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Original scientific article

Assessment of Speed Indicators of School Students Practicing Kyokushinkai Karate

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

The purpose of this study was to determine the age-specific features of the manifestation of differences in the speed fitness of younger grade boys who attend a karate class at the sports and health stage.

Materials and methods. The study participants were 60 younger grade boys (aged 7 to 10). They were divided into four groups: those aged 7, 8, 9, and 10, each of the age group comprising 15 participants. The children's technical level corresponded to the student grades of 10th or 9th Kyu (Orange Belt). The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment. The solution of the set tasks involved the use of the following research methods: review and analysis of scientific and methodical literature, pedagogical observation, timing of educational tasks, testing, pedagogical ascertaining experiment, methods of mathematical statistics.

Results. Statistically significant ($p<.05$) age-specific differences were observed in the speed in integral movements ($p=.037$; $p=.004$; $p=.041$), in the latent time of a simple motor response ($p=.003$; $p=.001$; $p=.026$), and in the frequency of unloaded movement ($p=.002$; $p=.039$; $p=.001$) between all the study groups aged 7-8, 8-9, and 9-10, respectively; in speed-strength abilities ($p=.009$; $p=.024$) between the groups aged 7-8 and 9-10; in the general motor function of the body ($p=.007$; $p=.006$) between the groups aged 7-8 and 8-9; and in the frequency of a single movement ($p=.044$) between the groups aged 8-9.

Conclusions. Based on the results of the SI and SSI indices, most younger grade karate boys develop harmoniously and have a sufficient level of development of speed abilities, their results clearly showing improvement. It was established that there are differences between children in various structural units of speed, which correspond to the age indicators and technical levels of the karate boys.

Keywords: boys, speed abilities, kyokushinkai karate, younger grade students.

Introduction

The State actively responds to the negative challenges of nowadays and promotes the development of new innovative approaches to implement the idea of 'Formation of a healthy nation'. State and regional programs are actively being created, international charitable foundations offer programs for the development of physical education and mass physical culture using modern technologies for teaching motor actions and developing physical abilities in various forms of work in physical education at school.

The President's nationwide Healthy Ukraine program has been developed. The healthy school model is one of the components of this program. It is designed to improve the citizens' health and quality of life, to make sports accessible to everyone. Its main task is to make a healthy lifestyle part of the Ukrainian mentality. The program was created by the Office of the President of Ukraine together with relevant ministries: Ministry of Education and Science, Ministry of Youth and Sports, and Ministry of Health. Many experts and specialists from various fields took part in the development and discussion of the program (The healthy school model is a component of the President's Healthy Ukraine program, 2021).

A comprehensive New physical education program was created on the platform of the international charitable fund Parimatch Foundation to develop and popularize physical education in schools with the aim of increasing the physical activity of children aged 6 to 16, motivating physical education teachers to introduce new modern approaches to conducting their classes, providing tools to make physical education classes up-to-date and interesting for the digital generation (The comprehensive New physical education pro-

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gram, 2021). New sports modules such as game, traditional, and new ones are being introduced to physical education classes. To date, the Ministry of Education and Science of Ukraine has approved more than 40 modules in sports. These modules also include various types of martial arts: hand-to-hand combat, wushu, military sports games, horting, fencing, and unarmed combat (Krutsevych, Tymchyk, Derevianko, and others, 2017; Pedan, Kolomoiets, Boliak, and others, 2022). A lot of research has been recently conducted on the implementation of kyokushinkai karate within the school process (Marchenko & Kovalenko, 2020; Marchenko & Satdyiev, 2021; Marchenko, Ivashchenko, Jagiello et al., 2022). Hence there are prerequisites for offering supplements to already existing modules, creating a separate new section of martial arts in the school curriculum or using the data obtained from completed studies in out-of-class and out-of-school work in the form of sports work in sports classes.

