	0.5	2.9	0.6	1.66	2.74	.019
	After the experiment	4.7	1.6	3.1	1.6	.50	6.46	.001
Creating goal score opportunity	Until the experiment	5.3	2.3	3.4	2.1	1.91	2.44	.032
	After the experiment	5.8	1.1	5.2	1.8	0.50	0.93	.364
Shots on goal	Until the experiment	4.0	1.0	4.5	1.9	0.58	-0.64	.530
	After the experiment	4.8	1.6	5.2	2.1	1.54	-0.57	.573

Discussion

From the results, the hypothesis of the study on the effectiveness of the Brain Kinetic methodology can be refuted, since it allows to reduce the activation of redundant cortical circuits that negatively condition the motor performance in stressful conditions, increasing the visuomotor coordination necessary to adapt the motor program to the environmental conditions. By observing the results of the experimental group, we can understand how to obtain a correct execution of the most important technical gestures, players must be able to solve multiple problems that are constantly encountered in the game. By observing the results of the control group, we can see how giving priority to the technique and the precise execution of the coach's orders, through the execution of stereotyped exercises, without motivating the players looking for solutions to the problems encountered in the game, prevents young people from understanding the game in its most basic aspects (Zuber, Zibung, & Conzelmann, 2015). Knowing that in 50% of the times the loss of ball possession occurs due to an incorrect decision making and not for a technical error, we need to reflect and be stimulated to look for new solutions in this sense (Altavilla, Riela, Di Tore, & Raiola, 2017; Sgrò, Aiello, Casella, & Lipoma, 2016). Exercises with limited spaces and with a reduced number of players have been presented, since the players touch the ball several times. This involves the realization of many passes, control, dribbling, shots, and rebounds, stimulating much more than football at 11 the learning of the technique by all players. According to some studies (Carvalho & Pacheco, 1990; Leso, Dias, Ferreira, Gama, & Couceiro, 2017), playing with the same players four 11-player soccer games and four 7-player soccer games in 2 halves of 20 minutes, the average number of contacts with the ball in 7-a-side football is 92% higher than in 11-player football. The authors who have studied the problem of internal and external load in young players have rarely referred to the possibility of using/varying the space (Kilding, Tunstall, & Kuzmic, 2008). The dynamic modulation of the space in which the exercise is performed seems to strongly influence the high intensity exercise with a reduction of the same by about 48% and about 39.6% respectively for U13 and U15. The total distance reached also decreased in the dynamic condition for U13 and U15, respectively by 16.5% and 13.6% (Panfil & Mazur, 2018; Sgrò, Quinto, Pignato, & Lipoma, 2016; Partington & Cushion, 2013). The results of these studies demonstrate the

possibility of practically applying this operational monitoring tool for the individual assessment of players, since it has a real and significant impact on the result of the game. This study is offered as an additional contribution to the methodology presented, since it produces greater effects than the traditional training process to which the experimental group was subjected. As for the cognitive aspect, this work acquires a special meaning because it is the essence of a sports game. The ability to quickly and effectively adapt a learned behaviour can only be acquired when the player is subjected from the beginning, and up to the high performance phase, to a systematic development of his mental abilities (Ceruso, Esposito, & D'Elia, 2019). These are considered, more than in the past, as the fundamental and essential skills for good performance. In view of further research, other investigations could be conducted on the identification of training protocols and tests at different ages during adolescence. It would be appropriate to compare the measures through the subsequent years of development of the participants. A possible proposal could be to identify, for those who have the possibility, directly the physiological capacities rather than relying on estimates based on performance, focusing in detail on this specific element, perhaps by administering self-efficacy questionnaires for a complete approach of self-evaluation.

Conclusions

This study allowed to experimentally test, through the use of specific field tests, the effectiveness of the Brain Kinetic training method. This allowed the players involved in the experimental group to take personal, individual and group actions that had a real impact on the outcome of the game. The essential concept that emerges is that the development of game intelligence in football necessarily passes from the ability to teach players to perceive and understand a game situation based on the knowledge and experience previously acquired, using simplified games with a increasing degree of difficulty. It doesn't matter if the action is the result of repeated practice of the same game situation, what matters is that the player is able to read the game situation and solve problems successfully.

Conflict of interest

The authors declare that there is no conflict of interest.

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МЕТОДИКА СПРИЯННЯ РОЗВИТКУ ІНТЕЛЕКТУ ТА ІГРОВИХ НАВИЧОК У МОЛОДІЖНОМУ ФУТБОЛІ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 3 табл., 3 рис., 30 джерел

Метою дослідження є оцінка ігрових навичок молодих гравців, які досліджуються, у глобальному контексті. Зокрема, призначено перевірити, чи сприятливо вплинула запропонована методика навчання на формування ігрових навичок та підвищення ефективності ігрової діяльності.

Матеріали та методи. Учасниками дослідження є 24 молоді гравці, віком від 13 до 14 років. Для досягнення поставлених завдань дослідження спиралось на такі методи: аналіз наукової літератури, польове тестування та методи математичної статистики. Експериментальна група виконувала специфічний тренувальний мезоцикл (такий, що стосується мозкової кінетики), а контрольна група – традиційний робочий мезоцикл. Для виявлення наслідків методології навчання використовувалися польові випробування як до, так і після навчального періоду, з дотриманням протоколів виконання, описаних Х. Вейном. Матеріали дослідження були оброблені програмним забезпеченням статистичного аналізу IBM

SPSS 22. Для порівняння результатів двох груп використовували парний зразок t-тесту.

Результати. Аналіз t-тесту вказує на статистично значущі зміни тренувального ефекту експериментальної групи. Кращий показник ефективності, виявлений в експериментальній групі у виконанні навичок, порівняно з контрольною групою, пояснюється диверсифікацією методології, якій вони були піддані. Тому зміни після навчання на кожному індексі навичок посилюються подальшим повторенням тестів. Відмінності між показниками тесту є статистично значущими.

Висновки. Дослідження підтвердило гіпотезу про те, що використання методу тренування мозкової кінетики визначає позитивний ефект у формуванні ігрових навичок. Цей метод дозволив гравцям, які беруть участь в експериментальній групі, виконувати індивідуальні та групові дії, що реально вплинули на результат гри.

Ключові слова: молодіжний футбол, навички прийняття рішень, спрощена гра.

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ORIGINAL SCIENTIFIC ARTICLE

ATHLETIC TECHNICAL SKILLS OF STUDENTS AS TRAINING EFFICIENCY INDICATOR

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Abstract

The purpose of the study is to evaluate the effectiveness of training sessions among the 1st-3rd year students of the general physical training (GPT) volleyball groups.

Materials and methods. The athletic technical skills (ATS) have been tested by results of tests on upper and lower passes and serves. ATS testing of students from GPT volleyball groups was carried out at the beginning and at the end of the spring semester, in which 45 of the 1st year students (2 study groups), 60 of the 2nd year students (3 groups), 33 of the 3rd year students (2 groups) took part. The same students took part in the testing at the beginning and at the end of the semester (pairwise comparison).

Research result. The method to evaluate the effectiveness of practical training for the Program of "Physical Culture" has been developed. Special aspects of ATS indicators dynamics of the 1st-3rd year students of GPT educational groups with sports orientation (volleyball) from the beginning to the end of spring semester were revealed.

Conclusion. The highest efficiency of training sessions was observed among the 2nd year students. It is characterized by an increase in the number of students who successfully passed the tests on upper and lower passes by 5%, and 12%, respectively. The number of students who successfully passed the tests on serves increased by 11%, and a performance level grew from middle at the beginning of the semester to high at the end of the semester.

The lowest effectiveness of training sessions was observed among the 1st year students. The outcome indicator of volleyball basic training corresponds to medium level at the beginning and at the end of the spring semester. The change in the number of students who successfully passed the tests on upper passes (–2%), lower passes (–2%), and serves (+2%) was insignificant from the beginning to the end of the semester.

Keywords: athletic and technical skills (ATS), general physical training (GPT), testing, training session's effectiveness.

Introduction

A literature review shows an increasing number of students who have a low level of physical education (Shilko, 2007; Martynyuk & Vilyansky, 2015; Druz, Iermakov, Nosko, Shesterova, & Novitskaya, 2017). This affects the state of health, which is a factor in wellbeing of a future specialist (Korol, 2014; Kenioua & Bowmased, 2016). The major reason is a sharp reduction in a physical activity (Grygiel-Górniak, Tomczak, Krulikowska, Przysławski, Seraszek-Jaros, & Kaczmarek, 2016; Sternfeld, Gabriel, Jiang, Whitaker, Jacobs, Quesenberry, Carnethon, & Sidney, 2019).

The main problem in the university physical education management is a lack of information providing a feedback between subjects (Semenov & Mironova, 2006; Anikieiev, 2015).

Assessment of a physical education state among students is a leading factor in the pedagogical process. It promotes a growth of athletic and technical skills of students (Sidorova, 2009) and contributes to increasing interest in a physical activity (Baka, 2010; Druz, Iermakov, Artemyeva, Puhach, & Muszkieta, 2017).

The dynamics of physical fitness indicators cannot be a one objective criterion of a physical education effectiveness (Akhmatgatin, Lebedinsky, Khomyakov, Kudryavtsev, Galimova, Kamoza, Panov, Kuzmin, Gaskov, Sidorov, & Doroshenko, 2020).

Athletic and technical skills (ATS) are defined as one of indicators of a training sessions effectiveness among students from the Main Department (Shcherbakov, Volkov, & Davidenko, 2010). It characterizes the level in the athletic technique. The need for the ATS assessment is noted by Ageevets, Efimov-Komarov, Efimova-Komarova, Lebedeva, and Perelman (2019), Ageevets, Efimov-Komarov, Efimova-Komarova, Nazarenko, and Puchkova (2020), Efimov-Komarova, Efimova-Komarova, Lebedeva, and Perelman (2020).

It is established that an athletic technique training increases the interest in practicing of a physical culture by students significantly (Sisova & Semiglazova, 2015; Surikova & Kozhanova, 2016; Bakuradze, 2020).

Tests to assess an athletic exercise technique in accordance with the athletic theory (Demchishin & Pilipchuk, 1979; Zhelezniak, 1988; Zhelezniak & Kunyansky, 2000; Sharafeyeva, 2009) are widely used in a volleyball practice (Zatsiorsky, 1982; Godick, 1988).

Akhmerov, Akhmerov, and Shiryayev (2004) presented the results of theoretical and experimental studies that allow objectively characterize the testometric level of physical and theoretical fitness of volleyball players. Tests must meet two basic requirements: they must be reliable and informative.

The literature offers tests that are developed for qualified athletes, not suitable for non-athletes and do not have a sufficient bandwidth.

The literature review didn't identify any tests and standards to evaluate technical skills of volleyball players among students of non-sports universities (Scherbakov, et al., 2010).

There are following tests to assess volleyball technical fitness of beginner athletes (9-13 years old) of sports schools such as upper and lower passes, (above and in front, respectively), serve, attack and block (Pashkova, 2009; Gulyayeva, 2013).

There were tests developed to assess athletic and technical skills of the 1st through 3rd year students of general physical training groups (GPT) with a specialization in volleyball (Barantsev, Naidyonova, & Sarycheva, 2009). Three tests were tested; they included upper/lower passes and serve. They became more complex from 1st through a 3rd study year. It has been established that testing allows to objectively analyze a training level in volleyball playing basic technical skills among students of 1-3 study year and to evaluate athletic and technical fitness of GPT student groups.

The studies by Barantsev, Domashchenko, and Chicherin (2019), Barantsev (2020) presented tests and standards for assessing ATS among the GPT groups with various specializations (GPT-volleyball, GPT-football, GPT-basketball, GPT-athletics, GPT-ping-pong, etc.).

Male and female 1st year students from the physical education groups, with a different sports specialization, showed significant differences in the development of general athletic fitness, both in the dynamics of average values and in comparing deviations (changes) in athletic fitness indicators from the beginning to the end of the school year. Female 1st year students from the GPT-aerobics group showed the highest level in a development of general physical fitness (6 points). In the GPT-athletics and GPT-volleyball groups the effectiveness is slightly lower (5 and 4 points, respectively). It corresponds to two points in the GPT athletics group (Grunina, Yermakov, Logacheva, & Naidyonova, 2009). The development of basic physical skills during a "Physical Culture" practice reaches 5 points among young men of GPT-boxing

group. The effectiveness is slightly lower among GTP-basketball group students (3 points). In the GPT-football groups, the effectiveness of classes is the lowest (1 point) (Barantsev, Kolesnikov, Pekhterev, & Skorodumov, 2010).

We studied the dynamics and developed standards for assessing athletic and technical skills among the 1st year students of GPT-volleyball groups (Barantsev, Katilin, Naidyonova, & Sarycheva, 2012). It was established that the use of the above tests in the educational process allows to objectively analyze a level of training among 1st and 2nd year students in basic technical methods of playing volleyball and to evaluate the athletic and technical skills of students of GPT-volleyball groups (Barantsev, Vedisheva, & Naidyonova, 2013).

Barantsev and Naydenov (2017) presented a methodology and standards to assess an athletic and technical fitness among 1st-3rd year students of the GPT-volleyball groups.

It was established that the indicators of the athletic and technical skills decrease significantly from the 3rd to 4th semester among non-athletic students of the 2nd study year from the GPT-volleyball groups. The reason is the decrease in the number of practical classes (from 40 in the 3rd semester to 24 in the 4th semester) (Barantsev, Chicherin, Naidyonova, & Bychkova, 2019).

The literature review didn't show any studies evaluating the effectiveness of practical classes based on indicators of athletic and technical skills among students from the GPT-volleyball groups.

The purpose of the study is to evaluate the effectiveness of training sessions among the 1st-3rd year students of the GPT-volleyball groups.

The objectives are:

1. To identify specifics of the test results among the 1st-3rd year students from the GPT-volleyball groups during the spring semester.

2. Based on the ATS dynamics during a semester, evaluate the effectiveness of training sessions among the 1st-3rd year students from the GPT-volleyball groups.

Materials and methods

Table 1 summarizes tests we developed to evaluate ATS among 1st-3rd year students from the GPT-volleyball groups (Barantsev et al., 2009).

Detailed recommendations for testing are presented in the monograph (Barantsev et al., 2019) and the manual (Barantsev, 2020). The height of an upper and lower serve is 1.5-2.0 m. A subject has three attempts to perform a test during one class. The test is performed a required number of times, non-stop. For each test, students get a "pass" or "failure" grade. Then, a study group training level is assessed for the first (test No. 1), second (test No. 2) and the third exercise (test No. 3).

Table 2 presents standards we developed to evaluate indicators of an athletic performance among GPT-volleyball groups (Barantsev & Naydenova, 2017). The standards are the same for female and male students of the same study year.

Students who regularly attended practical classes and participated in testing were included into a study cohort as 100%. A proportion of students who completed either upper or lower serve are considered 100%.

Statistical analysis methods were employed to analyze the results.

Table 1. Athletic and technical skills (ATS) tests evaluation of 1-3 courses students from GPT-volleyball groups

№	Test name	Pass		
		1 course	2 course	3 course
1	Upper pass with two hands – above itself (number of times)	15 (on area of 9×9 m ²)	20 (on area of 9×9 m ²)	20 (on area of 3×3 m ²)
2	Lower pass from below with two hands – in front of you (number of times)	15 (on area of 9×9 m ²)	20 (on area of 9×9 m ²)	20 (on area of 3×3 m ²)
3	Serve (number of times) optional: – bottom (or side) – from above	6 of 10 5 of 10	7 of 10 6 of 10	8 of 10 7 of 10

Study design

ATS testing of students from GPT-volleyball groups was carried out at the beginning and at the end of the spring semester, in which 45 of the 1st year students (2 study groups), 60 of the 2nd year students (3 groups), 33 of the 3rd year students (2 groups) took part. The same students took part in the testing at the beginning and at the end of the semester (pairwise comparison).

Students enrolled in study groups at the beginning of each semester at will. Therefore, their ability to play volleyball was different. In this regard, if a student did not play volleyball at all or took classes for just one semester, then he was tested according to the 1st study year program; if he took 2-3 semesters of classes then he was tested according to the 2nd study year program; 4-5 semesters – according to the 3rd study year program.

The curriculum of the training sessions for students of the GPT-volleyball groups is presented in the manual (Barantsev, 2015). Students in these groups are mainly engaged in a general physical training and improving volleyball skills. A practical training methodology is based on a modern knowledge about volleyball playing technical skills among the 1st-3rd study year students from the GPT-volleyball groups (Zheleznyk, 1989; Sharafieva, 2009).

There were 24 practical trainings conducted with the 1st, 2nd, 3rd study year students from the Main Department during a spring semester. Students neither from the Specialized department (students who had health problems) nor from the Sports Department (students who have a sports qualification and regularly participate in student sports competitions such as Moscow student games) didn't participate in the study. Health wise, all study participants belong to the core medical group.

Study results

Based on the test results, the teacher of the study group determines a proportion of students who pass the testing. Results are compared with the standards for assessing ATS indicators (Table 2).

Table 3 presents the dynamics of ATS indicators of the 1st, 2nd and 3rd study year students during a spring semester. A column on the left shows an academic semester and num-

Table 2. Athletic and technical skills (ATS) testing of students from general physical training group with sports orientation (volleyball)

Course	Level ATS	Upper pass (%)	Lower pass (%)	Serve (top or bottom - %)	Assessment of total level ATS
1	High	more 96	more 93	more 98	more 96
	Medium	85-96	80-93	88-98	82-96
	Low	less 85	less 80	less 88	less 82
2	High	more 97	more 94	more 98	more 96
	Medium	82-97	76-94	85-98	82-96
	Low	less 82	less 76	less 85	less 82
3	High	more 96	more 93	more 99	more 95
	Medium	82-96	76-93	86-99	83-95
	Low	less 82	less 76	less 86	less 83

ber of students in a study group who participated in the testing. The middle column represents a percentage of students who completed the test and reached a passing grade. The right column summarizes a final average test result for three tests.

Two groups of the 1st year students were tested in a spring semester. The trends in average performance indicators among 1st year students from the GPT-volleyball groups are presented in Figure 1.

The outcome indicator for students who completed upper and lower passes for a “pass” decreased by 2 percent, but still remained at the average level for training of these technical skills. The number of students who passed the testing increased by 2%. At the same time, a number of students performing upper pass increased by 7% (Table 3), which is indicating the effectiveness of the volleyball technique training among 1st year students.

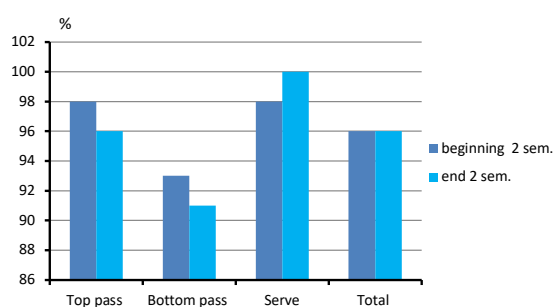


Fig. 1. Trends in average performance indicators of the 1st year students from GPT-volleyball groups

Three 2nd year groups of students were tested at the beginning and at the end of a spring semester. The Figure 2 depicts trends in performance indicators of the 2nd year students from GPT-volleyball groups.