The use of well-organized children's martial arts programs can lead to increased motor activity, improved physical condition, motor skills, and physical fitness of schoolchildren, influence the mental health and character formation of young people, increase social skills and self-confidence. As for motor skills, Khudolii & Marchenko (2007), Boguszewski & Socha, (2011), Stamenković, Manić et al. (2022) noted the need to develop explosive power, speed of movements, agility, strength, balance and accuracy during training.

The dominant physical components that martial arts athletes must constantly train are reaction, coordination, and speed. These three things are closely related to some techniques necessary in martial arts, specifically kicking and punching, and defense techniques (Siregar, Soegiyanto & Rustiadi, 2021; Marchenko, Jagiello, Iermakov et al., 2021; Zymogliad & Marchenko, 2021).

In view of the above, the study of the specific features of the manifestation of various speed components in school students is a topic of relevance.

The purpose of this study was to determine the age-specific features of the manifestation of differences in the speed fitness of younger grade boys who attend a karate class at the sports and health stage.

Materials and methods

Study participants

The study participants were 60 children who were tested to determine their level of speed abilities. The study sample was divided into four age groups: 7-year-old boys (n=15), 8-year-old boys (n=15), 9-year-old boys (n=15), and 10-year-old boys (n=15). The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment. The children's technical level corresponded to the student grades of 10th or 9th Kyu (Orange Belt). All the participants did regular practical training, which comprised 3 classes per week, each about 90 minutes long. The inclusion criteria were the absence of injuries in the last 2 months and the absence of intake of medication that could affect the correct performance of tests.

Ethical considerations. Ethical approval of the entire study was obtained from the Ethics Committee of H.S. Skovoroda Kharkiv National Pedagogical University. All the participants were given an information sheet detailing the study conditions. The study procedure and possible risks were explained to all the participants and their parents by members of the research team. The participants were informed that they could withdraw from the study at any time and for whatever reason without explanation. Informed consent was obtained from all the participants and their parents. All procedures were performed in accordance with the Declaration of Helsinki.

Study organization

The solution of the set tasks involved the use of the following research methods: review and analysis of scientific and methodical literature, pedagogical observation, timing of educational tasks, testing of speed abilities, pedagogical ascertaining experiment, and methods of mathematical statistics.

To determine the level of the indicators under study according to age, various manifestations of speed were tested using a battery of fitness tests that comprehensively characterize various manifestations of speed abilities. The tests were selected depending on the subject matter and were included in the analysis according to the purpose of the study. The tasks performed during the examination of the children were assessed using quantitative indicators (Eurofit, 1993; Krutsevych, Vorobiov & Bezverkhnia, 2011; Zymohliad & Marchenko, 2021).

Control exercises were carried out in the gym and on the sports field of the school. Before the examination, a set of exercises (10–15 minutes) was performed, which included running, jumping, general physical development exercises, and movement games. It was aimed at preparing the children to perform the test tasks.

The method of determining the speed and speed-strength indices proposed by Krutsevych, Vorobiov & Bezverkhnia (2011) was used as criteria for performing a differentiated assessment of the motor fitness of younger grade students. Both speed and speed-strength indices take into account the appropriate values of the ratio of the morphological and functional indicators of school students, because of this, a downward deviation of these values can be evidence of a low level of functional capabilities as an indicator of physical condition (Tables 1, 2).

Table 1. Speed Index (SI) assessment for children and adolescents, c. u. (according to Krutsevych et al., 2011)

Functional level				
High	**Above average**	**Average**	**Below average**	**Low**
4.3	4.2–3.9	3.8–3.5	3.4–3.1	3

Table 2. Speed-Strength Index (SSI) assessment for boys, c. u. (according to Krutsevych et al., 2011)

Age, years	Functional level				
	High	**Above average**	**Average**	**Below average**	**Low**
7 to 10	1.11	1.1–1.01	1.0–0.91	0.9–0.81	0.8
11 to 15	1.26	1.25–1.16	1.15–1.07	1.06–0.96	0.95
16 to 17	1.31	1.3–1.21	1.2–1.11	1.1–1.01	1.0
18 to 20	1.41	1.4–1.31	1.3–1.21	1.2–1 .11	1.1

Statistical analysis

The study used IBM SPSS 26 software application. The following parameters were calculated: arithmetic mean value (X), standard deviation, which characterizes the variability of the characteristic (S), independent samples t-test, and Mann-Whitney U-test. The hypothesis of equality of variances for the compared groups was determined using Levene's test.

Results

Tables 3–10 provide the data of the statistical analysis of the features of the manifestation of speed abilities in the younger grade boys who attend a sports class of kyokushinkai karate.

Table 3 shows a differentiated assessment of the development of speed and speed strength in younger boys depending on their anthropometric measures (body length). Comparison of the obtained values with the tabular data of Krutsevych, Vorobiov & Bezverkhnia (2011) makes it possible to conclude that the boys of all age categories have above average, average, below average, and low levels. It should be noted that a high level of normative differentiated assessment of the development of speed relative to body length is not observed in boys aged 7 and 8. Moreover, all group samples did not fall into the low level category, except for boys aged 7 with a percentage of 26.7%. The great bulk of the children (85%) was distributed in the SI according to levels as follows: above average (26.7%), average (31.7%), and below average (26.7%). The distribution is somewhat different in the SSI: 70% of the children fell into the categories of above average (36.7%) and average (33.3%) levels. The analyzed indices show that the children develop harmoniously and have a sufficient level of development of speed abilities.

The improvement of motor abilities with age and the effect of the body length of the children on their results are clearly visible. Guided by the obtained index data, it is possible to implement the person-centered approach, which contributes to the prerequisites for the development of the best motor mode in the process of developing motor abilities. This motivates younger children to develop motor skills during training sessions.

To choose a statistical method for the review of average values, variances in the groups were first compared using Levene's test of equality of variances. Depending on the level of significance, the parametric independent samples t-test (Tables 4, 7, 9) or the non-parametric Mann-Whitney U-test (Tables 5, 6, 8, 10) were chosen as the basis for calculations.

The calculated significance levels of empirical t-tests demonstrate that there are statistically significant differences ($p<0.05$) in almost all data between the groups of boys aged 7 and 8.

The age-specific characteristics of these children affect their level of speed in integral movements "30 m running

Table 3. Distribution of boys according to the level of development of speed abilities

Indices	Age	Functional level, %				
		High	Above average	Average	Below average	Low
Speed (SI)	7	–	20.0	33.3	20.0	26.7
	8	–	33.3	26.7	40.0	–
	9	13.3	33.3	33.3	20.0	–
	10	20.0	20.0	33.3	26.7	–
Speed-strength (SSI)	7	26.7	46.7	20.0	6.7	–
	8	6.7	46.7	40.0	6.7	–
	9	20.0	26.7	33.3	20.0	–
	10	26.7	26.7	40.0	6.7	–

Table 4. Analysis of the specific features of the manifestation of speed in boys aged 7 to 8

Test number	Investigated indicators	Test for independent samples							
		Levene's test		t-test for equality of means					
		F	p	t	p	Δx	Δs	95% confidence interval for the difference	
								Lower	Upper
1	30 m running from a standing start, s	5.172	0.031	2.596	0.015	0.680	0.262	0.143	1.217
2	Standing long jump, cm	0.032	0.86	-2.787	0.009	-8.933	3.205	-15.499	-2.368
3	Shuttle run 4×9 m, s	5.363	0.028	3.795	0.001	0.893	0.235	0.411	1.375
4	Falling Dietrich's stick grasp, cm	2.198	0.149	3.209	0.003	4.267	1.33	1.543	6.991
5	Rope jumping, times	0.525	0.475	-3.351	0.002	-3.933	1.174	-6.338	-1.529
6	Speed side kicks, (Cres)	1.903	0.179	-1.053	0.301	-0.027	0.025	-0.079	0.025
7	Speed Index, (SI)	2.185	0.150	-1.411	0.169	-0.200	0.142	-0.490	0.090
8	Speed Strength Index, (SSI)	0.014	0.908	-1.163	0.255	-0.036	0.031	-0.099	0.027
	Equal variances are assumed								