The upper pass training rate increased by 5%, the lower one – by 12% and remained at the medium level of training for both. The number of students who passed the testing increased by 11%. The levels of these skills were medium at the beginning of the semester, and became higher at the

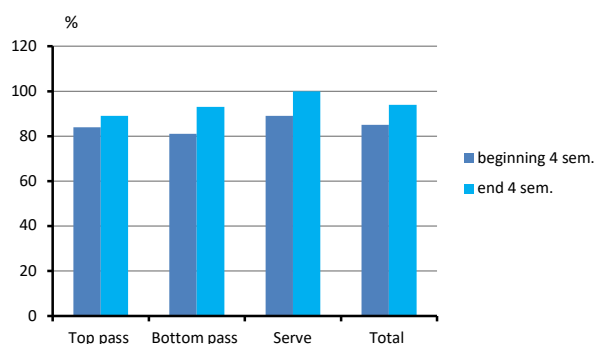
Table 3. Dynamics of ATS indicators (%) of students of 1-3 years academic group GPT-volleyball

Semester, number of students	Top pass	Bottom pass	Serve			Total
			Total	Bottom	Upper	
beginning 2 sem., n=26	96 (m*)	96 (h)	96 (m)	27	73	96 (m)
end 2 sem., n=26	92 (m)	92 (m)	100 (h)	25	75	95 (m)
beginning 2 sem., n=19	100 (h)	89 (m)	100 (h)	35	65	96 (m)
end 2 sem., n=19	100 (h)	89 (m)	100 (h)	24	76	96 (m)
Total: beginning 2 sem.	98 (m)	93 (m)	98 (m)	31	69	96 (m)
end	96 (m)	91 (m)	100 (h)	24	76	96 (m)
beginning 4 sem., n=22	95 (m)	95 (h)	95 (m)	25	75	95 (m)
end 4 sem., n=22	100 (h)	100 (h)	100 (h)	24	76	100 (h)
beginning 4 sem., n=16	75 (l)	75 (l)	93 (m)	36	64	81 (l)
end 4 sem., n=16	75 (l)	94 (m)	100 (h)	33	67	90 (m)
beginning 4 sem., n=22	82 (m)	73 (l)	79 (l)	16	84	78 (l)
end 4 sem., n=22	91 (m)	86 (m)	100 (h)	25	75	92 (h)
Total: beginning 4 sem.	84 (m)	81 (m)	89 (m)	26	74	85 (m)
end	89 (m)	93 (m)	100 (h)	27	73	94 (m)
beginning 6 sem., n=22	100 (h)	76 (m)	96 (m)	24	76	91 (m)
end 6 sem., n=22	95 (h)	91 (h)	100 (h)	23	77	95 (h)
beginning 6 sem., n=11	80 (m)	73 (m)	73 (l)	38	62	75 (l)
end 6 sem., n=11	80 (m)	82 (m)	73 (l)	38	62	78 (l)
Total: beginning 6 sem.	90 (m)	75 (l)	85 (m)	31	69	83 (m)
end	88 (m)	87 (m)	87 (m)	31	69	87 (m)

* In a parentheses is an assessment of testing results among GPT students of each academic group - high (letter "h"), medium - "m" and low - "l" (Table 2).

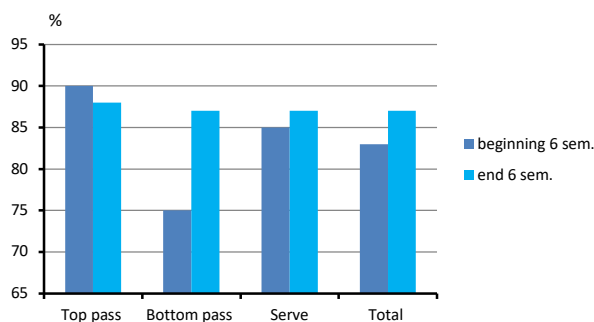
end of the semester. The outcome indicator for three tests increased by 9%, but remained at the medium level. The following proves a high efficiency of training sessions with the 2nd year students.

Two 3rd year student groups were tested at the beginning and at the end of the spring semester. Trends in performance

**Fig. 2.** Trends in performance indicators of the 2nd year students from GPT-volleyball groups

indicators of the 3rd year students from GPT-volleyball groups are presented in Figure 3.

The number of students who passed the test on upper pass decreased by 2%, but remained at medium level. Those ones who passed the test on lower pass and serve increased by 12% and 2%, respectively. Although, this number remained at the medium level of training in these technical skills. The outcome indicator of training in three volleyball playing

**Fig. 3.** Trends in performance indicators of the 3rd year students from GPT-volleyball groups

technical methods increased by 4%. Therefore, 3rd year students showed an improvement in the lower pass performing technique, and stabilizing in the upper pass and serves performing techniques during the semester. The outcome indicator of training in three volleyball technical methods remains at the medium level.

Discussion

The article presents the method to evaluate the effectiveness of practical training for the Program of "Physical Culture". It is based on the ATS indicators among 1st-3rd year students from the GPT-volleyball groups. It proposes the following:

- testing of volleyball basic techniques among students at the beginning and at the end of the semester;

- generalization of test results by study groups and study year;
- determining the percentage of students who successfully passed tests;
- determining the outcome test indicators of study groups by a study year;
- evaluation of test results of study groups according to developed standards;
- analysis of trends in ATS among students by a study year.

This methodology is designed for physical culture coaches. Therefore the simplified statistical analysis such as a percentage and average calculation is used to evaluate test results. The proportion of students who successfully passed tests is compared with the ATS assessment standards. This methodology is simple and it is widely used in our practice.

The study results showed that reliable differences correspond to the ATS indicators change among students from GPT-volleyball groups by 7% or more (Barantsev et al., 2019). Moreover, a high efficiency volleyball technical training is determined by moving from a lower to a higher level of training.

For example, the number of the 2nd year students who successfully passed tests increased by 11%. At the same time, the level of training has increased from medium at the beginning of the semester to high at the end of the semester. The most efficient training sessions for the 2nd year students are characterized by a 12% increase in the number of students who successfully passed lower passes. In this case, the result at the end of the semester is only 1% less than the top boundary of medium level.

Similar trends in performance of lower passes are seen among 3rd year students – low level of training at the beginning of the semester reached medium one by the end of the semester. The performance increased by 12%.

In one of 1st year training groups, the test results of upper and lower passes decreased by 4% but the test results of serves increased by 4%. This case shows downward trend in a technical skills development and an improvement in serve performance.

Study groups are formed according to student interests. The attendance, student commitment during trainings differs. Therefore, instructor's performance during a semester should be evaluated according to average outcome indicators.

The study results showed that the assessment of training effectiveness is the most accurate when the same students from the GPT-volleyball groups are tested at the beginning and at the end of the semester. The ATS testing at the end of a semester only, characterizes the effectiveness of practical classes less accurately. This is negatively affected by a long winter session, exams, and a winter break; as well as students enrollment to specific groups at will in the beginning of each semester. Additionally, student ATS testing at the end of the semester only, does not allow to evaluate trends in testing indicators in the fall semester.

The standards we developed to evaluate ATS of the 1st-3rd year students have three levels: high, medium and low level of training in basic volleyball techniques. Currently, statistical material to develop standards with additional educational levels is being compiled.

Conclusion

ATS testing results are one of the objective indicators to evaluate the effectiveness of practical classes and improve-

ment of technical skills among the 1st-3rd year students from GPT-volleyball groups;

The highest efficiency of training sessions was observed among the 2nd year students. It is characterized by an increase in a number of students who successfully passed the test on upper and lower passes by 5%, and 12%, respectively. The number of students who successfully passed the test on serves increased by 11%, and a performance level grew from medium at the beginning of the semester to a high at the end of the semester.

Less effective training sessions were observed among 3rd year students. It is characterized by a 12% increase in a number of students who successfully passed the test on lower passes, and maintaining the same percentage of students who completed successfully passed the test on upper passes and serves. The outcome indicator of a training in three volleyball technical skills corresponded to medium level;

The lowest effectiveness of training sessions was observed among 1st year students. The outcome indicator of volleyball basic training corresponds to medium level at the beginning and at the end of the spring semester. The change in a number of students who successfully passed the test on upper passes (-2%), lower passes (-2%), and serves (+2%) was insignificant from the beginning to the end of the semester.

Conflict of interest

Authors claim no conflict of interest.

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СПОРТИВНО-ТЕХНІЧНА ПІДГОТОВЛЕНІСТЬ СТУДЕНТІВ ЯК ІНДИКАТОР ЕФЕКТИВНОСТІ ПРАКТИЧНИХ ЗАНЯТЬ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 3 табл., 3 рис., 39 джерел

Мета дослідження – оцінити ефективність навчально-тренувальних занять зі студентами 1-3 курсів основного відділення навчальних груп загальної фізичної підготовки (ОФП) зі спортивною спрямованістю (волейбол).

Матеріали і методи. Спортивно-технічну підготовленість (СТП) студентів навчальних груп ОФП-волейбол оцінювали за результатами тестування верхньої, нижньої передачі та подачі. Тестування СТП студентів навчальних груп ОФП-волейбол проводили на початку та наприкінці весняного семестру, в якому взяли участь 45 студентів 1 курсу (2 навчальні групи), 60 студентів 2 курсу (3 групи), 33 студенти 3 курсу (2 групи). У тестуванні брали участь одні й ті ж студенти (попарно-зв'язкові варіанти).

Результати. Розроблено технологію оцінки ефективності практичних занять дисципліни «Фізична культура» на підставі одного з індикаторів – спортивно-технічної підготовленості студентів 1-3 курсів навчальних груп ОФП-волейбол. Виявлено особливості динаміки показників СТП студентів 1-3 курсів навчальних груп

ОФП зі спортивною спрямованістю (волейбол) від початку до кінця весняного семестру.

Висновок. Найбільш висока ефективність навчально-тренувальних занять відзначена на 2 курсі. Вона характеризується збільшенням кількості студентів які здали на «залік» верхні і нижні передачі на 5% і 12% – відповідно. Кількість студентів, які виконали на «залік» подачі, збільшилася на 11%, а рівень навченості з середнього на початку семестру виріс до високого в кінці семестру. Порівняно нижча ефективність навчально-тренувальних занять виявлена на 1 курсі. Підсумковий показник навченості студентів 1 курсу основним прийомом гри у волейбол на початку і в кінці весняного семестру відповідає середньому рівню. Динаміка кількості студентів, які виконали на «залік» верхні передачі (–2%), нижні передачі (–2%), подачі (+2%), від початку до кінця семестру незначна.

Ключові слова: спортивно-технічна підготовленість, загальна фізична підготовка, тестування, ефективність практичних занять.

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THE ASSESSMENT OF PHYSICAL FITNESS AND MORPHOFUNCTIONAL STATE OF FEMALE FIRST-YEAR STUDENTS IN NON-LINGUISTIC HIGHER EDUCATION INSTITUTIONS

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Abstract

The purpose of this research paper is to study physical fitness and functional state of female first-year students in Prydniprovsk State Academy of Civil Engineering and Architecture.

Materials and methods. The study involved 100 female first-year students of general group aged 17-18, all after medical examination and obtaining doctor's approval: the age group was 18 years old (n = 100). To meet the goals set, the following research methods were used: theoretical analysis and generalization of data in specialized scientific and methodological literature, pedagogical testing, anthropometric research methods, functional methods of cardiorespiratory system investigation and methods of mathematical statistics for processing the results of the research.

Results. the conducted study proved the hypothesis on the necessity to improve the system of physical education in technical higher educational institutions, which is connected with the low level of physical fitness among students.

Conclusions. The study revealed the low level of physical fitness among the investigated students in terms of speed and strength endurance indicators (with 83%), explosive physical force of the lower limbs (with 82%) and strength endurance of the upper limbs (with 68%), as well as reduced functional characteristics: resistance to hypoxia (according to the results of the Shtange test with 46% and the Gench test with 49%), workability (with 71%) and efficiency of cardiovascular system (with 55%). Low physical fitness levels among the tested girls necessitate the additional introduction of more intensive training. The high variability of the physical fitness indicators among the students requires personalization of the training process, as well as the obligatory use of express testing methods for the physical state of each student during a workout.

Keywords: students, physical education, physical state, functional indicators, physical fitness.

Introduction

Problem statement. When analysing individual physical fitness, some researchers primarily focus on the study of fitness level as one of its fundamental components. Some researchers have ascertained an overall decline in the physical fitness level in societies both in Ukraine (Kashuba, Asauliuk, & Diachenko, 2019; Bondarenko, Dziuban, Isaienko, & Bondarenko, 2018) and abroad (Prusik, Prusik, Iermakov, & Kozina, 2012; Osipov, Vonog, Prokhorova, & Zhavner, 2016). As the problem of physical activity is becoming increasingly pressing in Ukraine, the measures aimed at improving the physical fitness of the country's population have

been enforced legislatively, namely the requirements for annual fitness assessment of people under 21 years of age in compliance with the Resolution of the Cabinet of Ministers of Ukraine "On approval of annual physical fitness assessment of Ukraine's population" (Resolution No 1045 as of December 9, 2015) and the Order of the Ministry of Education and Science of Ukraine (Order No 4665 as of December 15, 2016). However, in practice such measures do not seem to have led to any significant changes in the physical fitness level of young people (Osipov & Budnyi, 2017).

Thus, Kashuba et al. (2019), Bondarenko et al. (2018) and Malimon, Pantik, and Tsos (2018) highlight the predominantly low fitness level among students, besides, according to studies by Moskalenko and Pichurin (2017), Osipov and Budnyi (2017) and Zhamardiy, Shkola, Tolchieva, and Saienko (2020),

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the fitness level of girls and young women was lower than the fitness level of boys and young men of the same age.

All that necessitate a more thorough study and analysis dedicated to the issue of physical fitness and functional state among young people in Ukraine.

Analysis of research and publications. Studies of physical fitness and functional state of students is a crucial issue of national importance, which can be evidenced by a large number of publications devoted to this issue. Most experts in both physical education and health care have been making efforts to increase the levels of young people's physical fitness.

The analysis has shown that the main reasons for low physical fitness levels among youth are as follows:

- decline in motor activity of the population related to universal automation and modernization of life (Osipov, Kudryavtsev, Iermakov, Yanova, Lepilina, Plotnikova, & Dorzhieva, 2017);
- lack of motivation to do sports or work out (Anikieiev, 2015; Jaakkola, Yli-Piipari, Barkoukis, & Liukkonen, 2017; Sulz, Temple & Gibbons, 2016);
- lack of a differentiated approach while selecting the load level at physical education classes (Nagovitsyn, Osipov, Manurov, Zhuikov, & Verzhinina, 2019);
- reduction of mandatory hours on physical education in nonspecialized universities and transfer of these classes to an optional or elective form (Kashuba et al., 2019; Gryban, 2014);
- deterioration of ecological environment (Lebedinskiy, Koipysheva, Rybina, Kudryavtsev, Iermakov, Osipov, & Sidorov, 2017; Paliienko, 2017; Trotska, Homlia, & Kovalenko, 2018).

The researchers offer a range of measures to increase the youth's fitness levels. Thus, Aghyppo, Tkachov, and Orlenko (2016) recommend promotion of a healthy lifestyle as the main objective of physical education in schools and universities. Gryban (2014) believes that it is possible to change the existing situation by improving the educational process at physical education classes and increasing the quality of education by enhancing teacher's performance. Kozina, Ol'khovyj, and Temchenko (2016) suggest computer technologies as an important component aimed at enhancing the quality and effectiveness of PE classes. Puzdymir (2019) and Vaskevich (2019) offer to prioritize physical training and purposeful development of physical skills as the main component of physical education programme. Butenko, Goncharova, Saienko, and Tolchieva (2017) recommend promoting tourism with the aim of increasing students' interest, and Yarmak, Galan, Hakman, Dotsyuk, and Blagii (2017) and Skurikhina, Kudryavtsev, Kuzmin, and Iermakov (2016) advise including fitness technologies in physical education programme.

Other experts consider it necessary to focus efforts on improving the physical fitness of those categories of youth who already suffer a decrease in this indicator. Kuzmina, Lebedinskiy, and Kudryavtsev (2018), Prosvirina, Kolokoltsev, Kolchanova, Cieslicka, and Stankiewicz (2015) and Skurikhina et al. (2016) investigate the issue of organizing educational process in groups with special health needs. Kuzmin, Kopylov, Kudryavtsev, Galimov, and Iermakov (2015) research the issue concerning students who lack physical fitness. Adyrkhaev (2016) works on the methods of physical education improvement for disabled students. Kashuba, Kolos, Rudnytskyi, Yaremenko, Shandrygos, Dudko, and Andrieieva (2017)

substantiated the technology of the female students' body state improvement with the use of wellness fitness means.

The problem of weight control is also addressed by a group of scholars: Osipov, Kudryavtsev, Gruzinky, Kramida, and Iermakov (2017) point out the issue of obesity prevention, whereas Kolokoltsev, Iermakov, and Jagiello (2018) study underweight health risks.

Thus, the undertaken analysis of academic literature proves the topicality of the problem stated and conditions the necessity of doing a complex research into youth's physical fitness and morphofunctional state.

The purpose of this research paper is to identify the level of physical fitness and morphofunctional state among the female first-year students at SHEI "Prydniprovsk State Academy of Civil Engineering and Architecture".

Materials and methods

Participants of the research

The study involved 100 female first-year students of general group aged 17-18, all after medical examination and obtaining doctor's approval: the age group was 18 years old ($n = 100$). All students gave permission to process their personal data.

Organization of the research: to meet the goals set, the following research methods were used: theoretical analysis and generalization of data in specialized scientific and methodological literature, pedagogical testing, anthropometric research methods, functional methods of cardiorespiratory system investigation and methods of mathematical statistics for processing the results of the research.

The investigation into the girls' anthropometric indicators was conducted by comparing them with the average indicators within their gender and age group. Their body length, weight and girth body dimensions were studied, which were measured with a rubber-modified tape measure to within 0.5 cm (the length of the tape was calibrated according to a metal standard mould after every 20th measuring).

Moreton and Morley (2011) and Shulga (2019) justify the need for assessing students' physical fitness using the index method.

The body mass index (BMI), which is used to assess the correspondence between person's weight and height, is calculated by formula (1).

$$BMI \left(\frac{kg}{m^2} \right) = \frac{m(kg)}{L(m)^2}; \quad (1);$$

where m is body weight; L is body length.

According to the World Health Organization, the BMI scale is as follows: normal body weight corresponds to BMI indicator between 18.5 and 24.99; indicators of 16-18.4 mean that a person is underweight; figures 25-30 show that a person is overweight; BMI of more than 30 indicates obesity.

To assess the proportionality and the correspondence of particular segments with the basic anthropometric parameters, the proportionality index (PI) was calculated by dividing the values of different parts of the body girth measurements (cm) by the body length figures (cm) and comparing them to actual and guideline values, provided in table 3.

Tests and standards, which are used during the annual assessment of Ukrainians' physical fitness level, were included

Table 1. Guidelines on assessment of Ukrainians' physical fitness level*

No.	Tests	Fitness level				
		high	sufficient	average	low	poor
	The corresponding mark	5	4	3	2	0
1	Steady running 2000 m, min.	≤10.3	11.15	11.5	12.3	≥12.4
2	Push-ups, times	≥25	21-24	18-20	15-17	≤14
	or long standing jump, cm	≥210	200-209	185-199	165-184	≤164
3	Sprint 100 m, c	≤14.8	14.9-15.5	15.6-16.3	16.4-17.0	≥17.1
4	Shuttle running 4 × 9 m, sec	≤10.4	10.5-10.8	10.9-11.3	11.4-11.6	≥11.7
5	Forward bend from a seated position, cm	≥20	18-19	16-17	9-15	≤8
–	Total score	21-25	16-20	11-15	6-10	0-5

Note: * - for girls aged 18-22

into the scheme of testing to assess physical fitness levels (Prontenko, Griban, Medvedeva, Aloshyna, Bloshchynskyi, Bezpalii, Bychuk, Mudryk, Bychuk, Radziyevsky, Filatova, & Yevtushok, 2019). The criteria of these tests are stated in Table 1.

The corresponding number of points was awarded for each of the results. In the end, the scores for each of the tests were summed. The assessment of the physical fitness level was carried out depending on the total number of points.

Such cardiorespiratory indicators as heart rate (HR), systolic and diastolic blood pressure (SBP and DBP respectively) and respiratory rate (RR) were measured at rest according to standard methods in order to assess the functional state of the students. Yarmak et al. (2017) and Kozhokar, Vaskan, Palagniuk, Zavgorodnia, Strazhnikova, Kyselytsia, Balatska, and Yarmak (2019) recommend using such tests, based on breath holding to determine the resistance to hypoxia, as Shtange and Genchi timed inspiratory capacity tests, performed according to standard methods. Standard heart rate for a healthy person at rest is 60-80 beats per minute, SBP is between 100 and 120 mmHg; DBP is between 60 and 80 mmHg; RR at rest is 16-18 respiratory acts per minute, the result of the Shtange test for untrained people is 40-50 seconds, the Genchi test is 25-30 seconds.

The Ruffier cardiovascular endurance test, which was also performed in compliance with standard methods, allows to assess workability (capability to endure dynamic load). Before the test starts, the subject is given an opportunity to rest: they sit still for 5 minutes. Then their pulse is taken for 15 seconds (P1). Afterwards 30 deep squats are done within 45 seconds. Immediately after the load the pulse is taken again in the standing position for 15 seconds (P2). After the first minute of recovery the pulse is taken again in the sitting position for 15 seconds (P3). The Ruffier index is calculated by formula (2):

$$Ruffier\ index = (4 * (P1 + P2 + P3) - 200) / 10 \quad (2);$$

the results were evaluated by the index guidelines: less than 3 means excellent performance; 4-6 means good performance; 7-9 is average performance; 10-14 is satisfactory performance, and above 15 is poor performance.

Additional indicators showing circulatory system performance were calculated for a more detailed study of physical fitness levels:

Circulation efficiency factor (CEF) was calculated by formula (3): $CEF = (SBP - DBP) * HR$ (3);

normally the factor is 2400-2600 conventional units; it can increase because of fatigue, overexertion or overtraining.

Furthermore, adaptive potential (AP), which was introduced by R. M. Baevsky in order to predict prenozoology within a mass screening, was assessed to determine female students' adaptive capacity. The level of adaptive potential is determined by formula (4):

$$AP = 0.011 * HR + 0.014 * SBP + 0.008 * DBP + 0.009 * M + 0.0014 * A - 0.009 * L - 0.27, \quad (4);$$

where M is body weight (in kg); A is age (in years); L is body length (in cm).

The adaptive potential points can be interpreted as follows: figures under 2.1 indicate sufficient adaptive potential; the score of 2.11-3.2 demonstrates some strain of adaptation mechanisms; the total of points between 3.21 and 4.3 reflects insufficient adaptation; the result less than 4.31 reflects adaptation failure.

In order to evaluate myocardium metabolic and energy processes, the *Robinson's Index*, which characterizes cardiovascular system regulation and is determined by formula (5), was used.

$$The\ Robinson's\ Index = (HR * SBP) / 100 \quad (5).$$

Myocardium metabolic and energy processes can be interpreted relative to the Robinson's index as follows: the index of less than 69 demonstrates high level of energy metabolism, the rate of 70-84 is higher than average, the score 85-94 indicates an average level of processes, 95-110 points show lower than average rates, the total of more than 111 reflects poor myocardium energy metabolism.

Statistical analysis

The results obtained were processed using descriptive statistics of the licensed Excel package. In order to analyze the sample for each variable, the mean value (X), the mean error (m), standard deviation (S) and the coefficient of variation (V) were determined. In order to statistically test the hypothesis regarding the reliability of the differences, the Student's T -test was applied.

Results

The results of studying the main anthropometric characteristics in comparison with the benchmarks of physical

Table 2. The main anthropometric indicators among first-year female students (n = 100)

Anthropometric indicators	X	S	V	Average parameters of physical fitness level for girls aged 18*
Body length, cm	166.6	5.332	3.2	160.4-167.0
Body weight, kg	58.12	8.669	14.92	56.5-65.3
Chest circumference, cm	83.45	5.49	6.58	80.8-86.4

Note: * – according to the assessment of physical fitness with the population of central (Kuts, 1993).

Table 3. Anthropometric indicators of first-year students (n = 100)

Indices, CU	X	S	V	Guideline intervals	Number of students, %		
					< N	N*	> N
BMI	20.932	2.852	13.62	18.5-24.99	18	76	6
Chest PI	0.507	0.032	6.39	0.5-0.55	2	93	5
Waist PI	0.402	0.040	9.90	0.35-0.4	4	83	13
Pelvis PI	0.582	0.041	7.08	0.54-0.62	11	72	17
Thigh PI	0.340	0.030	8.76	0.32-0.36	17	62	21
Shin PI	0.215	0.017	7.92	0.21-0.23	25	63	12
Shoulder PI	0.162	0.026	16.24	0.16-0.18	42	48	10

Note: N* – N - indicators within the norm

fitness with the population of central Ukraine are presented in table 2.

The study of the variation coefficient for anthropometric parameters and indices revealed their insignificant and average variability (Table 2-3).

Thus, 76% of students had normal body weight, 18% of respondents were underweight, and only 6% of surveyed female students were overweight. The evaluation of the students' body dimensions proportionality according to the corresponding indices revealed a minor downward variation of

the shin PI and shoulder PI indicators, as well as the upward variation of the waist PI and pelvis PI.

The study of students' physical fitness level revealed a predominantly low level of physical fitness among girls according to all the indicators, except the results of such tests as shuttle running and forward bend from a seated position (Table 4).

Thus, according to the results of such tests as steady running for 2000 meters, long standing jump and sprint for 100 meters, about 80% of the girls have low physical fitness level (83%, 82% and 80% respectively). The investigation into the sample variation revealed a low level of variability for the results of such tests as shuttle running and sprint 100 m, such tests as steady running 2000 m and long standing jump showed the average variability, whereas the variability for such tests as push-ups and forward bend from a seated position was high.

The results of statistical verification of the hypothesis concerning the credibility of the diversity of the physical fitness level indicators, which were calculated using different tests clusters, are presented in Table 5.

The study of variability indicators for functional state revealed the high level of variability for functional tests and CEF, as well as the average level of variability for HR and RR at rest, the indices of blood pressure, AP and the Robinson's index (Table 6).

The investigation of respiratory system among female students revealed the excess of RR at rest (with 29% of girls) as well as the decrease in the Stange test (46%) and the Genchi test (49%). Among the cardiovascular system indicators the excess was noted for such indices as CEF (55% of students), and HR at rest (36% of students). According to the Ruffier index, only 1% of girls have excellent performance; good performance was noted only with 12% of girls; 16% showed average performance; satisfactory performance was revealed with 37% of the girls investigated, and poor performance was registered with 34% of students. The indicators of BP (blood pressure), the adaptation to the physical load according to AP and the processes of energy exchange in myocardium according to the Robinson's index, were satisfactory with most investigated students.

Table 4. The indicators of physical fitness among first-year students (n = 100)

Tests	X	S	V	Number of students, %				
				high	sufficient	average	low	poor
Steady running 2000 m.	13.356	1.594	11.93	3	3	11	12	71
Push-ups	13.55	6.844	50.51	10	3	19	14	54
Long standing jump	168.65	17.633	10.46	–	6	12	50	32
Sprint 100 m.	17.175	1.073	6.25	2	5	13	25	55
Shuttle running 4 x 9 m.	10.508	0.521	4.96	50	32	9	6	3
Forward bend from a seated position	16.02	7.015	43.79	33	19	12	17	19
Fitness level*	11.58	3.856	33.30	2	15	47	31	5
Fitness level**	11.98	3.875	32.53	2	18	44	31	5

Note: * - by the sum of points taking into account the result of long standing jump

** - by the sum of points taking into account the result of push-up test

Table 5. The comparison of physical fitness level indicators, calculated using different tests clusters

The physical fitness level calculated considering test results:						The results of statistical comparison
Long standing jump			Push-ups			
X_1	m_1	S_1	X_1	m_1	S_1	t calc.
11.58	0.386	3.857	11.91	0.388	3.875	0.604*

Note: *the discrepancy between the samples is unreliable, because $t_{calc.} < t$ of the criterion ($p = 0.001$)

Table 6. Assessment of first-year students' functional state of (n = 100)

Indices	X	S	V	Normative intervals	Number of students, %		
					< N	N	> N
HR at rest, bpm	78.61	13.82	17.58	60-80	1	63	36
SBP, mmHg	107.66	11.08	10.29	100-120	–	98	2
DBP, mmHg	71	7.61	10.72	60-80	–	98	2
RR at rest, times	16.9	4.10	24.22	16-18	34	37	29
The Shtange test, sec	43.68	13.71	31.39	40-50	46	27	27*
The Genchi test, sec	26.74	11.092	41.48	25-30	49	24	27*
The Rufier index, CU	12.725	5.317	41.78	0-14	–	66	34
CEF, CU	2896.88	823.74	28.44	2400-2600	31*	14	55
AP, CU	1.718	0.30	17.50	< 2,11	–	89	11
The Robinson's index, CU	85.076	19.70	23.16	< 111	–	88	12

Note: * - the value of the indicator is better than the norm

Discussion

According to the results of comparison of the body length, body weight and chest circumference indicators among female first-year students in Prydniprovsk State Academy of Civil Engineering and Architecture with the standard indicators within their gender and age group, the investigated students have the average level of physical fitness (see Table 2). The correction of the minor insufficiency with the girths (see Table 3) of the shoulder (42% of the girls investigated) and shin (25%) is possible with the implementation of strength exercises with the aim of increasing the girths by increasing the circumference of the corresponding muscle groups.

In the course of the research, there were confirmed the findings by Maslyak and Krivoruchko (2016), Kozhokar et al. (2019), Lebedinskiy, Koipysheva, Rybina, Kudryavtsev, Iermakov, Osipov, and Sidorov (2017), and Yarmak et al. (2017) concerning the indices of body length and weight; by Tsybul'ska (2014), Druz, Iermakov, Nosko, Shesterova, and Novitskaya (2017) and Kozhokar, Kurnyshev, Palichuk, Balatska, and Yarmak (2018) concerning the girths of waist and pelvis; by Yarmak, Buhaienko, Zhukov, Cherniakova, Vorona, Bilenkova, and Blagii (2019) and Kashuba et al. (2017) concerning the BMI.

According to the results of running for 2000 meters, sprint for 100 meters and the push-up tests, 71%, 54% and 55% of girls (respectively) were not able to meet even the standard approved for low fitness level (see Table 4). Students' poor physical fitness test results condition using the means and methods aimed at the development of speed and strength endurance and the upper limbs strength in further activities for students showing low physical fitness levels as well as the implementation of additional self-training, aimed at the development of the corresponding physical features. Besides, the high level of variability for such indices as the strength of the upper limbs and flexibility demonstrates the necessity to divide the girls into subgroups while developing the corresponding physical features or the necessity for them to attend additional PE classes of various types. The conducted studies of female students' physical fitness confirmed and supplemented the findings by Osipov, Kudryavtsev, Iermakov, Yanova, Lepilina, Plotnikova, and Dorzhieva (2017), Kashuba et al. (2017) and Fotynyuk (2017).

The statistical verification of the hypothesis on the reliability of differences between the values of physical fitness indicators, determined by the sum of points scored on the results of 5 tests, taking into account the long steady jump test or the push-ups test, confirmed the feasibility of complementing the physical exercises, selected to determine the level of physical fitness among female students (see Table 5).

The study of functional state revealed insufficient resistance to hypoxia with a significant number of girls tested, as well as variations from the standard indices of the cardiorespiratory system (see Table 6). Thus, according to the results of the Shtange and the Genchi tests, the reduced indicators were revealed with 46% and 49% of the girls investigated, respectively. The excess of CEF was observed with 55% of students, and the excess of heart rate and RR at rest was found with 36% and 29%, respectively. According to the Rufier test results, the reduced indicators were observed with 71% of girls investigated. The decreased indices of the cardiorespiratory system performance and workability necessitate the use of additional breathing exercises and the exercises aimed at developing endurance.

At the course of these studies of female students' functional state there were confirmed the findings by Maslyak et al. (2016), Kozhokar et al. (2019) regarding blood pressure; as well as the findings by Kozhokar et al. (2019) and Fotynyuk (2017) regarding the Rufier index; the findings by Druz et al. (2017) and Kozhokar et al. (2018) concerning the Robinson's index; as well as the findings by Yarmak et al. (2017) and Kozhokar et al. (2019) concerning the Genchi test.

According to the study, the functional characteristics of most students tested are on the border between the norm and pathology, which justifies the need to prevent their further deterioration by increasing the amount of physical activity through the introduction of new forms of training and improving the students' physical fitness level by means of physical education.

Thus, despite the fact that the anthropometric characteristics of the investigated girls are mostly within the norm, most female students have reduced physical fitness levels in terms of speed and strength endurance, explosive physical force of the lower limbs and strength endurance of the upper limbs, which confirms the findings of other studies. The low level of physical fitness, as well as reduced indicators of the functional state among the tested students necessitate

the improvement of the system of physical education at the technical higher education institution. The high variability of physical fitness indicators requires obligatory taking into consideration the students' individual characteristics during the selection of exercises and calculation of training load.

Conclusions

The study revealed the low level of physical fitness among the investigated students in terms of speed and strength endurance indicators (83% according to the 2000 meters running test and 80% according to the 100 meters running test), explosive physical force of the lower limbs (82% for the results of the long steady jump test) and strength endurance of the upper limbs (68% according to the push-ups test), as well as reduced functional characteristics: resistance to hypoxia (according to the results of the Shtange test with 46% and the Gench's test with 49%), workability (71% according to the results of the Ruffier test) and efficiency of cardiovascular system (55% according to the circulation efficiency factor). Low physical fitness levels among the tested girls necessitate the additional introduction of more intensive training, and the reduced cardiorespiratory system performance and workability condition the need to use breathing exercises and exercises aimed at developing endurance. The high variability of the physical fitness indicators among the students requires personalization of the training process, as well as the obligatory use of express testing methods for the physical state of each student during a workout, especially during exercising at maximum capacity.

Prospects for further research: improving the system of physical education in Prydniprovska State Academy of Civil Engineering and Architecture in connection with the low level of physical fitness among first-year students.

Conflict of interest

The authors declare no conflict of interest.

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АНАЛІЗ ФІЗИЧНОЇ ПІДГОТОВЛЕНOSTI ТА МОРФО-ФУНКЦІОНАЛЬНОГО СТАНУ СТУДЕНТОК ПЕРШОГО КУРСУ ЗАКЛАДУ ВИЩОЇ ОСВІТИ ТЕХНІЧНОГО ПРОФІЛЮ

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Реферат. Стаття: 8 с., 6 табл., 42 джерела

Мета дослідження – визначити рівень фізичної підготовленості та морфо-функціонального стану студенток першого курсу ДВНЗ ПДАБА.

Матеріали та методи. У дослідженні взяли участь студентки основної групи I курсу ДВНЗ ПДАБА, вік 18 років (n = 100). Для вирішення поставлених завдань було використано: теоретичний аналіз і узагальнення даних спеціальної науково-методичної літератури, педагогічне тестування, антропометричні методи дослідження, функціональні методи дослідження кардіореспіраторної системи та методи математичної статистики обробки результатів дослідження.

Результати. Проведене дослідження підтвердило гіпотезу про необхідність удосконалення системи фізичного виховання у закладі вищої освіти технічного профілю у зв'язку з низьким рівнем фізичного стану студентів.

Висновки. Під час дослідження виявлено низький рівень фізичної підготовленості обстежених студенток

за показниками швидкісно-силової витривалості (у 83%), вибухової сили нижніх кінцівок (у 82%) та силової витривалості верхніх кінцівок (у 68%), а також знижені функціональні характеристики: стійкості організму до гіпоксії (за результатами проб Штанге у 46% та Генчі у 49%), роботоздатності (у 71%) та ефективності системи кровообігу (у 55%). Низька фізична підготовленість обстежених дівчат обумовлює необхідність додаткового впровадження більш інтенсивних форм занять. Велика варіативність показників фізичного стану контингенту вимагає індивідуалізації тренувального процесу, а також обов'язкового використання методів експрес-контролю за фізичним станом кожного студента.

Ключові слова: студентки, фізичне виховання, фізичний стан, функціональні показники, фізична підготовленість.

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ОРИГІНАЛЬНА НАУКОВА СТАТТЯ

ДИНАМІКА ПІДГОТОВЛЕНOSTІ УЧНІВ ЛІЦЕЮ З ПОСИЛЕНОЮ ВІЙСЬКОВО-ФІЗИЧНОЮ ПІДГОТОВКОЮ ПІД ВПЛИВОМ ВИКОРИСТАННЯ ЗАСОБІВ БОРОТЬБИ

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Анотація

Сучасне фізичне виховання у закладах середньої освіти зазнає реформування. Для його оптимізації в навчальний процес все частіше пропонують вводити засоби різних видів спорту. Зокрема доцільним сьогодні вважається включення різновидів єдиноборств до програм з фізичної культури закладів військово-фізичного спрямування.

Мета дослідження: обґрунтувати використання засобів спортивної боротьби у процесі фізичного виховання учнів ліцею з посиленою військово-фізичною підготовкою.

Матеріал та методи. Дослідження проводилося на основі вивчення показників функціональної та фізичної підготовленості учнів 10-х класів ліцею з поглибленою військово-фізичною підготовкою упродовж проведення педагогічного експерименту. Він полягав у вивченні впливу різноспрямованих засобів боротьби на рівень зазначених сторін підготовленості учнів упродовж року.

Результати. В учнів, які впродовж року виконували навантаження згідно експериментальної програми з фізичної культури, за час першого навчального семестру сумарний середній приріст щодо вихідних показників склав 10,7%, а за час другого – ще 5,7%, тоді як в учасників групи, яка працювала за традиційною програмою з фізичної культури у першому семестрі результати проб зросли на 6,1% і ще на 2,0% – впродовж другого. У фізичній підготовленості учнів ЕГ сумарний приріст показників за перший семестр склав 31,6% і ще 24,5% – впродовж другого. Натомість в досліджуваних КГ зміни були порівняно менш виражені: 24,7% – за перший і 8,9% – за другий семестр.

Висновки. Обґрунтовано ефективність застосування засобів боротьби у фізичному вихованні учнів ліцею з посиленою військово-фізичною підготовкою, що сприяє достовірно більш вираженому приросту показників функціональної та фізичної підготовленості учнів порівняно з традиційною програмою з фізичної культури.

Ключові слова: фізичне виховання, учні, засоби боротьби, фізична підготовленість, функціональні можливості.

Вступ

Фізичне виховання та фізична підготовка ліцеїстів реалізуються за навчальними програмами загально-освітньої школи з використанням традиційних методичних підходів і педагогічних умов, що характеризуються низькою ефективністю щодо оптимізації фізичного стану (Андрес, Сербо, & Фестрига, 2015).

Фізична підготовка у навчальних закладах із посиленою військово-фізичною підготовкою – є цілеспрямований керований процес фізичного удосконалення військовослужбовців, який здійснюється з урахуванням особливостей їхньої військово-професійної діяльності (Бортюк, 2006; Науменко, 2009; Гоншовський, 2011). Під системою фізичної підготовки військ прийнято розуміти упорядковану, у відповідності до вимог бойової діяльності, сукупність взаємопов'язаних компонентів, які складають концептуальні основи, процес фізичного удосконалення військовослужбовців та керування цим

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процесом (Анохін, 2001; Єдинак, Рошук, & Мисів, 2003; Величко, 2006).

Питання, присвячені удосконаленню фізичної підготовки учнівської молоді, розглядалися останнім часом у роботах значної кількості дослідників (Черенчиков, 2013; Ilnytskyi, Okopnyy, Palatnyy, Pityn, Kyselytsia, & Zoriy, 2018). Зокрема, значну увагу в дослідженнях різних авторів приділено змісту і структурі фізичної підготовки дітей шкільного віку, її спрямованості та організації. Водночас аналіз останніх досліджень і публікацій, а також практичний досвід свідчить про те, що проблеми теорії, методики і організації фізичного виховання в системі підготовки кадрів для Міністерства оборони, залишаються відкритими, тобто наукових даних, пов'язаних з дослідженнями фізичної підготовки фахівців військового профілю, їх фізичного розвитку і рівня розвитку фізичних якостей у вітчизняній науково-методичній літературі представлено недостатньо.