Table 5. Analysis of the specific features of the manifestation of speed in integral movements (30 m running) in boys aged 7 to 8

Summary of the Mann-Whitney U-test for independent samples	
Total	30
Mann-Whitney U value	62.000
Wilcoxon W value	182.000
Test statistics	62.000
Standard error	24.055
Standardized test statistics	-2.099
Asymptotic significance (2-tailed test)	.036
Exact significance (2-tailed test)	.037

Table 6. Analysis of the specific features of the manifestation of the general motor function of the body and resistance to tempo changes (shuttle run 4x9 m) in boys aged 7 to 8

Summary of the Mann-Whitney U-test for independent samples	
Total	30
Mann-Whitney U value	48.000
Wilcoxon W value	168.000
Test statistics	48.000
Standard error	24.058
Standardized test statistics	-2.681
Asymptotic significance (2-tailed test)	.007
Exact significance (2-tailed test)	.007

from a standing start" (p=.037), in speed-strength abilities "Standing long jump" (p=.009), in the general motor function of the body and resistance to tempo changes "Shuttle run 4x9 m" (p=.007), in the latent time of a simple motor response "Falling Dietrich's stick grasp" (p=.003), and in the frequency of unloaded movement "Rope jumping" (p=.002).

In the test "Speed side kicks on rackets with a partner in running around the cones following an S-shaped path" (side kicks – SK), which characterizes the manifestation of the frequency of a single movement in the boys of this category, the obtained data do not differ statistically significantly (p=.301). No significant differences were observed between the speed and speed-strength indices in these age groups (p=.169; p=.255, respectively).

The ascertaining experiment revealed great statistically significant age-specific differences in children aged 8 and 9 based on the results of the tests "30 m running from a standing start" (p=.004), "Shuttle run 4x9 m" (p=.006), "Falling Dietrich's stick grasp" (p=.001), "Rope jumping" (p=.039), and "SK" (p=.044).

Table 8. Analysis of the specific features of the manifestation of speed-strength abilities (standing long jump) in boys aged 8 to 9

Summary of the Mann-Whitney U-test for independent samples	
Total	30
Mann-Whitney U value	158.500
Wilcoxon W value	278.500
Test statistics	158.500
Standard error	24.085
Standardized test statistics	1.910
Asymptotic significance (2-tailed test)	.056
Exact significance (2-tailed test)	.056

Table 7. Analysis of the specific features of the manifestation of speed in boys aged 8 to 9

Test for independent samples									
Test number	Investigated indicators	Levene's test		t-test for equality of means				95% confidence interval for the difference	
		F	p	t	p	Δx	Δs	Lower	Upper
1	30 m running from a standing start, s	0.013	0.91	4.87	0.004	1.013	0.208	0.587	1.44
2	Standing long jump, cm	4.987	0.034	-2.305	0.029	-9.6	4.165	-18.131	-1.069
3	Shuttle run 4x9 m, s	0.201	0.657	3.002	0.006	0.647	0.215	0.205	1.088
4	Falling Dietrich's stick grasp, cm	2.766	0.107	4.313	0.001	4.867	1.128	2.555	7.178
5	Rope jumping, times	1.238	0.275	-2.167	0.039	-3.2	1.477	-6.225	-0.175
6	Speed side kicks, (Cres)	3.247	0.082	-2.110	0.044	-0.085	0.041	-0.168	-0.002
7	Speed Index, (SI)	0.01	0.922	-3.746	0.001	-0.473	0.126	-0.732	-0.214
8	Speed Strength Index, (SSI)	0.585	0.451	-0.898	0.377	-0.029	0.033	-0.096	0.038
	Equal variances are assumed								

Table 9. Analysis of the specific features of the manifestation of speed in boys aged 9 to 10