Сьогодні наявно багато різноманітних, достатньо ефективних методик покращення фізичної підготовленості осіб різних вікових груп, у тому числі і учнів старшого шкільного віку (Friedman, 2016; Bohuslavska, Furman, Pityn, Galan, & Nakonechnyi, 2017; Prystupa, Okopnyy, Hutsul, Khimenes, Kotelnik, Hryb, & Pityn, 2019). Однак, фахівцями недостатньо уваги приділяється особливостям розвитку фізичних якостей юнаків, які навчаються у профільних середніх навчальних закладах, зокрема у військових ліцеях. Тому в сучасних умовах значення фізичного виховання суттєво зростає (Шиян & Омеляненко, 2012; Wei-Ting Hsu & Min Pan, 2019; Khudolii, Karpan, Harkusha, Marchenko, & Veremeenko, 2020). Потрібно створити оптимальні умови для поліпшення фізичного потенціалу й здоров'я дітей. Для цього необхідно проаналізувати стан розвитку фізичних якостей учнів і на цій основі розробити рекомендації щодо удосконалення процесу фізичного виховання в школах і спеціалізованих закладах середньої освіти, що і визначило актуальність нашої роботи.

Мета дослідження – обґрунтувати використання засобів спортивної боротьби у процесі фізичного виховання учнів ліцею з посиленою військово-фізичною підготовкою.

Матеріал та методи

Учасники дослідження

У дослідженні приймали участь 49 учнів 10-х класів Ліцею з посиленою військово-фізичною підготовкою імені Героїв Крут віком 15-16 років. Вони були розподілені на дві групи – експериментальну (24 учні) та контрольну (25 учнів).

Методи дослідження

Теоретичний аналіз та узагальнення даних науково-методичної літератури та емпіричних матеріалів наукового дослідження (вивчення стану розробленості проблеми фізичного виховання в ліцеях із посиленою військово-фізичною підготовкою); педагогічне спостереження (з'ясування за даними антропометрії, методу індексів, функціональних проб, фізичної підготовленості

учнів ліцеїв із посиленою військово-фізичною підготовкою); педагогічний експеримент (визначення ефективності використання засобів боротьби в програмі з фізичної культури учнів ліцею з посиленою військово-фізичною підготовкою); методи статистичного опрацювання (опрацювання емпіричних результатів на різних етапах дослідження).

Визначення рівня фізичного розвитку та функціонального стану проведено за показниками довжини тіла (см), маси тіла (кг), кистьової динамометрії правої та лівої рук (кгс), проб Штанге та Генчі (характеристика функціонального стану дихальної системи організму), проби Руф'є (визначення рівня функціонування серцево-судинної системи та загальної фізичної працездатності) та проби Розенталя (визначення витривалості дихальних м'язів (міжреберні, діафрагма)) (Wilmore & Costill, 1994).

Визначення рівня фізичної підготовленості проводилося за допомогою тестів (Yockey, 2005; Круцевич, 2008; Пістун, 2008): стрибок у довжину з місця (см), стрибок у довжину з розбігу (см), згинання та розгинання рук у висі на перекладині (кількість разів), підйом переворотом на перекладину (кількість разів), підйом силою на перекладину (кількість разів), згинання та розгинання рук у упорі на брусах (кількість разів), кут у упорі на брусах із зігнутими ногами (с), біг 100 м з високого старту (с), біг 1000 м (с), біг 3000 м (с).

Організація дослідження

Враховуючи базові засади формування програми з фізичної культури учнів ліцею з посиленою військово-фізичною підготовкою, а також основні принципи фізичного виховання цього контингенту досліджуваних, ми розробили авторську програму з акцентованим застосуванням засобів боротьби. Вона не виходила за межі структурних вимог діючої програми фізичної культури у ліцеях такого типу, зміненим було лише 30% її змістовного наповнення.

У Ліцеї з посиленою військово-фізичною підготовкою імені Героїв Крут згідно нормативних вимог проводиться п'ять уроків фізичної культури на тиждень. Ми пропонували учням кожне друге заняття займатися за авторською програмою з акцентом на використання засобів боротьби. Тобто в кожному непарному тижні з ними проводилося три таких уроки, а в кожному парному – два. На інших уроках учні експериментальної групи працювали в межах традиційної програми з фізичної культури. При цьому, зважаючи на профільні для боротьби як виду спорту фізичні якості, а саме: силові, швидко-силові та координаційні, більшість засобів підготовки в межах експериментальної частини програми були спрямовані на їхній розвиток (30% уроків фізичною культурою, 28 занять). Водночас в тій частині програми, яка фактично не відрізнялася змістовно від традиційної (70% уроків фізичною культурою, 56 занять), учні виконували навантаження пов'язані здебільшого з розвитком різних проявів витривалості (28 занять) та швидкості і гнучкості (24 заняття). Розвиток цих фізичних якостей відбувався із застосуванням засобів легкої атлетики, гімнастики, спортивних ігор, рукопашного бою тощо. Такий розподіл часу на розвиток фізич-

них якостей значною мірою зумовлений специфікою військової діяльності.

Учні контрольної групи в межах занять фізичною культурою виконували навантаження та застосовували засоби різних видів спорту, які запропоновані в традиційній програмі з фізичної культури для учнів ліцею з посиленою військово-фізичною підготовкою.

Наше дослідження тривало впродовж навчального року, які дещо відрізнялися за змістовим наповненням в межах розробленої експериментальної програми. У першому семестрі 70% часу, відведеного для занять боротьбою, приділялося виконанню вправ переважно силового та швидко-силового характеру в межах методів строго регламентованої вправи (інтервальний, безперервний, комбінований) і лише 30% часу учні працювали в ігровому і змагальному режимах (ігри, спаринги тощо). На завершення цього етапу було проведено оцінку фізичного розвитку й підготовленості досліджуваних та їх анкетування (пропонувалося оцінити ефективність нововведених занять). У відповідності до отриманих результатів спрямованість підготовки в межах уроків фізичної культури у другому семестрі було скориговано. Так, в другому семестрі 70% часу учні переважно працювали в ігровому та змагальному режимах і 30% часу – в межах методів строго регламентованої вправи.

Керуючись принципом поступовості ми на початкових етапах пропонували учням виконувати відносно нескладні в координаційному відношенні вправи з незначним обсягом та інтенсивністю в межах 50-60%. З ростом рівня фізичної підготовленості та освоєнням базових технічних вмінь з прийомів боротьби, ми пропонували учням вже складніші вправи зі зростаючим обсягом та інтенсивністю (до 80-90% від максимальної) (Rutherford & Jones, 1986).

Статистичний аналіз

З метою виявлення достовірності змін та розбіжностей показників в ході проведення педагогічного експерименту ми визначали середні статистичні значення, стандартне відхилення середніх значень, порів-

няння середньостатистичних значень двох зв'язаних та незв'язаних сукупностей за параметричним t-критерієм Стьюдента (пакет IBM SPSS Statistics Base 2.0).

Результати

Враховуючи наявність двох етапів педагогічного експерименту ми провели обговорення динаміки за основними показниками, які вивчалися упродовж усього періоду.

Вивчення даних упродовж усього періоду педагогічного експерименту вказало на такі особливості зміни показників функціональних проб (табл. 1).

Позитивно характеризуючи загальні зміни показників проби Штанге, демонстрацію чого проведено окремо на першому та другому етапах, зазначимо на відносних приростах результатів учнів КГ, що становили 6,09% в першому семестрі та лише 0,93% у другому семестрі навчального року.

Схожа тенденція спостерігається для показників проби Генчі. На першому етапі педагогічного експерименту в учнів КГ наявний приріст у 9,41% та на другому це значення є суттєво нижчим і становить лише 1,63%.

При розгляді темпів приростів результатів за пробою Руфф'є отримано і на першому і на другому етапах педагогічного експерименту позитивні зміни. Відмінності між відносними значеннями першого етапу (2,05%) та другого (1,30%) є меншими, порівняно з попередніми функціональними пробами.

Зміни показників за пробою Розенталя, яка відображає можливості дихальної системи вказують, що як і за пробами Штанге і Генчі спостерігаються вищі темпи приростів у першому семестрі (6,90%) та нижчі у другому (4,30%).

Для представників ЕГ за пробою Штанге спостерігалися достатньо виражені у відсотковому значенні зміни функціональних можливостей. За перший етап педагогічного експерименту результати представників цієї групи зросли на 17,29%. Також в другій частині позитивні тенденції збереглися, хоча за відносними значеннями становили 7,09%. Результати проби Генчі дали також

Таблиця 1. Зміни результатів функціональних проб учнів ліцею контрольної (КГ, n = 25) та експериментальної (ЕГ, n=24) груп упродовж педагогічного експерименту

Проба		Результати КГ					Результати ЕГ					$P_{\text{ШКГ-ЕГ}}$	$P_{\text{ШКГ-ЕГ}}$
		КГ _I	КГ _{II}	КГ _{III}	$P_{\text{КГI-II}}$	$P_{\text{КГII-III}}$	ЕГ _I	ЕГ _{II}	ЕГ _{III}	$P_{\text{ЕГI-II}}$	$P_{\text{ЕГII-III}}$		
Ш	X	24,3	25,8	26,0	$\leq 0,01$	$= 0,54$	25,5	30,0	32,1	$\leq 0,01$	$\leq 0,01$	$\leq 0,01$	$\leq 0,01$
	SD	3,4	3,0	3,2			4,0	4,2	3,4				
Г	X	15,7	17,2	17,5	$\leq 0,01$	$= 0,59$	17,1	19,5	21,5	$\leq 0,01$	$\leq 0,01$	$\leq 0,01$	$\leq 0,01$
	SD	2,1	1,9	3,0			3,4	2,7	2,0				
Рф	X	10,3	10,1	10,0	$\leq 0,01$	$= 0,03$	10,3	10,0	9,9	$= 0,02$	$= 0,08$	$= 0,68$	$= 0,74$
	SD	1,2	1,0	0,9			1,9	1,6	1,5				
Рн	X	3,5	3,7	3,9	$= 0,08$	$= 0,16$	3,5	3,8	3,9	$= 0,03$	$= 0,10$	$= 0,85$	$= 0,81$
	SD	0,7	0,5	0,5			0,7	0,6	0,6				

Примітки: Ш – проба Штанге; Г – проба Генчі; Рф – проба Руфф'є; Рн – проба Розенталя; I – початкові дані педагогічного експерименту; II – дані усередині педагогічного експерименту; III – кінцеві дані педагогічного експерименту

Таблиця 2. Показники фізичної підготовленості учнів ліцею контрольної (КГ, n = 25) та експериментальної (ЕГ, n = 24) груп упродовж педагогічного експерименту

Показники та статистичні величини		Результати КГ					Результати ЕГ					$P_{\text{КГ-ЕГ}}$	$P_{\text{III КГ-ЕГ}}$
		КГ _I	КГ _{II}	КГ _{III}	$P_{\text{КГ-I-II}}$	$P_{\text{КГ-II-III}}$	ЕГ _I	ЕГ _{II}	ЕГ _{III}	$P_{\text{ЕГ-I-II}}$	$P_{\text{ЕГ-II-III}}$		
1	X	223,8	226,6	229,4	$\leq 0,01$	$\leq 0,01$	212,9	223,3	231,63	$\leq 0,01$	$\leq 0,01$	=0,43	=0,64
	SD	22,2	18,39	18,33			15,1	10,11	14,31				
2	X	397,4	415,76	427,00	$\leq 0,01$	$\leq 0,01$	381,8	415,4	450,42	$\leq 0,01$	$\leq 0,01$	=0,97	=0,08
	SD	57,2	39,04	42,84			57,9	36,14	49,78				
3	X	7,64	9,36	10,40	$\leq 0,01$	$\leq 0,01$	8,29	11,6	13,53	$\leq 0,01$	$\leq 0,01$	=0,02	=0,02
	SD	4,32	2,99	3,79			5,37	3,39	4,47				
4	X	2,92	4,96	6,16	$\leq 0,01$	$\leq 0,01$	2,58	4,67	8,79	$\leq 0,01$	$\leq 0,01$	=0,47	$\leq 0,01$
	SD	2,19	1,67	1,52			2,35	1,17	3,13				
5	X	2,40	4,72	5,60	$\leq 0,01$	$\leq 0,01$	2,33	5,1	7,83	$\leq 0,01$	$\leq 0,01$	=0,55	$\leq 0,01$
	SD	2,44	2,21	1,38			2,69	2,01	2,97				
6	X	9,20	12,04	13,96	$\leq 0,01$	$\leq 0,01$	10,9	14,0	18,63	$\leq 0,01$	$\leq 0,01$	=0,04	$\leq 0,01$
	SD	5,18	3,34	2,05			6,12	3,41	5,10				
7	X	51,9	60,92	68,60	$\leq 0,01$	$\leq 0,01$	52,0	63,3	84,96	=0,02	$\leq 0,05$	=0,62	$\leq 0,01$
	SD	25,6	20,55	13,53			27,3	11,94	19,65				
8	X	14,3	14,14	14,09	$\leq 0,01$	=0,06	14,7	14,21	13,62	$\leq 0,01$	$\leq 0,01$	=0,65	=0,02
	SD	0,89	0,69	0,78			0,86	0,27	0,47				
9	X	205,41	200,88	199,04	$\leq 0,01$	=0,13	224,12	202,42	199,21	$\leq 0,01$	=0,18	=0,57	=0,94
	SD	5,28	5,71	5,20			14,08	12,15	8,97				
10	X	741,79	738,28	732,60	=0,25	$\leq 0,01$	756,33	748,9	738,10	=0,07	$\leq 0,01$	=0,30	=0,63
	SD	43,04	33,93	37,2			49,42	37,07	41,43				

Примітки: 1 – стрибок у довжину з місця, см; 2 – стрибок у довжину з розбігу, см; 3 – згинання та розгинання рук у висі на перекладині, кількість разів; 4 – підйом силою на перекладину, кількість разів; 5 – підйом переворотом на перекладину, кількість разів; 6 – згинання та розгинання рук в упорі на брусах, кількість разів; 7 – кут в упорі на брусах із зігнутими ногами, с; 8 – біг 100 м з високого старту, с; 9 – біг 1000 м, с; 10 – біг 3000 м, с; I – початкові дані педагогічного експерименту; II – дані усередині педагогічного експерименту; III – кінцеві дані педагогічного експерименту

значні прирости у першій та другій половинах педагогічного експерименту. Спочатку можливості учнів ЕГ підвищилися на 13,87% та у подальшому ще на 10,47%.

За показниками проби Руфф'є, як і у випадку з учасниками КГ, для учнів ЕГ наявні позитивні зміни на першому і на другому етапах. Цікаво, що своїми відносними значеннями (3,24%) на першому етапі представники ЕГ переважають свої однолітків з КГ, а на другому дещо відстають (0,96%). Це може підтверджувати наші припущення щодо вищих резервів для адаптації в першому семестрі та відносну стабілізацію упродовж другого етапу педагогічного експерименту, незалежно від змістовного наповнення програм.

За показниками проби Розенталя, можливості ди- хальної системи учнів ЕГ також підвищилися більшою мірою, порівняно із представниками КГ на першому етапі педагогічного експерименту (8,43%) та на схожому рівні – на другому етапі (4,44%). Загальний сумарний середній приріст за функціональними пробами для учнів КГ становив 6,11% за перший семестр і лише 2,04% – за другий семестр навчального року. Водночас такий же показник для учасників ЕГ становив 10,71% та 5,74% відповідно.

Базовими показниками для визначення ефективності програм з фізичної культури для учнів ліцею з посиленою військово-фізичною підготовкою були темпи приростів результатів з фізичної підготовленості учнів (табл. 2).

Загалом для показників учнів КГ спостерігається ситуація більш вираженого відсоткового покращення результатів за більшістю тестів в першій частині (перший семестр навчального року) та менші відносні значення приростів у другій частині педагогічного експерименту. Середньогрупові показники тесту «стрибок у довжину з місця» в учнів КГ зросли на 1,27% за першу частину та 1,24% за другу частину реалізації програми з фізичної культури із традиційним змістом.

За результатами «стрибка у довжину з розбігу» спостерігаємо дещо вищі відновні значення приростів, а саме 4,61% у першому семестрі та 2,70% у другому семестрі навчального року.

Найбільш виражені зміни фізичної підготовленості учнів КГ відбулися за показниками силових якостей. За результатами «згинання та розгинання рук у висі на перекладині» приріст становив у першій частині педагогічного експерименту 22,51% та у другій учням також

вдалося покращити середню групову результативність на 11,11%. У таких тестах, як «підйом силою на перекладині», «підйом переворотом на перекладині», що вказують на розвиток динамічної силової витривалості та входять до обов'язкових у більшості комплексів вправ для військових, прирости були ще більш вираженими. За перший семестр вони становили 69,86% та 96,67% та за час другого семестру – 24,19 та 18,64% відповідно. За результатами «згинання та розгинання рук в упорі на брусах» ці відносні значення були високими (30,87% у першому семестрі та 15,95% у другому семестрі).

За результатами тесту «кут в упорі на брусах із зігнутими ногами» на визначення статичної силової витривалості, для учнів КГ встановлені відсоткові прирости на рівні 17,33% та 12,61% упродовж першого та другого семестрів навчального року. Це свідчить про достатньо позитивну динаміку та дотримання основних параметрів навантаження.

Значно менші темпи приростів наявні за тестами щодо визначення швидкісних якостей та витривалості. Вони перебувають у незначному діапазоні та вказують на малі зрушення в підготовленості. За результатами тесту «біг 100 м з високого старту» зростання результатів на першому етапі становило 1,17% та на другому – 0,34%. Це вказує на зовні непомітні покращення. Те саме характерне для інших бігових тестових навантажень. Результати «бігу на 1000 м» покращилися на 2,21% та 0,92% та «бігу на 3000 м» на 0,47% та 0,77% відповідно для першого та другого етапів педагогічного експерименту.

За показниками учнів ЕГ можна закономірно спостерігати покращення за усіма результатами тестів. За результатами тестів на визначення швидко-силових якостей можна спостерігати рівномірні темпи приростів результатів у першому та другому семестрі навчального року. За результатами тесту «стрибок у довжину з місця» вони становили 4,87% (перший етап) та 3,71% (другий етап педагогічного експерименту). Також наближено однакові темпи зафіксовані для тесту «стрибок у довжину з розбігу». Вони становили 8,78% та 8,43% на першому та другому етапах педагогічного експерименту.

Як у випадку з представниками КГ, найбільші темпи приросту спостерігалися для тестів на визначення силових якостей учнів. Для учасників ЕГ у тестів «згинання та розгинання рук у висі на перекладині» результати зростали на 40,20% та 16,49% упродовж першого та другого етапів педагогічного експерименту. Для результатів тестів «підйом силою на перекладині» та «підйом переворотом на перекладині» спостерігалися ще більші прирости. Вони становили 80,65% та 117,86% за результатами першого етапу та 88,39% та 54,10% – за результатами другого етапу педагогічного експерименту.

За тестом «згинання та розгинання рук в упорі на брусах» темпи приростів були меншими та становили 28,63% у кінці першого семестру та 32,64% в кінці другого семестру навчального року.

На відміну від учнів КГ, представникам ЕГ вдалося дещо більшою мірою покращити свої результати в тесті «біг 100 м з високого старту» та «біг 1000 м». У першому тесті результати зросли на 3,39% та 4,13% (упродовж першого та другого етапів педагогічного експерименту). Для другого тесту ці значення становили 9,69% та 1,59% відповідно. Причиною цього вважаємо більшу відповід-

ність режимів роботи під час виконання вправ з боротьби та схожих механізмах енергозабезпечення м'язової діяльності.

Найнижчими виявилися темпи приростів для тесту «біг 3000 м», які становили лише 0,99% (перший етап) та 1,44% (другий етап педагогічного експерименту).

Дискусія

Якщо для традиційної програми (КГ) зміст засобів був стандартизованим упродовж усього навчального року, то для учнів ЕГ дві частини мали методичні відмінності. Вони зумовлені, окрім пріоритетного використання засобів, уподобаннями учнів щодо спрямованості цих засобів. Перша частина була побудована здебільшого на засобах спрямованих на розвиток силових якостей та застосуванням методу строго регламентованої вправи. Друга частина програми, після врахування побажань учнів зазнала певної методичної корекції та містила блок засобів спрямованих на розвиток координаційних здібностей й застосовування методів ігрової та змагальної вправи.

Суттєво вищі значення приростів за результатами проби Штанге на першому етапі дослідження можуть свідчити про недостатній рівень підготовленості учнів перед зарахуванням на поточний рік навчання та/або негативні зміни під час проведення літніх канікул та певної втрати рівня функціональних можливостей. За перший семестр спостерігаємо активну адаптацію до навчального та фізичного навантаження, яке притаманне для ліцеїв з посиленою військово-фізичною підготовкою. У другому ж семестрі, швидше за все, після повернення до оптимального рівня в учнів суттєво сповільнилися темпи приросту цього показника, чого варто було очікувати. Схожі причини вбачаємо й в аналізі темпів змін за результатами проби Генчі. Зазначимо, що для цих двох проб є характерним втягування до виконання м'язів, що забезпечують дихальну діяльність (діафрагми, тулуба тощо) (Wilmore & Costill, 1994). Тому тенденції для них є спільними.

Незначні прирости результатів за пробою Руфф'є ми пов'язуємо із більшою консервативністю діяльності серцево-судинної системи та меншою піддатливістю до змін. Позитивні зрушення зафіксовані в показниках учнів КГ вказують на ефективність традиційних підходів до побудови змісту програми з фізичної культури, що було достатньо очікуваним.

Отже традиційні засоби для програми з фізичної культури ліцеїв з посиленою військово-фізичною підготовкою дають стандартизований вплив, що виражений вищими приростами показників у першій частині навчального року та нижчими в другій його частині.

Обговорення результатів учнів ЕГ вказало на суттєвий вплив засобів боротьби для підвищення функціональних можливостей учнів щодо затримки дихання на вдиху і на видиху, реактивності серцево-судинної системи та підтримання дихальних показників. Ми це пов'язуємо з вищим відсотком виконання вправ за умов затримання подиху, а саме при подоланні опору ваги власного тіла та ваги тіла партнера, інших засобів, що використовувалися на заняттях. Адже в першій частині педагогічного експерименту зміст програми з викори-

станням засобів боротьби був здебільшого спрямований на розвиток силових можливостей. Проте й у другій на-явні позитивні та значні зміни вказують на дещо менший, проте ґрунтовний, вплив обраного методичного змісту занять.

Значні прирости силової підготовленості у представників КГ ми пояснюємо наявністю обґрунтованих акцентів на розвитку силових якостей учнів у програмі з фізичної культури для 10 класів. Більшість професійно-визначеної діяльності проводиться за необхідності подолання опорів різного характеру та змісту, тому це й покладено в основу (Phillips, 1999; Анохін, 2001; Pityn, Briskin, & Zadorozhna, 2013; Destani, Hannon, Podlog, & Brusseau, 2014).

Можна зробити узагальнення, що стандартний зміст програми з фізичної культури для учнів ліцею з посиленою військово-фізичною підготовкою загалом має вплив на фізичну підготовленість учнів. Проте більш виражені зміни відбуваються за показниками силової витривалості, дещо менші за результатами тестування швидкісної сили та мінімальні зрушення наявні для швидкісних якостей та витривалості.

Такі відносні прирости ми частково пов'язуємо із достатньо низьким початковим рівнем підготовленості. Багато учнів на початку педагогічного експерименту не могли якісно виконати ці тести. Тобто за час дослідження, разом із зростанням силових показників, засоби боротьби дали змогу більш якісно продемонструвати техніку виконання цих тестів, та, відповідно, економізувати роботу м'язів.

Також, значні темпи приростів за силовими показниками ми можемо пояснити, окрім добору злагодженого методологічного змісту програми, наявністю найбільших резервів для адаптації в учнів та завершенням пубертатного періоду, який характеризується збільшенням концентрації гормону тестостерону, що має суттєвий вплив на прояви силових можливостей (Aagaard, Simonsen, Andersen, Magnusson, & Dyhre-Poulsen, 2002; Платонов, 2004; Khudoli, Ivashchenko, Iermakov, Veremenko, & Lopatiev, 2019).

На наш погляд у тестах із бігу учні підійшли до свого максимального індивідуального результату і подальше удосконалення може проводитися виключно спеціалізованими впливами фізичних навантажень.

Виявлені дані вказують на малу ефективність як традиційного, так і авторського змісту програм з фізичної культури для учнів ліцеїв з посиленою військово-фізичною підготовкою та необхідності додаткових цілеспрямованих тренувальних впливів щодо розвитку та контролю витривалості.

Отже запропонований нами методичний зміст програми з фізичної культури з використанням засобів боротьби для учнів ліцею з посиленою військово-фізичною підготовкою загалом довів свою ефективність за рахунок значних та позитивних темпів приросту показників фізичної підготовленості учнів. Загальний сумарний середній приріст результатів фізичної підготовленості для учнів КГ становили 24,70% за перший семестр і лише 8,85% – за другий семестр навчального року. Водночас такий же показник для учасників ЕГ становив 31,65 та 24,52% відповідно.

Основними чинниками суттєвої ефективності ми вважаємо наявність у вправах, що запропоновані в авторській програмі, компонентів переключення уваги, протистоян-

ня в умовах виконання вправ з партнером чи умовним суперником тощо. Посилення впливу на фізичну підготовленість ми також вбачаємо в необхідності роботи організму в різних режимах енергозабезпечення. Здебільшого це були анаеробний та змішаний режими енергозабезпечення фізичних навантажень. Окрім цього було збільшено частку таких засобів у другій частині педагогічного експерименту за рахунок певної зміни методологічного змісту програми у напрямі підвищення частки складно координційних вправ та методів ігрової та змагальної вправи.

Отримані результати вказують на низьку ефективність традиційних засобів, що застосовуються в програмі з фізичної культури ліцеїв з посиленою військово-фізичною підготовкою для удосконалення швидкісних та швидкісно-силових якостей.

Враховуючи відносну консервативність швидкісних здібностей (Платонов, 2004) вважаємо певні зрушення в показниках швидкісних якостей позитивним свідченням для ефективності авторського методичного підходу та використання засобів боротьби у програмі з фізичної культури ліцеїв з посиленою військово-фізичною підготовкою.

Таким чином, за результатами дослідження доповнено інформацію щодо впливу якісного навчально-виховного процесу з фізичного виховання у ліцеях із посиленою військово-фізичною підготовкою на становлення професійно-прикладних навичок майбутнього фахівця (Єдинак, Рошук, & Мисів, 2003; Гоншовський, 2011).

Окрім цього набули подальшого розвитку знання про ефективність традиційної структури та змісту програми з фізичної культури для учнів ліцеїв з посиленою військово-фізичною підготовкою (Pnytskyi et al., 2018).

Певне доповнення отримали наукові відомості щодо структури та змісту фізичної підготовленості учнів ліцеїв з посиленою військово-фізичною підготовкою та її динаміки упродовж навчального року, що частково відображені в наукових працях (Бортюк, 2005; Черенщikov, 2013; Щирба, 2016).

Важливо що нами доповнені дані про фізичний розвиток та динаміку фізичної підготовленості учнів ліцеїв з посиленою військово-фізичною підготовкою віком 15-16 років під впливом програм різного методичного наповнення.

Найбільш важливі результати дослідження дали змогу уперше обґрунтувати ефективність застосування засобів боротьби у фізичному вихованні учнів ліцею з посиленою військово-фізичною підготовкою, що сприяє достовірно більш вираженому приросту показників фізичного розвитку, фізичної підготовленості учнів. Також уперше обґрунтовано структуру та зміст програм з фізичної культури із використанням засобів боротьби різного методичного змісту, що поєднують в собі загальноприйняті засоби розвитку фізичних якостей (70% від загального часу уроку) та засоби спортивної боротьби (30% від загального часу уроку). Перша з акцентів на розвиток силових якостей та метод строго регламентованої вправи та друга – координаційних здібностей та методи ігрової та змагальної вправи.

Висновки

Впродовж педагогічного експерименту фактично за усіма групами показників авторська програма з фізичної

культури із застосуванням засобів боротьби виявилася більш ефективною порівняно з традиційною програмою для 10-х класів ліцею з посиленою військово-фізичною підготовкою.

За час педагогічного експерименту учням груп, які приймали участь у дослідженні вдалося в основному покращити рівень своїх функціональних можливостей та фізичної підготовленості. Так, в учнів ЕГ за час першого етапу педагогічного експерименту сумарний середній приріст щодо вихідних показників склав 10,7%, а за час другого – ще 5,7%, тоді як в учасників КГ у першому семестрі результати проб зросли на 6,1% і ще на 2,0% – впродовж другого. У підсумку навчального року встановлено вищі прирости функціональних можливостей в учнів, які займалися за експериментальною програмою з фізичної культури, проте статистично міжгрупова перевага на користь ЕГ були підтверджені лише у пробі Штанге ($p \leq 0,05$).

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У фізичній підготовленості учнів ЕГ спостерігалися виражені зміни більшості показників. Середній сумарний їх приріст за перший семестр склав 31,6% і ще 24,5% – впродовж другого. Натомість в досліджуваних КГ зміни були порівняно менш виражені: 24,7% – за перший і 8,9% – за другий семестр. Порівняння міжгрупових розбіжностей вказало на перевагу ЕГ над КГ за усіма показниками фізичної підготовленості. Достовірного характеру вони набули у шести з десяти тестів ($p \leq 0,05-0,001$).

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Автори відзначають, що не існує ніякого конфлікту інтересів.

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PREPAREDNESS DYNAMICS OF PUPILS OF LYCEUM WITH ENHANCED MILITARY AND PHYSICAL TRAINING UNDER THE INFLUENCE OF THE WRESTLING MEANS USE

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Modern physical education in secondary schools is undergoing reform. It is increasingly suggested to introduce the means of different sports to optimize physical education in the educational process. In particular, it is advisable today to include combative sports to the programs of physical culture of military-physical institutions.

The purpose of the study: to substantiate the use of wrestling means in the physical education process of students of the Lyceum with enhanced military and physical training.

Material and methods. The study was conducted on the basis of studying the functional and physical fitness indicators of 10th grade pupils of the Lyceum with enhanced military and physical training during the pedagogical experiment. It consisted in studying the impact of multidirectional wrestling means on the level of these sides of student preparedness during the year.

Results. In pupils who during the year performed the loads according to the experimental physical culture program

during the first semester, the total average increase relative to baseline was 10.7%. In addition, during the second – 5.7%. While members of a group that worked according to a traditional physical culture program in the first semester increased the results of the tests by 6.1% and by 2.0% during the second semester. In the physical fitness of EG students, the total increase of indicators for the first semester was 31.6% and 24.5% – during the second. In contrast, the changes in the studied CG were relatively less pronounced: 24.7% – for the first and 8.9% – for the second semester.

Conclusions. The effectiveness of the use of wrestling means in the physical education of pupils of the Lyceum with enhanced military and physical training is substantiated, which contributes to a significantly more pronounced increase in functional and physical fitness indicators of pupils compared to the traditional program of physical culture.

Keywords: physical education, pupils, wrestling means, fitness, functional capabilities.

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STRENGTH ABILITIES: ASSESSMENT OF TRAINING EFFECTS OF STRENGTH LOADS IN BOYS AGED 8 YEARS

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Abstract

The purpose of this paper is to determine the impact of strength training modes on the dynamics of training effects in 8-year-old boys.

Materials and methods. The study participants were 48 boys aged 8. The experiment was performed using a 2² factorial design. The study implemented the first variant of the combined method for developing arm and shoulder muscles (station I), strength of abdominal muscles (station II), strength of back muscles (station III), and strength of leg muscles (station IV). The study materials were processed using the IBM SPSS 22 statistical analysis program. Discriminant analysis was performed. The study examined the impact of four variants of strength load on the immediate training effect (ITE₁) after performing exercises at four stations, the immediate training effect (ITE₂) after training, and the delayed training effect (DTE) 24 hours after training.

Results. The findings indicate that each of the variants of strength load can be effectively used depending on educational objectives of both one or a series of physical education lessons, and also show that the ITE and DTE of strength training depend on the initial level of fitness and the total amount of strength training in a physical education lesson.

Conclusions. The findings point to the possibility of using a discriminant function to assess and predict the development of strength in 8-year-old boys. The study confirmed the effectiveness of using factorial designs to obtain objective data on the dynamics of training effects in primary school pupils.

Keywords: boys aged 8 years, training effects, strength training, combined method of strength development, discriminant analysis, factorial design.

Introduction

The basis for managing training effects of physical exercises in schoolchildren's physical education is control and targeted regulation of rest intervals between exercise repetitions (Ivashchenko, 2016; Bosenko, 2016; Veremeenko, 2019).

One of the methods based on the regulation of rest intervals between exercises and alternation of muscle training modes is the combined method of strength development. Since the methods of maximal and isometric effort are not recommended to be used separately when training children, they can be successfully used in combination with others in the combined method of strength development (Kuramshin,

Grigorev, & Latysheva, 2004; Khudolii & Ivashchenko, 2014; Ivashchenko, 2016; Veremeenko, 2019).

The need for balanced efforts in both physical education and sports training is indicated in papers by Washabaugh, Augenstein, and Krishnan (2020), Benzing, and Schmidt (2019), Haghighi, Mohammadtaghipoor, Hamedinia, and Harati (2019). Thus, Bogdanis, Donti, Papia, Donti, Apostolidis, and Sands (2019), Wertheimer, Antekolovic, and Matkovic (2018) note a positive effect of plyometric loads on the level of motor fitness of both children and adults. Lovric, Mandic Jelaska, and Bilic (2018), Marttinen, Fredrick III, and Silverman (2018) highlight the need to accurately determine the effects of physical loads in children.

Thus, the issue of controlling strength loads in physical education lessons of primary school pupils is relevant and requires additional research.

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The purpose of the study is to determine the impact of strength training modes on the dynamics of training effects in boys aged 8 years.

Materials and methods

Study participants

The study participants were boys aged 8 years ($n = 48$). The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Study organization

To solve the tasks set, theoretical and empirical methods were used: analysis and generalization of scientific and methodological literature; modeling, pedagogical observation and experiment, discriminant analysis.

To determine the dynamics of strength training effects in boys aged 8 years, the study carried out an experiment according to the plan given in Table 1. Variant I of the combined method was used to strengthen arm and shoulder muscles (station I), abdominal muscles (station II), back muscles (station III), and leg muscles (station IV). At each station, the following methods were used: dynamic effort method, maximal effort method, isometric effort method, repeated effort method. The modes of performance for each group, for the indicated stations are given in Table 1. The study examined

Table 1. Factorial design in studying the influence of different modes of the combined method of strength development (variant I) in primary school children (X_1 – number of repetitions in a set; X_2 – rest interval, s)

No. of strength load variant	Method	X_1	X_2
I	Dynamic effort method	3–	30–
	Maximal effort method	1–	30–
	Isometric effort method	3–	30–
	Repeated effort method	6–	30–
II	Dynamic effort method	5+	30–
	Maximal effort method	3+	30–
	Isometric effort method	5+	30–
	Repeated effort method	12+	30–
III	Dynamic effort method	3–	60+
	Maximal effort method	1–	60+
	Isometric effort method	3–	60+
	Repeated effort method	6–	60+
IV	Dynamic effort method	5+	60+
	Maximal effort method	3+	60+
	Isometric effort method	5+	60+
	Repeated effort method	12+	60+

the impact of four variants of strength load on the immediate training effect (ITE_1) after performing exercises at four stations, the immediate training effect (ITE_2) after training, and the delayed training effect (DTE) 24 hours after training.

At each station, the following exercises were performed:

- Station I. Exercises for arm and shoulder muscles.
1. Dynamic effort method. Knee push-ups. The exercise is performed as quickly as possible.
 2. Maximal effort method. Weighted push-ups (stuffed ball).
 3. Isometric effort method. Knee push-ups. The exercise is performed with two stops and fixation of joint angles (5 s).
 4. Repeated effort method. Knee push-ups.

Station II. Exercises to strengthen abdominal muscles.

1. Dynamic effort method. Sit-ups. The exercise is performed as quickly as possible.
2. Maximal effort method. Hanging 90-degree leg raises on wall bars.
3. Isometric effort method. Decline bench 90-degree leg raises. The exercise is performed with two stops and fixation of joint angles (5 s).
4. Repeated effort method. Decline bench leg raises to plow.

Station III. Exercises to strengthen back muscles.

1. Dynamic effort method. Trunk lift. The exercise is performed as quickly as possible.
2. Maximal effort method. Trunk lift on a pommel horse with feet supported under wall bars.
3. Isometric effort method. Trunk lift with two stops and holding each static position for 5 s. The exercise is performed with two stops and fixation of joint angles (5 s) (hold positions in the upper point and horizontally).
4. Repeated effort method. The same starting position. Trunk lift.

Station IV. Exercises to strengthen leg muscles.

1. Dynamic effort method. Squats. The exercise is performed as quickly as possible.
2. Maximal effort method. Weighted squats (stuffed ball, dumbbells).
3. Isometric effort method. Weighted squats with stops. The exercise is performed with two stops and fixation of joint angles (5 s) (90° , 135°).
4. Repeated effort method. Squats.

During the experiment, the study recorded the results of the following tests: 1. Push-ups. 2. Speed push-ups, 3 times. 3. Sit-ups in 30 seconds. 4. Trunk lift in 10 seconds. 5. Standing long jump.

On the first day before the experiment, the study recorded the results of Test 2 “Speed push-ups, 3 times”, Test 1 “Push-ups”, Test 3 “Sit-ups in 30 seconds”, Test 4 “Trunk lift in 10 seconds”, Test 5 “Standing long jump”. After performing the exercises at station I – Tests 2, 1; at station II – Test 3; at station III – Test 4; at station IV – Test 5. After the lesson – Tests 2, 1, 3, 4. Twenty-four hours after training – Tests 2, 1, 3, 4, 5. The dynamics of test results was determined as a percentage relative to the initial level.

Statistical analysis

The study materials were processed using the IBM SPSS 22 statistical analysis program. In the process of discriminant analysis, the researchers created a prognostic model for group membership.

For each canonical discriminant function, the study calculated: eigenvalue, dispersion percentage, canonical correlation, Wilks' Lambda, Chi-square.

The study protocol was approved by the Ethical Committee of H. S. Skovoroda Kharkiv National Pedagogical University.

Results

The results of the 2² full factorial experiment are given in Tables 2-4.

The results of the analysis of the immediate training effect (ITE₁) after performing exercises at four stations: station I "Exercises for arm and shoulder muscles"; station II "Exercises to strengthen abdominal muscles"; station III "Exercises to strengthen back muscles"; station IV "Exercises to strengthen leg muscles" are given below (see Table 2).

The first load variant has the largest ITE₁ on arm and shoulder muscles relative to the others ($p = 0.005$). The fourth variant has a larger ITE₁ on speed strength of arm and shoulder muscles than the first one ($p = 0.001$). The first load variant has the largest ITE₁ on abdominal muscles relative to the others ($p = 0.001$). The fourth load variant has the smallest ITE₁ relative to the others ($p = 0.001$). The first load variant has the largest ITE₁ on back muscles relative to the others ($p = 0.001$). The fourth load variant has the smallest ITE₁ relative to the others ($p = 0.001$). The difference between the ITE₁ of the first, second, and third load variants is not statistically significant ($p > 0.05$). The ITE₁ on leg muscles is most influenced by the third ($p = 0.019$, $p = 0.043$) and fourth load variants ($p = 0.012$).