Test number	Investigated indicators	Test for independent samples							
		Levene's test		t-test for equality of means					
		F	p	t	p	Δx	Δs	95% confidence interval for the difference	
								Lower	Upper
1	30 m running from a standing start, s	5.044	0.033	2.404	0.023	0.44	0.183	0.065	0.815
2	Standing long jump, cm	3.258	0.082	-2.38	0.024	-10.2	4.286	-18.98	-1.42
3	Shuttle run 4x9 m, s	0.92	0.346	1.811	0.081	0.373	0.206	-0.049	0.796
4	Falling Dietrich's stick grasp, cm	0.466	0.501	2.352	0.026	2.867	1.219	0.37	5.363
5	Rope jumping, times	1.159	0.291	-5.309	0.001	-10.4	1.959	-14.413	-6.387
6	Speed side kicks, (Cres)	0.058	0.811	-0.997	0.327	-0.047	0.047	-0.143	0.049
7	Speed Index, (SI)	0.137	0.714	-0.937	0.357	-0.120	0.128	-0.382	0.142
8	Speed Strength Index, (SSI)	0.760	0.391	-0.586	0.563	-0.019	0.032	-0.084	0.047
	Equal variances are assumed								

In the "Standing long jump" test, which characterizes speed-strength abilities, the boys aged 8 do not statistically differ from those aged 9 (p=.056). We believe that boys do not have enough strength to perform a powerful muscular effort of a reactive-explosive nature. Moreover, jumping requires a higher level of neuromuscular coordination.

The karatekas aged 10 demonstrate a higher level of speed fitness than those aged 9. Statistical data processing revealed significant differences in test results. The largest differences are observed in the values of the following tests: "30 m running from a standing start" (p=.041), "Standing long jump" (p=.024), "Falling Dietrich's stick grasp" (p=.026), and "Rope jumping" (p=.001).

Table 10. Analysis of the specific features of the manifestation of speed in integral movements (30 m running) in boys aged 9 to 10

Summary of the Mann-Whitney U-test for independent samples	
Total	30
Mann-Whitney U value	63.000
Wilcoxon W value	183.000
Test statistics	63.000
Standard error	23.991
Standardized test statistics	-2.063
Asymptotic significance (2-tailed test)	.039
Exact significance (2-tailed test)	.041

No statistically significant differences were found between the samples of boys aged 9 and 10 based on the results of testing of all other types of manifestation of speed abilities (p>0.05). The age-specific characteristics of the boys of these groups do not affect the level of the general motor function of the body, resistance to tempo changes (p=.081), and the frequency of a single movement (p=.227).

In the "Shuttle run 4x9 m" test, the braking speed is important, which is characterized by a quick stop and an instant change in the direction of movement. Physical development of the boys is gradually accelerating, growth processes are becoming more active, but weight gain is still lagging behind. This may result in clumsiness of the stature, disproportionality, and coordination of movements decreases in children.

Summarizing the results of the study, it can be stated that an increase in the speed of movements for younger grade students practicing karate is natural in ontogenesis.

Discussion

It was assumed that the study of the specific features of the manifestation of various speed components in younger grade karate boys can facilitate the development of correct training programs and talent identification by coaches, physiologists, sports scientists, sports doctors and sports performance researchers who work with young athletes of various categories.

The implementation of new sports modules will make it possible to increase children's interest in physical education classes and develop their interest in sports, teach physical education teachers modern approaches and improve their pedagogical skills (Marchenko & Taranenko, 2020; The comprehensive New physical education program, 2021; Pedan, Kolomoiets, Boliak, and others, 2022). Our studies comple-

ment the findings of Marchenko & Kozar (2015), Marchenko & Handymov (2021), Pinto-Escalona, Gobbi, Valenzuela et al. (2021) about the need to involve children as much as possible in mass and sports activities in out-of-class and out-of-school work.