Thus, the ITE₁ of physical exercises for different muscle groups depends on the variant of strength load. The choice of the variant of strength load is influenced by the focus and amount of ITE₁:

- the first load variant has the largest ITE₁ on arm and shoulder muscles, the test result decreases to 84.98% relative to the initial level, this variant has a 7.932% larger effect (variant II), 4.278% (variant III), 8.331% (IV) relative to the others;
- the fourth variant leads to an increase in the speed of strength training, the test result is 97.45% relative to the initial level and has an 11.936% larger effect than the first variant;
- the first load variant has the largest ITE₁ on abdominal muscles, the test result decreases to 89.63% relative to the initial level, this variant has an 11.936% larger effect than the fourth variant;
- the first load variant has the largest ITE₁ on back muscles, the test result decreases to 92.03% relative to the initial level, this variant has a 5.746% larger effect than the fourth variant;
- the third and fourth load variants have the largest ITE₁ on leg muscles.

The data of the analysis of the immediate training effect (ITE₂) after training are shown in Table 3.

The first load variant has the largest ITE₂ on arm and shoulder muscles relative to the others ($p = 0.007-0.05$). The difference between the ITE₂ on speed strength of arm and shoulder muscles of the variants of strength load is not statistically significant ($p > 0.05$). The first and second load variants have the largest ITE₂ on abdominal muscles relative to the others ($p = 0.001$). The third load variant has the smallest ITE₂ relative to the others ($p = 0.001$). The fourth load variant has the smallest ITE₂ on back muscles relative to the others ($p = 0.035$). The difference between the ITE₂ of the first, second, and third load variants is not statistically significant ($p > 0.05$). The difference between the impacts of the variants of strength load on the ITE₂ on leg muscles is not statistically significant.

Table 2. The results of the impact of different variants of strength load on the dynamics of immediate training effect (ITE₁) after performing exercises in boys aged 8 years ($n = 12$)

No.	Test	Variant	X	s	Δ_{1-2-4}	Δ_{2-3-4}	Δ_{3-4}	P_{1-2-4}	P_{2-3-4}	P_{3-4}
1	Push-ups	1	84.98	4.737						
		2	92.91	7.784	-7.932			0.005		
		3	89.25	6.419	-4.278	3.654		0.077	0.209	
		4	93.31	2.104	-8.331	-0.399	-4.053	0.001	0.865	0.050
2	Speed push-ups, 3 times	1	109.39	6.009						
		2	106.56	4.579	2.834			0.185		
		3	105.24	5.706	4.148	1.314		0.097	0.521	
		4	97.45	5.489	11.936	9.102	7.788	0.001	0.001	0.003
3	Sit-ups in 30 seconds	1	89.63	6.103						
		2	90.46	4.515	-0.831			0.694		
		3	92.77	0.857	-3.136	-2.305		0.092	0.095	
		4	98.15	2.735	-8.517	-7.685	-5.380	0.001	0.001	0.001
4	Trunk lift in 10 seconds	1	92.03	6.271						
		2	91.94	6.170	0.093			0.970		
		3	94.02	7.074	-1.990	-2.082		0.474	0.430	
		4	97.78	3.282	-5.746	-5.839	-3.757	0.010	0.007	0.109
5	Standing long jump	1	100.32	2.408						
		2	99.69	2.473	0.630			0.519		
		3	97.06	3.768	3.262	2.632		0.019	0.043	
		4	98.00	1.644	2.320	1.690	-0.942	0.012	0.055	0.436

Table 3. The results of the impact of different variants of strength load on the dynamics of immediate training effect (ITE₂) after training in boys aged 8 years (n = 12)

No.	Test	Variant	X	s	Δ_{1-2-4}	Δ_{2-3-4}	Δ_{3-4}	P_{1-2-4}	P_{2-3-4}	P_{3-4}
1	Push-ups	1	84.85	2.190						
		2	90.53	6.283	-5.680			0.007		
		3	89.25	6.419	-4.407	1.273		0.035	0.615	
		4	86.53	1.765	-1.688	3.992	2.719	0.050	0.044	0.171
2	Speed push-ups, 3 times	1	108.31	7.183						
		2	106.42	7.196	1.889			0.511		
		3	105.66	7.077	2.647	0.758		0.373	0.790	
		4	104.04	7.372	4.267	2.378	1.620	0.165	0.414	0.588
3	Sit-ups in 30 seconds	1	89.78	3.587						
		2	89.10	5.277	0.676			0.711		
		3	95.55	3.301	-5.767	-6.443		0.001	0.001	
		4	92.36	2.581	-2.583	-3.259	3.185	0.055	0.064	0.015
4	Trunk lift in 10 seconds	1	91.28	6.575						
		2	91.54	4.237	-0.263			0.903		
		3	93.68	4.785	-2.406	-2.142		0.317	0.238	
		4	95.00	3.761	-3.722	-3.458	-1.316	0.103	0.039	0.462
5	Standing long jump	1	98.99	2.282						
		2	98.60	2.940	0.399			0.706		
		3	99.17	3.621	-0.171	-0.570		0.891	0.662	
		4	99.18	2.309	-0.184	-0.583	-0.013	0.847	0.584	0.992

Table 4. The results of the impact of different variants of strength load on the dynamics of delayed training effect (DTE) 24 hours after training in boys aged 8 years (n = 12)

No.	Test	Variant	X	s	Δ_{1-2-4}	Δ_{2-3-4}	Δ_{3-4}	P_{1-2-4}	P_{2-3-4}	P_{3-4}
1	Push-ups	1	96.57	3.615						
		2	94.37	7.551	2.200			0.366		
		3	101.39	3.244	-4.824	-7.024		0.002	0.006	
		4	94.81	4.273	1.750	-0.450	6.574	0.290	0.857	0.001
2	Speed push-ups, 3 times	1	102.60	2.164						
		2	106.33	5.143	-3.723			0.028		
		3	104.20	6.091	-1.599	2.124		0.401	0.344	
		4	102.83	4.295	-0.228	3.495	1.371	0.871	0.075	0.531
3	Sit-ups in 30 seconds	1	95.46	2.141						
		2	95.83	2.813	-0.370			0.713		
		3	95.55	3.301	-0.088	0.282		0.939	0.816	
		4	94.81	4.273	0.642	1.013	0.731	0.646	0.476	0.644
4	Trunk lift in 10 seconds	1	97.68	3.460						
		2	97.79	3.643	-0.113			0.936		
		3	94.64	8.972	3.038	3.150		0.286	0.240	
		4	94.81	4.273	2.861	2.974	-0.176	0.085	0.067	0.952
5	Standing long jump	1	99.96	2.139						
		2	99.89	2.590	0.075			0.937		
		3	101.80	4.576	-1.841	-1.916		0.220	0.193	
		4	94.81	4.273	5.146	5.071	6.986	0.001	0.001	0.001

Thus, the ITE₂ of physical exercises for different muscle groups depends on the variant of strength load. The choice of the variant of strength load is influenced by the focus and amount of ITE₂.

The results of the analysis of the delayed training effect (DTE) 24 hours after training are shown in Table 4.

The third load variant has the largest DTE on arm and shoulder muscles relative to the others ($p = 0.002-0.006$). The difference in the DTE on speed strength of arm and shoulder

muscles between the variants of strength load is not statistically significant ($p > 0.05$). The difference between the impacts of the variants of strength load on the DTE on abdominal and back muscles is not statistically significant ($p > 0.05$). The fourth load variant has the largest DTE on leg muscles relative to the others ($p = 0.001$).

Thus, the DTE depends on the variant of strength load. The choice of the variant of strength load depends on the muscle group.

Table 5. Structure matrix. Boys aged 8 years

Station	Indicators	ITE ₁ Function			ITE ₂ Function			DTE Function		
		1	2	3	1	2	3	1	2	3
Station I "Exercises for arm and shoulder muscles"	Push-ups	-0.275	0.604	-0.739	-0.175	0.854	-0.423	0.443	-0.542	0.263
	Speed push-ups, 3 times	0.650	-0.265	-0.200	-0.113	-0.102	0.671	0.036	0.438	0.896
Station II "Exercises to strengthen abdominal muscles"	Sit-ups in 30 seconds	-0.667	0.082	0.330	0.639	0.578	0.093	0.068	0.173	0.097
Station III "Exercises to strengthen back muscles"	Trunk lift in 10 seconds	-0.328	-0.010	0.244	0.271	0.040	-0.723	-0.002	0.491	-0.406
Station IV "Exercises to strengthen leg muscles"	Standing long jump	0.303	0.284	0.818	0.091	-0.039	0.012	0.656	0.480	0.218

Table 6. Functions at group centroids. Boys aged 8 years

Indicators	Training effect		
	ITE ₁	ITE ₂	DTE
variant I	1.250	-0.206	0.391
variant II	0.815	-1.283	-0.267
variant III	-0.330	1.003	1.416
variant IV	-1.871	0.700	-1.495

Thus, the DTE of physical exercises for different muscle groups depends on the variant of strength load. The choice of the variant of strength load is influenced by the focus and amount of DTE.

To assess the overall impact of different variants of strength load on the formation of training effects, a discriminant analysis was performed. Tables 5-6 show the results of the discriminant analysis.

The analysis of the immediate training effect (ITE₁) after performing exercises at the stations showed that the first canonical function explains 71.4% of the variation of results, the second one – 24.0%, which indicates a high informativeness of the first and second canonical functions ($r_1 = 0.780$; $r_2 = 0.585$).

The verification of the first and second functions showed their high discriminative ability and value in interpretation with respect to the general population ($\lambda_1 = 0.234$; $p_1 = 0.001$; $\lambda_2 = 0.597$; $p_2 = 0.001$). The first function characterizes the impact of four variants of strength load on the ITE₁ after performing exercises at the station.

Structure coefficients show that the most significant changes in the ITE₁ are associated with the second station's "exercises to strengthen abdominal muscles" and the first station's "exercises to strengthen arm and shoulder muscles" ($r_2 = -0.667$, $r_1 = 0.650$, see Table 5, variant 1). During a discriminant analysis, it was found that 76% of cases were classified correctly. The analysis of group centroids for the ITE₁ shows that at the positive pole of the first function, there are the centroids of training effects of the first and second load variants, at the negative pole – the centroids of the third and fourth variants of strength load. Thus, the differentiation of training effects is observed in the response to strength load (see Table 6, ITE₁). The fourth variant of strength load has the largest overall impact on the ITE₁.

The analysis of the immediate training effect (ITE₂) after training showed that the first canonical function explains 72.3 % of the variation of results, the second one – 21.9%, which indicates a high informativeness of the first and second canonical functions ($r_1 = 0.689$; $r_2 = 0.463$).

The verification of the first and second functions showed their high discriminative ability and value in interpretation with respect to the general population ($\lambda_1 = 0.385$; $p_1 = 0.001$; $\lambda_2 = 0.732$; $p_2 = 0.085$). The first function characterizes the impact of four variants of strength load on the ITE₂ after training.

Structure coefficients show that the most significant changes in the ITE₂ are associated with the second station's "exercises to strengthen abdominal muscles" ($r_2 = 0.639$, see Table 5, ITE₂). During a discriminant analysis, it was found that 56% of cases were classified correctly. The analysis of group centroids for the ITE₂ shows that at the positive pole of the first function, there are the centroids of training effects of the third and fourth load variants, at the negative pole – the centroids of the second and first variants of strength load. Thus, in the response to strength load, the differentiation of training effects is observed between the variants of strength load (see Table 6, ITE₂). The second variant of strength load has the largest overall impact on the ITE₂.

The analysis of the delayed training effect (DTE) 24 hours after training showed that the first canonical function explains 76.4 % of the variation of results, the second one – 18.9%, which indicates a high informativeness of the first and second canonical functions ($r_1 = 0.734$; $r_2 = 0.473$).

The verification of the first and second functions showed their high discriminative ability and value in interpretation with respect to the general population ($\lambda_1 = 0.334$; $p_1 = 0.001$; $\lambda_2 = 0.724$; $p_2 = 0.072$). The first function characterizes the impact of four variants of strength load on the DTE 24 hours after training.

Structure coefficients show that the most significant changes in the DTE are associated with the fourth station's "exercises to strengthen leg muscles" ($r_2 = 0.656$, see Table 5, DTE). During a discriminant analysis, it was found that 60% of cases were classified correctly. The analysis of group centroids for the DTE shows that at the positive pole of the first function, there are the centroids of training effects of the first and third load variants, at the negative pole – the centroids

of the second and fourth variants of strength load. Thus, in the response to strength load, the differentiation of training effects is observed between the variants of strength load (see Table 6, DTE). The fourth variant of strength load has the largest overall impact on the DTE.

Consequently, the ITE₁, ITE₂, and DTE of physical exercises for different muscle groups depend on the variant of strength load. The choice of the variant of strength load is influenced by the focus and amount of training effect of strength exercises.

Discussion

The paper assumed that the formation of ITE₁, ITE₂, and DTE of exercises for different muscle groups in 8-year-old boys is influenced by the variants of strength load, as well as the methods of strength development in physical education lessons. According to scientific data, the study assumed that a combined method of the first variant, which includes a comprehensive development of strength of different muscle groups at four stations using the methods of dynamic effort – maximal effort – isometric effort – repeated effort may be an effective method of strength development in primary school children (Ivashchenko, 2016, 2017; Cieśllicka & Ivashchenko, 2017; Khudolii, Ivashchenko, Iermakov, Nosko, & Marchenko, 2019).

The findings show that each of the variants of strength load can be effectively used depending on the educational objectives of both one and a series of physical education lessons, and also indicate that the ITE and DTE of strength training depend on the initial level of fitness and the total amount of strength training in a physical education lesson. This supports the conclusion of researchers about the need for structural and functional analysis of the effects of physical exercises and rest intervals in strength development of primary school pupils (Ivashchenko, Nosko, & Ferents, 2019; Khudolii, Ivashchenko, Iermakov, Veremeenko, & Lopatiev, 2019). The results of discriminant analysis corroborate the findings of Bosenko (2016) about age and gender peculiarities of the response to physical load in schoolchildren aged 7-16.

The study proved the effectiveness of using the combined method of strength development in the suggested strength training modes in the educational process of boys aged 8 years. The paper supplements the data on the need to manage training loads in the process of learning and strength development in school-age children (Khudolii et al., 2019; Khudolii, Ivashchenko, Iermakov, Veremeenko, & Lopatiev, 2019; Khudolii, Iermakov, & Bartik, 2020).

The findings point to the possibility of using the discriminant function to assess and predict the development of strength in 8-year-old boys. In physical education and sport, the discriminant function is used to determine the dynamics of physical fitness of children aged 9-12 under the influence of fitness programs, for the final control of functional and motor fitness of children and adolescents (Ivashchenko, Khudolii, Iermakov, & Harkusha, 2017; Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018).

The study confirmed the effectiveness of using factorial designs to obtain objective data on the dynamics of training effects in primary school pupils (Ivashchenko et al., 2018; Khudolii et al., 2019). Factorial designs make it possible to

neutralize the influence of unknown factors and increase the efficiency of research (Correa, Grima, & Tort-Martorell, 2009, 2012).

Strength training of schoolchildren is seen as a necessary condition of the educational process (Ivashchenko, 2016, 2017; Kapkan, Khudolii, & Bartik, 2019). Based on the analysis of structure coefficients (Table 5), it is possible to choose a load by focus, based on the analysis of centroids (Table 6), a total load can be chosen.

Conclusions

Thus, the strength training of boys aged 8 years can be planned depending on the objectives of schoolchildren's educational process:

- if the educational program requires a certain level of speed strength development, the fourth variant of strength load is used;
- if the initial level of strength development is insufficient to master the movement, then in the series of lessons the second and fourth variants of strength load are used;
- if the strength of a particular muscle group is a priority for developing a motor skill, then the variant of strength load is chosen accordingly.

Conflict of Interest

The author declares no conflict of interests.

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СИЛОВІ ЗДІБНОСТІ: ОЦІНКА ТРЕНУВАЛЬНИХ ЕФЕКТІВ СИЛОВИХ НАВАНТАЖЕНЬ У ХЛОПЦІВ 8 РОКІВ

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Метою даної роботи є визначення впливу режимів виконання силових вправ на динаміку тренувальних ефектів у хлопців 8 років.

Матеріали і методи. У дослідженні прийняли участь 48 хлопців 8 років. Експеримент був проведений за планом факторного експерименту 2². Був реалізований перший варіант комбінованого методу для розвитку м'язів

рук і плечового поясу (станція I), сили м'язів черевного преса (станція II), сили м'язів спини (станція III) і сили м'язів ніг (станція IV). Матеріали дослідження опрацьовані в програмі статистичного аналізу – IBM SPSS 22. Здійснений дискримінантний аналіз. Вивчався вплив чотирьох варіантів силового навантаження на терміновий тренувальний ефект (ТТЕ) після виконання вправ

на чотирьох станціях, терміновий тренувальний ефект (TTE_2) після заняття та відставлений тренувальний ефект (ВТЕ) – через 24 години після заняття.

Результати. Кожний з варіантів силового навантаження може бути ефективно використаний у залежності від навчальних завдань як одного так і серії уроків фізичної культури, а також вказують на те, що TTE і ВТЕ силових вправ залежить від початкового рівня підготовленості та сумарного обсягу силових вправ в уроці фізичної культури. Силова підготовка школярів розглядається як необхідна умова навчального процесу. На основі аналізу структурних коефіцієнтів можливий ви-

бір навантаження за спрямованістю, на основі аналізу центроїдів – вибір сумарного навантаження.

Висновки. Отримані дані вказують на можливість використання дискримінантної функції для оцінки і прогнозування розвитку сили у хлопців восьми років. У процесі дослідження підтверджена ефективність використання планів факторного експерименту для отримання об'єктивних даних про динаміку тренувальних ефектів у школярів молодших класів.

Ключові слова: хлопці 8 років, тренувальні ефекти, силові вправи, комбінований метод розвитку сили, дискримінантний аналіз, план факторного експерименту.

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ORIGINAL SCIENTIFIC ARTICLE

COMPARATIVE ANALYSIS OF THE KICKBOXERS' IMPACT TECHNIQUES INDICATORS AT THE PRELIMINARY BASIC TRAINING STAGE TAKING INTO ACCOUNT THE WEIGHT CATEGORIES

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Abstract

The objective of the study is to conduct a comparative analysis of the kickboxers experimental and control groups' performance.

Materials and methods. The pedagogical study involved 60 kickboxers who were at the stage of preliminary basic training. There were formed two homogeneous groups. The experimental group consisted of 30 people in three categories: I (67 kg), II (70 kg), III (74 kg). There were 10 people in each category. The control group also consisted of 30 people in the same three categories: I (67 kg), II (70 kg), III (74 kg). There were also 10 people in each category.

Results. The ratio of impact techniques quantitative indicators between the control and experimental groups determines the effectiveness of kick-boxers' impact techniques at the stage of preliminary basic training, taking into account the weight categories, where the experimental group significantly exceeded ($p \leq 0.05$) the control group by all indicators.

Conclusions. The study of existing research has revealed that the analysis of motor performance techniques of kickboxers can be a component of training to improve the efficiency of the training process and the effectiveness of competitive activities.

The analysis of the special literature allowed to determine the most frequently performed percussion techniques in oriental martial arts.

The results obtained after the experiment indicate that the indicators of technical motor actions of kickboxers in the experimental group are significantly higher ($p \leq 0.05$) than in the control group. A detailed analysis of the technique of percussion among kickboxers allowed to establish the difference in technical training between athletes of the experimental and control groups, taking into account weight categories during the performance of eight strokes for the first category (67 kg) were in the range of 14.7-36.3% (in the second category, 70 kg) – 15.0-51.2% and III category (74 kg) – 15.3-66.6% in favor of the experimental group.

Keywords: technique, kicks, kickboxers, weight classes, preliminary basic training stage.

Introduction

Kickboxing is one of the most intensively studied martial arts nowadays. This is evidenced by fundamental papers by Yaremko (2001), Skyrta, Horbenko, Khatsaiuk, and Piniker (2014). As far as it is known, modern kickboxing battles are full of considerable workload, mental, physical and emotional stress. And as a result there arises the role of technical readiness and, accordingly, training of kickboxers' technique.

Traditional methods of the kickboxers' technical skills improving are aimed at working out the basic techniques, as well as taking into account the individual features of athletes and kinematic features of their attacking actions.

Based on the method of competitive activity analysis (by the Frolov's Method, which allows determining the level of technical and tactical readiness of athletes, due to obtaining quantitative and qualitative characteristics of the battle. Kickboxing racing activities were analyzed by Buse, and Santana (2008), Yaremko (2001) and more others.

In sports theory, there are several approaches to defining the technique of sport. Platonov (1997) describes sports

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equipment as a set of techniques and actions that provide the most effective solution to motor problems, due to the specificity of a particular sport, type of competition.

One of the important types of kickboxers training is the key to improving their technical skills. It was studied by Romanov (2003), Skyrta and Khatsaiuk (2014). Several other authors have spoken on this issue, for example, Yaremko (2001), Hutsul, Skyrta, and Rykhal (2019). High-level kickboxers (ISUs and ISMCs) have difficulty in technical training. More details about these issues are considered by such authors as: Booth (2006), Kiatbusaba (2013), Stewart (2011).

The problem of improving the technical skill of athletes in martial arts recently considered the following experts: Ostianov and Haidamak (2001), Bakulev, Nazarenko, and Momot (2007), Skyrta, Horbenko, Khatsaiuk, and Piniker (2014).

The high level of modern kickboxing requires an effective solution to the main problems of formation and improvement of the theory and methodology of the educational and teaching process. Effective technical actions in competitive activities were studied in the papers of Pat O'Keeffe (2002), Ouergui, Hssin, Haddad, Franchini, Behm, Wong, Gmada, and Bouhlef (2014), Savchyn (2016), Pityn, Okopnyy, Tyravskaya, Hutsul, and Ilnytsky (2017).

Studies of various aspects of kickboxer training confirm the high level of dependence on the results of competitive activity on the level of technical training. The key aspect is to increase the effectiveness of the impact. This methodical approach to the analysis of technical skill in martial arts was used by Sayenko (2010), Gerasimov, (2014), Hutsul and Rykhal (2020).

As it is known, the bases of the physical exercises technique are movements, the totality of which is part of human motor skills. It can only be described by technical specifications. The issue of kickboxing technical training is covered in the papers of Skyrta and Khatsaiuk (2014). A number of authors claimed the rational technology performance of certain martial arts types, like Sayenko (2010), Prystupa, Okopnyy, Hutsul, Khimenes, Kotelnik, Hryb, and Pityn (2019).

Improvements in technical skill are justified by many experts on various sports. Kickboxing is not an exception, because to win in a minimum amount of time in a competition is one of the leading single-player challenges. For the effective implementation of this task, it is necessary to carry out at the expense of a high level of technical skill. That means the most rational structure of their performance during the battle. The analysis of impact techniques remains poorly understood in kickboxing during the pre-basic weight training stage.

The objective of the study is to conduct a comparative analysis of the kickboxers experimental and control groups' performance, taking into account the weight categories.

Materials and methods

Study participants

Sixty kickboxers who were at the stage of preliminary basic training participated in the pedagogical study. Two homogeneous groups were created. The experimental group consisted of 30 people in three categories: I (67 kg), II (70 kg), III (74 kg). There were 10 people in each category. The control group also consisted of 30 people in the same three categories:

I (67 kg), II (70 kg), III (74 kg). There were also 10 people in each category.

Study organizing

The indexes of the kickboxers impact techniques were recorded by a special equipment. It was created by professor M.P. Savchyn (2003, Lviv). This is a specialized Spuderg impact dynamometer. This digital instrument allows you to continuously record various parameters of impact techniques. Among them there is the force of each stroke, the time intervals between strokes, the gradient of the efficiency of the stroke by the Savchyn's method (2003). The rapid acquisition of an indicator set provides an opportunity to monitor the technique during the strike and, if necessary, to adjust the training process. It works thanks to electronic instrumentation and chronodynamometry techniques. This technique has been tested in kickboxing, karate, and more other martial arts.

The athletes of the experimental group (30 people of 10 in each category, I (67 kg), II (70 kg), and III (74 kg) were at the stage of preliminary basic training. They were trained by the signature program to improve their technical skills. The athletes improved the basic technique, combat technique (attack-counterattack-defense), tactical techniques, psychological techniques, etc. However, the main tools in competitive activity are impact techniques. The study of the kickboxers technique due to weight categories is possible under the conditions of determining the most frequently performed impact techniques. They have been identified in competitive activities. So, the analysis of battles allowed us to select the following: arm punch (straight right, left side and bottom right), knee strike (bottom right), foot kick (straight right and straight left) and shin kick (right side to the head and right side to the thigh). Kickboxers were tested at the Typhoon sports complex. According to the training method, kickboxers were to perform in a competition mode, showing their ten strongest separate strokes from above at a sound signal. To perform the kicks, the kickboxer was tested mid-range by a torque bag, maintained by an assistant, and sounded a conditioned punch. The best result, out of ten blows, was put in the record. To avoid deterioration in performance, as well as to maintain efficiency and maintain competitive testing conditions after ten strokes, the tested athlete was provided rest and substituted by another.

Statistical analysis

The processing of the test results was performed using mathematical statistics methods with the calculation of the Mann-Whitney probability difference ($p \leq 0.05$).

Results

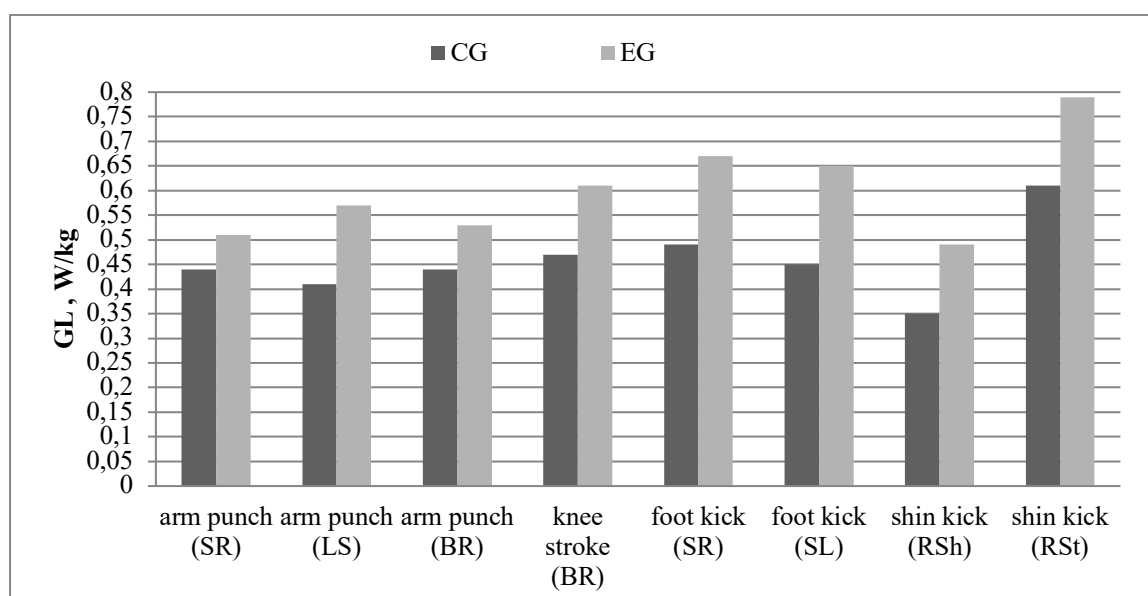
According to the impact technique, there were recorded quantitative indicators of the strokes effectiveness. The experimental group achieved a reliable indicator at $p \leq 0.05$ (Tables 1-3).

The study of the impact techniques gave reason to consider the difference between effectiveness of the standard ISKA program and the experimental group program, which trained by the signature program of improving technical

Table 1. The ratio of the impact of kickboxers of the first category (67 kg) of the control and experimental groups ($M \pm m$)

Indicator	Execution of blows	I (67 kg) (CG) (n = 10)	I (67 kg) (EG) (n = 10)	p
GL, W/kg	arm punch (SR))	0,44 $\pm$ 0,05	0,51 $\pm$ 0,09	$p \leq 0.05$
	arm punch (LS)	0,41 $\pm$ 0,03	0,57 $\pm$ 0,12	$p \leq 0.05$
	arm punch (BR)	0,44 $\pm$ 0,04	0,53 $\pm$ 0,10	$p \leq 0.05$
	knee strike (BR)	0,47 $\pm$ 0,06	0,61 $\pm$ 0,14	$p \leq 0.05$
	foot kick (SR)	0,49 $\pm$ 0,08	0,67 $\pm$ 0,16	$p \leq 0.05$
	foot kick (SL)	0,45 $\pm$ 0,03	0,65 $\pm$ 0,15	$p \leq 0.05$
	foot kick (RSh)	0,35 $\pm$ 0,02	0,49 $\pm$ 0,08	$p \leq 0.05$
	foot kick (RSt)	0,61 $\pm$ 0,014	0,79 $\pm$ 0,18	$p \leq 0.05$

Note: CG – control group; EG – experimental group

**Fig. 1.** The impact techniques of the kickboxers of the first category (67 kg): SR – straight right; LS – left side; BR – bottom right; SR – straight right; SL – straight left; RSh – right side to the head; RSt – right side to the thigh.

kickboxers technique, taking into account weight categories. According to the ratios of quantitative indicators of impact techniques between groups (control and experimental) the effectiveness of technical actions of kickboxers at the stage of preliminary basic training, taking into account, can be determined. The weight categories had some differences. Judging by the impact techniques of the kickboxers of the first category (67 kg), the experimental group significantly exceeded ($p \leq 0.05$) the control group by all indicators.

The indicator of arm punch (straight right) is higher on 14.7%, to the left – 32.6% ($p \leq 0.05$). Punching below, the indicator is higher as well as the previous one – 18.5% at ($p \leq 0.05$).

On the other index, knee strikes (bottom-right) were also at a significant level and were higher – 25.9% at ($p \leq 0.05$).

Another trend in foot strikes was the same as for previous indicators, where the SR was higher – 31.0% at ($p \leq 0.05$) and the SL – 36.3% at ($p \leq 0.05$).

The last indicator was also higher for the experimental group, but it was low compared to other. The kick (right side

to the head) is higher – 33.3% at ($p \leq 0.05$) and the one to the thigh – 25.7% at ($p \leq 0.05$).

The analysis of kickboxers' impact techniques at the pre-basic training stage, taking into account the weight categories for athletes of the second category (70 kg) had some differences. According to the ratio of indicators between the control and the experimental group, the reliability was in favor of the second one at ($p \leq 0.05$).

In the right-handed punch, the figure is significantly higher – 18.1% at ($p \leq 0.05$), in the side-left punch – 37.5% at ($p \leq 0.05$) and in the bottom right – 15.0% at ($p \leq 0.05$).

The figure on the right knee bottom stroke was also higher for the experimental group (35.5% at ($p \leq 0.05$)).

In terms of impact, the foot was also statistically significant for the experimental group compared to the control group. For the straight right stroke it was 36.6% at ($p \leq 0.05$) and for the straight left – 38.5% at ($p \leq 0.05$). The index increased for both feet.

The last shin stroke right to the head was higher by 51.2% at ($p \leq 0.05$) and the side right to the thigh at 19.8% at ($p \leq 0.05$).

Table 2. The ratio of impact indicators of kickboxers of the second category (70 kg) of the control and experimental groups ($M \pm m$)

Indicator	Execution of blows	II (70 kg) (CG) (n = 10)	II (70 kg) (EG) (n = 10)	P
GL, W/kg	arm punch (SR))	0,45 $\pm$ 0,05	0,54 $\pm$ 0,08	$p \leq 0,05$
	arm punch (LS)	0,39 $\pm$ 0,03	0,58 $\pm$ 0,16	$p \leq 0,05$
	arm punch (BR)	0,43 $\pm$ 0,04	0,50 $\pm$ 0,08	$p \leq 0,05$
	knee strike (BR)	0,44 $\pm$ 0,06	0,63 $\pm$ 0,12	$p \leq 0,05$
	foot kick (SR)	0,50 $\pm$ 0,11	0,71 $\pm$ 0,17	$p \leq 0,05$
	foot kick (SL)	0,46 $\pm$ 0,03	0,68 $\pm$ 0,16	$p \leq 0,05$
	foot kick (RSh)	0,29 $\pm$ 0,02	0,49 $\pm$ 0,08	$p \leq 0,05$
	foot kick (RSt)	0,50 $\pm$ 0,08	0,61 $\pm$ 0,11	$p \leq 0,05$

Note: CG – control group; EG – experimental group

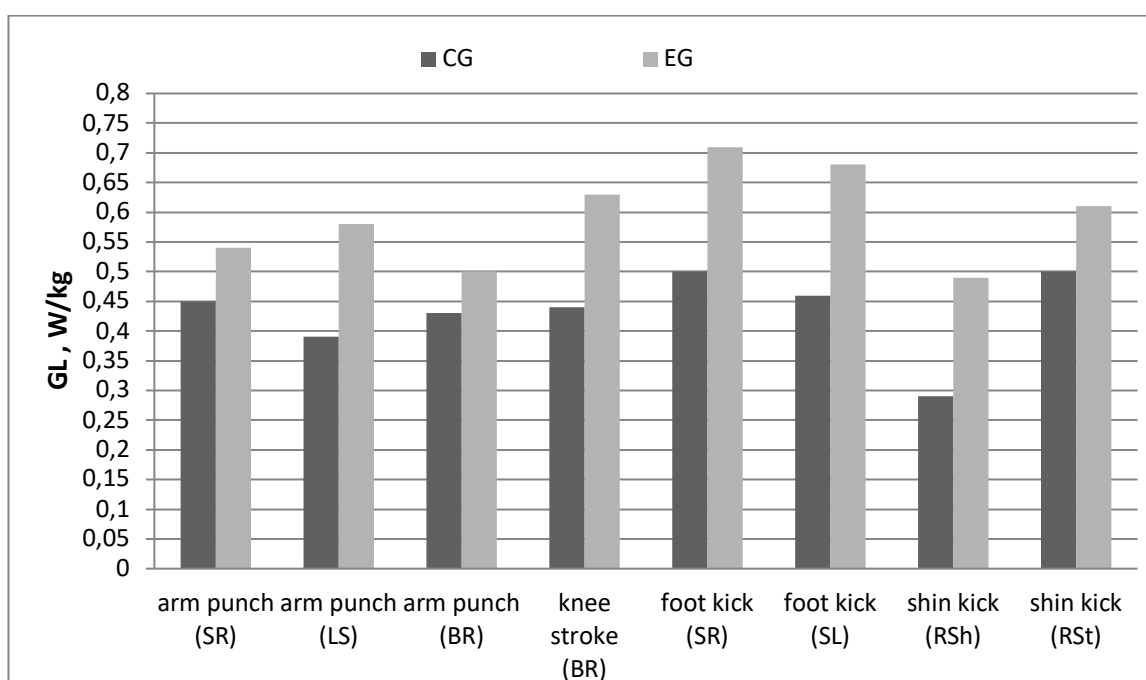


Fig. 2. The impact techniques of the kickboxers of the second category (70 kg): SR – straight right; LS – left side; BR – bottom right; SR – straight right; SL – straight left; RSh – right side to the head; RSt – right side to the thigh

For the last subgroup of the third category (74 kg) comparing the indicators between the groups (control and experimental) showed significantly higher results for the experimental group ($p \leq 0.05$).

All indicators were significant and reliable at ($p \leq 0.05$) for the strokes. For the straight right – 15.3%, straight left – 41.5%, and bottom-right blow – 30.3% at ($p \leq 0.05$).

The index in the knee-lower right-hand stroke is higher, respectively 37.1% W/kg at ($p \leq 0.05$) and in the straight right stroke – 25.2% at ($p \leq 0.05$) and straight left – 33.7% at ($p \leq 0.05$).

But the shin stroke is also a statistically significant indicator right side to the head – 66.6% at ($p \leq 0.05$) and right side to the thigh – 23.8% at ($p \leq 0.05$).

Table. 4 compares the performance of the impact technique between the kickboxer control group at the pre-basic weight training stage. Analysing the impact technique for the control group, the indicators had some differences. For the control group, reliability was found in four indicators.

When, to a certain extent, certain values of growth, they came from the definition of indicators of the straight right punch – 6.89% ($p \leq 0.05$) – the second category (70 kg).

The straight left stroke, which was higher but not reliable, ranged from 2.5-5% in favor (1st category, 67 kg) ($p > 0.05$). For shin strokes there were following results: straight right – 18.7-50% ($p \leq 0.05$) right-sided stroke – 19.8-23.8% ($p \leq 0.05$) and foot strokes: straight right – 25.2% ($p \leq 0.05$), left-sided – 34.8% ($p \leq 0.05$) (1st category, 67 kg).

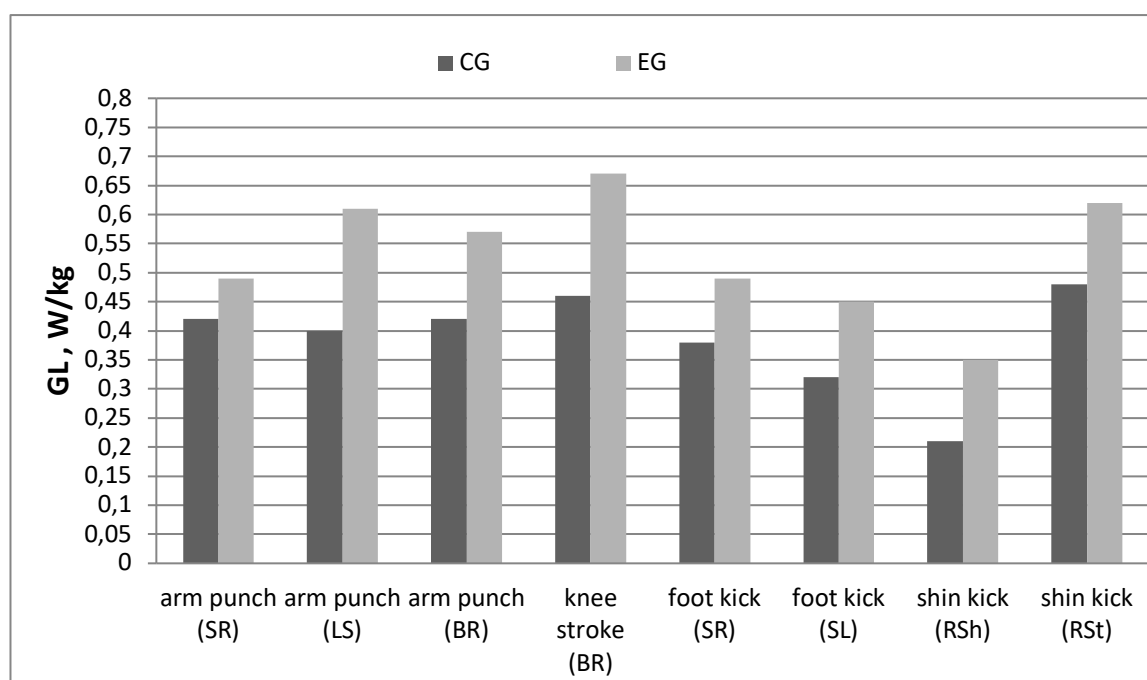
However, for one stroke, the right bottom knee stroke – 4.44-6.81% with positive shifts for the results of most athletes (representatives of different weight categories) no reliable level was reached ($p > 0.05$). This indicates the low efficiency of the proposed methodological approach used in the standardized (traditional program).