The analysis of the obtained average values of the karate athletes confirms a higher level of speed abilities compared to children of these age categories who do not practice any sports activities (Marchenko, 2008; Marchenko & Holubov, 2015; Herrmann, Heim & Seelig, 2019).

The conducted study also shows that the level of speed fitness of karatekas can be assessed using a set of simple tests (Martinez-de-Quel, Alegre, Castillo-García & Ayán, 2021). They are easy to perform and their informativeness and reliability have been confirmed by many studies (Chaabène, Hachana et al., 2012; Marchenko & Verdysh, 2021). Taking the test results as a basis, coaches and teachers obtain the necessary useful information for further planning of the academic process with children in accordance with the individual characteristics of the organism.

The obtained results expand and complement the data of Ivashchenko, Berezhna & Cieślicka (2020), Litvin & Marchenko (2021), Minenko & Marchenko (2021) on the need to improve the motor fitness of school students as a condition for improving the learning process (Marchenko, 2007; Khudolii, Kapkan, Harkusha et al., 2020). Speed fitness plays a central role in the education of boys aged 7 to 10, and it makes it possible to increase the effectiveness of the education process. Quick application of force and a high level of mechanical power are important for young karatekas, as they allow to perform quick and explosive movements, kicks and punches, i.e., the basic skills necessary for success in karate (Martinez-de-Quel, Alegre, Castillo-García & Ayán, 2021).

Conclusions

The analysis of State programs makes it possible to conclude that the entire system of physical education and mass sports needs an urgent reboot. There is a need to introduce up-to-date technologies in the teaching of motor actions and the development of physical abilities in various forms of work in physical education at school.

The review of scientific and pedagogical literature made it possible to identify the need to develop speed as a key factor in the effectiveness of young karatekas at the initial stage of training as well as to determine the main structural components of speed.

The obtained SI and SSI indices show that the majority of young grade karate boys develop harmoniously and have a sufficient level of development of speed abilities, and the improvement of speed abilities with age is clearly visible.

Statistically significant ($p<.05$) age-specific differences are observed in the speed in integral movements, in the latent time of a simple motor response, and in the frequency of unloaded movement between all the study groups; in speed-strength abilities between the groups aged 7-8 and 9-10; in the general motor function of the body between the groups aged 7-8 and 8-9; and in the frequency of a single movement between the groups aged 8-9.

No statistically significant differences ($p>.05$) were found when comparing the results in terms of speed-strength abilities between the samples aged 8-9; in the general motor function of the body between the samples aged 9-10; and in the frequency of a single movement in the groups aged 7-8 and 9-10.

Conflict of interest

All authors have read and approved the final version of the manuscript and declare no conflict of interest.

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Оцінка показників швидкості школярів, що займаються кіокушинкай карате

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 10 табл., 30 джерел.

Мета дослідження – визначити вікові особливості прояву відмінностей у швидкісній підготовленості хлопців молодших класів, які займаються в секції карате на спортивно-оздоровчому етапі.

Матеріали і методи. У дослідженні взяли участь 60 хлопців молодших класів (7-10 років). Їх розподілили на чотири групи: 7, 8, 9 і 10 років. В кожній віковій групі було по 15 учасників. Технічний рівень дітей відповідав учнівським ступеням 10-9 Кю (помаранчевий колір поясу). Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури, педагогічне спостереження, хронометраж навчальних завдань, тестування, педагогічний констатуючий експеримент, методи математичної статистики.

Результати. Спостерігаються статистично достовірні (p<,05) вікові розбіжності між усіма досліджуваними групами у швидкості в цілісних рухах 7-8 (p=,037), 8-9 (p=,004), 9-10 (p=,041), латентному часі простої рухової реакції (p=,003; p=,001; p=,026 відповідно) та частоти ненавантаженого руху (p=,002; p=,039; p=,001); між групами 7-8, 9-10 років у швидкісно-силових здібностях (p=,009; p=,024); 7-8, 8-9 років у загальній моториці тіла (p=,007; p=,006); 8-9 років у частоті одиночного руху (p=,044).