Thus, it is confirmed that a standardized program of technical readiness for kickboxers at the stage of preliminary basic training does not lead to positive changes in athletes'

Table 3. The ratio of the impact of kickboxers III category (74 kg) of the control and experimental groups ($M \pm m$)

Indicator	Execution of blows	III (74 kg) (CG) (n = 10)	III (74 kg) (EG) (n = 10)	p
GL, W/kg	arm punch (SR))	0.42 ± 0.04	0.49 ± 0.06	$p \leq 0.05$
	arm punch (LS)	0.40 ± 0.03	0.61 ± 0.14	$p \leq 0.05$
	arm punch (BR)	0.42 ± 0.04	0.57 ± 0.10	$p \leq 0.05$
	knee strike (BR)	0.46 ± 0.07	0.67 ± 0.14	$p \leq 0.05$
	foot kick (SR)	0.38 ± 0.03	0.49 ± 0.07	$p \leq 0.05$
	foot kick (SL)	0.32 ± 0.02	0.45 ± 0.05	$p \leq 0.05$
	foot kick (RSh)	0.21 ± 0.03	0.35 ± 0.04	$p \leq 0.05$
	foot kick (RSt)	0.48 ± 0.06	0.62 ± 0.15	$p \leq 0.05$

Note: CG – control group; EG – experimental group

**Fig. 3.** The impact techniques of the kickboxers of the third category (74 kg): SR – straight right; LS – left side; BR – bottom right; SR – straight right; SL – straight left; RSh – right side to the head; RSt – right side to the thigh

readiness for various technical actions. The lower results of the kickboxers of the control group of the third category (74 kg) in technical actions are associated with a complex structure of movements ($p \leq 0.05$) and their own endurance. This means that athletes performed the work with maximum force in the process of execution but could not ensure the effectiveness of technical action. Probably the lack of a sufficient level of technical preparedness made it impossible to carry out the stroke effectively.

According to the ratio of impact techniques between the experimental group at the stage of preliminary basic training, taking into account the weight categories, although they are at a higher level than the control group, but also have some differences. Analyzing the hands impact techniques (bottom right punch) although it was not significant, but reliable at 7.2%, $p \leq 0.05$, II category (70 kg), by side stroke criteria –

6.7% ($p \leq 0.05$) and bottom stroke 5.8-13.0%. bottom-right knee stroke – 9.37% ($p > 0.05$) (III category (74 kg)).

The other five indicators were statistically significant in favor of a particular weight category. Yes, reliable indicators for the 1st category (67 kg) ($p \leq 0.05$) right-sided to the head and right-sided stroke to the hip which was within 25.7-33.3% ($p \leq 0.05$). According to the latest blow, which is the highest in the group of the II category (70 kg), the straight right is 31.0% and the straight left is 36.5% ($p \leq 0.05$).

As a result of technical actions for I (67 kg) and II (70 kg) categories, we associate them with higher coordination and adaptation processes. According to them, we see possible positive trends in the continuing of training influences under the experimental program. However, the representatives of the experimental group showed an increase in performance for all technical activities, achieved higher shock gains ($p \leq 0.05$).

Table 4. The ratio of the impact of kickboxers at the stage of preliminary basic training considering weight categories

Indicator	Execution of blows	Groups	I (67 kg) (n = 10)	p	II (70 kg) (n = 10)	p	III (74 kg) (n = 10)
GL, W/kg	arm punch (SR)	CG	0.44 ± 0.05	p ≤ 0.05	0.45 ± 0.05	p > 0.05	0.42 ± 0.04
		EG	0.51 ± 0.09	p ≤ 0.05	0.54 ± 0.08	p > 0.05	0.49 ± 0.06
	arm punch (LS)	CG	0.41 ± 0.03	p > 0.05	0.39 ± 0.03	p ≤ 0.05	0.40 ± 0.03
		EG	0.57 ± 0.12	p ≤ 0.05	0.58 ± 0.16	p ≤ 0.05	0.61 ± 0.14
	arm punch (BR)	CG	0.44 ± 0.04	p > 0.05	0.43 ± 0.04	p > 0.05	0.42 ± 0.04
		EG	0.53 ± 0.10	p > 0.05	0.50 ± 0.08	p ≤ 0.05	0.57 ± 0.10
	knee strike (BR)	CG	0.47 ± 0.06	p > 0.05	0.44 ± 0.06	p ≤ 0.05	0.46 ± 0.07
		EG	0.61 ± 0.14	p ≤ 0.05	0.63 ± 0.12	p ≤ 0.05	0.67 ± 0.14
	foot kick (SR)	CG	0.49 ± 0.08	p ≤ 0.05	0.50 ± 0.11	p > 0.05	0.38 ± 0.03
		EG	0.67 ± 0.16	p ≤ 0.05	0.71 ± 0.17	p > 0.05	0.49 ± 0.07
	foot kick (SL)	CG	0.45 ± 0.03	p ≤ 0.05	0.46 ± 0.03	p > 0.05	0.32 ± 0.02
		EG	0.65 ± 0.15	p ≤ 0.05	0.68 ± 0.16	p ≤ 0.05	0.45 ± 0.05
	foot kick (RSh)	CG	0.35 ± 0.02	p > 0.05	0.29 ± 0.02	p > 0.05	0.21 ± 0.03
		EG	0.49 ± 0.08	p ≤ 0.05	0.50 ± 0.10	p > 0.05	0.35 ± 0.04
	foot kick (RSt)	CG	0.61 ± 0.014	p > 0.05	0.50 ± 0.08	p > 0.05	0.48 ± 0.06
		EG	0.79 ± 0.18	p > 0.05	0.61 ± 0.11	p ≤ 0.05	0.62 ± 0.15

Note: CG – control group; EG – experimental group

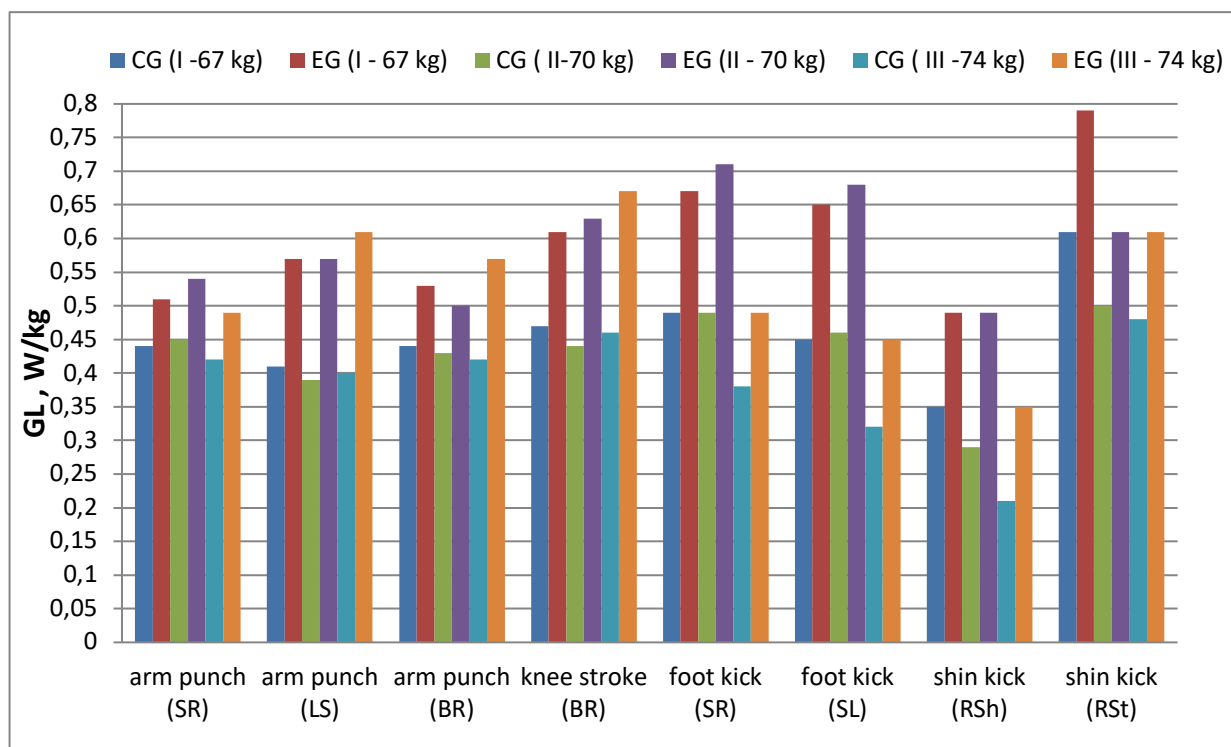


Fig. 4. Impact techniques indicators taking into account the weight categories: SR – straight right; LS – left side; BR – bottom-right; SR – straight right; SL – straight left; RSh – right side to the head; RSt – right side to the thigh

Discussion

The work compares the impact technique of kickboxers on the stage of preliminary basic training, considering the weight categories for further improvement of competitive activity. The results are complementary to those of kickboxing

scientists, as Skyrta and Khatsaiuk (2014), Pityn, Okopnyy, Tyravska, Hutsul, and Ilnytsky (2017) and other martial karate – Sayenko (2010).

The obtained data complements the one gathered by Skyrta and Khatsaiuk (2014), Pityn et al. (2017), Zadorozhna, Okopnyy, Hutsul, Kotelnik, Grashchenkova, Perederiy,

Pityn, and Svistelnik (2019) that due to the effective technical actions used in the competitive battle led to its successful outcome.

The data on the improvement of motor technique, which is one of the crucial components in the realization of the motor potential of the athlete, have been supplemented (Platonov, 2004; Kashuba & Lytvynenko, 2010).

Data on improving the quality of technical training in martial arts have been supplemented (Boychenko, 2008; Stewart, 2011; Agafonov, 2013).

The results of the technical analysis of motor actions indicate the data Gartland, Malik, and Lovell (2005), Gerasimov (2014) about the success of competitive activities. The results confirm the conclusions Skyrta and Khatsaiuk (2014); Hutsul and Rykhal (2020) on the need to expand the arsenal of technical means, eliminate technical shortcomings in the movement (when striking the upper and lower extremities, protection and economical execution of movements and increase the speed of movements).

The study specified the data Romanov (2014), Hölbling, Preuschl, Hassmann, and Baca (2016), Hutsul et al. (2019) on the features of coordinated motor action on the effectiveness of the kickboxer technique.

The results show that a successful fight depends on the level of technical training in martial arts. This confirms the conclusion of researchers that the technique of sports exercises is closely related to competitive activities that determine the achievement of the highest sports results (Pat, 2002; Khatsaiuk & Karataieva, 2008; Morgunov, Sagaydak, & Dorofeeva, 2009).

As a result of the analysis it is established that time for performance of effective shock action in kickboxing is an informative indicator of technical readiness of kickboxers of various qualification during competitive activity. These data complement the results of the study by Ouergui, Hssin, Franchini, Gmada, and Bouhlel (2013), Gerasimov (2014), Skyrta and Khatsaiuk (2014) and indicate the features of the technical training of kickboxers in the competitive process. Data on the use of the chronodynamometry method to determine the dynamics of technical readiness of fighters have been supplemented (Yaremko, 2001; Savchyn, 2003; Saienko, 2010).

Conclusions

The study of existing research has revealed that the analysis of motor performance techniques of kickboxers can be a component of training to improve the efficiency of the training process and the effectiveness of competitive activities.

The analysis of the special literature allowed to determine the most frequently performed percussion techniques in oriental martial arts.

The results obtained after the experiment indicate that the indicators of technical motor actions of kickboxers in the experimental group are significantly higher ($p \leq 0.05$) than in the control group. A detailed analysis of the technique of percussion among kickboxers allowed to establish the difference in technical training between athletes of the experimental and control groups, taking into account weight categories during the performance of eight strokes for the first category (67 kg) were in the range of 14.7-36.3% (in the second category, 70 kg) – 15.0-51.2% and III category (74 kg) – 15.3-66.6% in favor of the experimental group.

Conflict of interests

The authors declare no conflict of interest.

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ПОРІВНЯЛЬНИЙ АНАЛІЗ ПОКАЗНИКІВ ТЕХНІКИ УДАРНИХ ДІЙ КІКБОКСЕРІВ НА ЕТАПІ ПОПЕРЕДНЬОЇ БАЗОВОЇ ПІДГОТОВКИ З УРАХУВАННЯМ ВАГОВИХ КАТЕГОРІЙ

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Реферат. Стаття: 8 с., 4 табл., 4 рис., 31 джерело

Мета дослідження – провести порівняльний аналіз показників техніки ударних дій кикбоксерів експериментальної та контрольної групи на етапі попередньої базової підготовки з урахуванням вагових категорій.

Матеріали і методи. У педагогічному дослідженні прийняли участь 60 кикбоксерів, які знаходились на етапі попередньої базової підготовки. Були створені дві одно-

рідні групи, експериментальна група (30 чоловік по 10 в кожному розряді, I (67 кг), II (70 кг) та III (74 кг) та контрольна група (30 чоловік по 10 в кожному розряді, I (67 кг), II (70 кг) та III (74 кг).

Результати. За співвідношенням кількісних показників техніки ударних дій між групами (контрольної та експериментальної) визначають ефективність технічних

дій кікбоксерів на етапі попередньої базової підготовки з урахуванням вагових категорій, де за всіма показниками експериментальна група достовірно перевищила ($p \leq 0,05$) контрольну групу.

Висновки. Вивчення існуючих досліджень дозволило констатувати, що аналіз техніки виконання рухових дій у кікбоксерів може бути компонентом підготовки з метою підвищення ефективності тренувального процесу та результативності змагальної діяльності.

Проведений аналіз спеціальної літератури дозволив визначити найчастіше виконувані ударні технічні прийоми у східних єдиноборствах.

Результати, що були отримані унаслідок проведення експерименту, свідчать про те, що показники технічних

рухових дій кікбоксерів експериментальної групи достовірно вищі ($p \leq 0,05$) ніж в контрольній групі. Детальний аналіз техніки ударних дій серед кікбоксерів дозволив встановити різницю в технічній підготовленості між спортсменами експериментальної та контрольної групи з урахуванням вагових категорій під час виконання восьми ударів для I розряду (67 кг) знаходились в межах 14,7-36,3%, в II розряді (70 кг) – 15,0-51,2% та III розряді (74 кг) – 15,3-66,6% на користь експериментальної групи.

Ключові слова: техніка, удари, кікбоксери, масові розряди, етап попередньої базової підготовки.

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- відомості про авторів.

Рекомендуємо використовувати шаблон для оформлення статті (.dotx, 19 KB).

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Зазначається заголовок статті, перелік авторів, їх приналежність до навчального закладу, авторський вклад у рукопис, інформація про автора-кореспондента. Вимоги до оформлення перелічених елементів такі:

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Наприклад:

ОСОБЛИВОСТІ ВІДНОВЛЕННЯ СПОРТСМЕНІВ ЗАСОБАМИ МАСАЖУ

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Вступ

Постановка проблеми. Вказується основне протиріччя, яке буде досліджено в роботі.

Аналіз останніх досліджень і публікацій.

Гіпотеза і мета дослідження.

Матеріали і методи

Для оригінальних статей

Учасники дослідження. Вказується контингент досліджуваних.

Організація дослідження. Вказуються методи і з якою метою вони були використані; процедури дослідження і алгоритм проведення педагогічного експерименту.

Статистичний аналіз. Вказуються методи математистики і з якою метою вони були використані.

Дослідження повинно мати етичне схвалення відповідної установи з підписами комітету з питань етики. Для експериментів, проведених у галузі фізичного виховання та спорту, автор(и) повинен мати схвалення установи для публікації експериментальних даних.

Для оглядових статей

Матеріали для аналізу. Вказуються характеристики досліджень, що будуть відібрані для аналізу. Зазначаються усі джерела інформації (наприклад, бази даних з датами висвітлення) під час пошуку та дати останнього пошуку. Надається повна стратегія електронного пошуку зонайменше для однієї бази даних, щоб її можна було повторити.

Організація дослідження. Формулюються правила відбору досліджень. Описується спосіб вилучення даних. Перераховуються та визначаються всі змінні, для яких шукалися дані.

Методи аналізу. Описуються методи обробки даних та об'єднання результатів досліджень.

Результати дослідження

Для оригінальних статей

Результати дослідження повинні бути представлені у таблицях і описані в логічній послідовності в тексті. У

таблицях наводяться у першому стовбчику номер тесту (1) далі назва тесту (2), умови тестування (3), кількість учасників дослідження (4), середнє арифметичне (5), стандартне квадратичне відхилення (6) експериментальної групи, середнє арифметичне (7), стандартне квадратичне відхилення (8) контрольної групи, середнє арифметичне різниці результатів тестування експериментальної і контрольної групи (9), фактичне значення t -критерію (або іншого показника) (10), фактичне значення p (11).

У тексті посилання на таблиці обов'язкові. Не слід повторювати в тексті всі дані з таблиць або графіків. Необхідно акцентувати увагу на статистично достовірних змінах результатів тестування та показати характерні тенденції динаміки. Вказуйте фактичне значення p у двох десяткових знаках, записуйте « $p = 0,25$ », а не « $p > 0,05$ ». Результати аналізу статистичної значущості динаміки результатів повинні супроводжуватися показниками, що вказують на величину ефекту втручання (9) або довільні інтервали різниці.

Слід обмежити кількість таблиць і малюнків (графіків) до шести.

Для оглядових статей

Наводиться кількість перевірених досліджень, оцінених на придатність та включених до огляду. Для кожного дослідження подаються характеристики, за якими були вилучені дані та наводяться цитати. Для всіх розглянутих результатів, для кожного дослідження наводяться: прості підсумкові дані для кожної групи аналізу та оцінки можливих наслідків.

Обговорення результатів дослідження

Для оригінальних статей

- огляд основної гіпотези;
- обговорення висновків: порівняння з даними публікацій, дотичними до теми статті наведеними у вступі рукопису;
- міркування щодо можливості практичного застосування результатів;
- обґрунтування і коментарі щодо важливості викладених результатів дослідження;
- висновок про перспективи подальших досліджень, який ґрунтується на матеріалах дискусії.

Для оглядових статей

Узагальнення основних висновків з врахуванням надійності доказів для кожного головного результату. Обговорення обмеження на рівні дослідження та результатів.

Висновки

Висновки повинні відображати результати і бути пов'язані з метою дослідження. Слід уникати висновків, які не підтверджуються отриманими даними.

Вдячності

Вказується тема дослідження за якою виконана робота, номер державної реєстрації.

Наприклад:

Дослідження виконано згідно плану науково-дослідної роботи Міністерства освіти і науки, молоді і спорту

України за темою 13.04 «Моделювання процесу навчання та розвитку рухових здібностей у дітей і підлітків» (2013-2014 рр.) (номер державної реєстрації 0113U002102).

Конфлікт інтересів

Наприклад:

Автори заявляють про відсутність конфлікту інтересів.

Література

Кількість посилань — не менше 30. Переважна більшість посилань повинна включати в себе дослідження, опубліковані в наукових журналах, будь ласка, обмежте кількість інших типів посилань (книг, матеріалів конференцій тощо) до 5 і менше. Будь ласка, зменшіть кількість посилань, не опублікованих англійською мовою, і, як правило, уникайте тих, що не мають, принаймні, англійського тексту. Ідентифікатори DOI необхідні для всіх онлайн-публікацій. Для DOIs використовуйте повну форму URL-адреси (наприклад, <https://doi.org/10.17309/tmfv.2018.3.01>).

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Наприклад:

Мороз, Ю.В. (2015). Особливості розвитку рухових здібностей у школярів 7-8 класів. *Теорія та методика фізичного виховання*, (3), 15-31.

<https://doi.org/10.17309/tmfv.2015.3.1145>

References

Дублюється список літератури. Для статей кирилицею здійснюється транслітерація на латиницю. Оформляється за стандартом APA, подається за алфавітом або у порядку цитування, не нумерується.

Транслітерація для видань російською мовою: <http://translit.net>

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Бібліографічні посилання у тексті

У рукописі повинні використовуватися посилання на не нумерований список. У тексті посилання вказувати не більше 2-3 джерел.

Відомості про авторів

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