Висновки. За результатами індексів ІШ і ІШС більшість хлопців-каратистів молодшого шкільного віку розвиваються гармонійно і мають достатній рівень розвитку швидкісних здібностей, чітко простежується покращення результатів. Встановлено, що між дітьми існують відмінності за різними структурними одиницями швидкості, які відповідають віковим показникам і технічному рівню каратистів.

Ключові слова: хлопці, швидкісні здібності, кіокушинкай карате, школярі молодших класів.

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Influence of Strength Fitness Classes on the Development of Motor Abilities of High School Students

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Abstract

The purpose of study is to determine the effectiveness of the influence of strength fitness on the development of motor abilities of high school students.

Materials and methods. The study was conducted on the basis of secondary school No. 55 Kharkiv in several stages. During the study, two groups were created: experimental and control. The control and experimental groups included 10 boys of 10 grade each. In the control group, lessons were held on the module "Gymnastics" according to the thematic plan. And in the experimental group the lessons content included: strength fitness, stretching exercises and aerobic combinations. Special attention was paid to the preparation of muscles for performing the exercises of the main part of the lesson - strength training. Research methods: study, synthesis and comparative analysis of literature and other sources on the research issue; observation; questionnaires, diagnosis of well-being, activity, mood according to the WAM method, testing of motor readiness, methods of mathematical statistics.

Results. According to the study results, in the experimental group was found a probable improvement in the state of activity by 11.3 points ($p<0.01$) and mood by 12.7 points ($p<0.01$). This indicates the positive impact of strength fitness exercises, modern music accompaniment and the corresponding load on these indicators. In the control group under the program of the variable module "Gymnastics" we observed an improvement in strength abilities such as flexion and extension of the arms in the abutment position by 3.8 ($p<0.05$). Indicators of motor abilities of students in the experimental group at the end of the trial had probable shifts towards improvement: shuttle run 4×9 m by 0.9 sec. ($p<0.01$), flexion and extension of the arms in the abutment position by 3.9 times ($p<0.05$), flexion and extension of the arms in suspension by 1.5 times ($p<0.05$), bent suspension by 7.4 sec. ($p<0.001$), jump in length from the place by 7.4 cm ($p<0.05$), flexibility (torso inclination) by 3.1 cm ($p<0.001$).

Conclusions. The use of recreational fitness in physical education classes in high school students not only contributes to an increase in the level of motor abilities, but also improves the emotional state of students. Through a combination of physical education, aerobic exercise, stretching, strength fitness, breathing exercises, visualization, high school students noted an improvement in well-being, mood, and activity.

Keywords: strength fitness, motor abilities, high school students.

Introduction

The current problem remains a decrease in motor activity and interest in physical education classes at school. This is determined in the observations and research of the leading scientists (Krutsevych, & Chervotoka, 2019; Khudolii et al., 2019; Bahinska, 2015). The study of the authors Moskalenko and Torbanyuk (2019) found that a significant number of schoolchildren have harmful habits (smoking, alcohol, drugs). All this leads to a decrease in the indicators of physical, mental, and social health of children in Ukraine.

Modern society requires the system of higher pedagogical education to train teachers who are ready to innovatively approach physical education lessons (Babiy, 2017; Tulaidan & Shelekhova, 2021).

There is a constant search for modern approaches to conducting physical education classes in secondary and higher education institutions (Sermeev et al., 2016; Kravchuk et al., 2017; Dubynska et al., 2021). Scientists study the dynamics of changes in the indicators of motor abilities according to the age of students and planned load (Marchenko & Kovalenko, 2020; Petrov et al., 2020; Sanzharova et al., 2019).

According to modern scientists Kravchuk and Kurochka (2013), Sinitsa and Lytovchenko (2022) fitness has become

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one of the popular areas of physical culture and health technologies, which are used in physical education classes among different segments of the population. The study of new forms of recreational fitness classes, the structure and content of classes is devoted to the scientific works of the authors Dubinska et al. (2019), Litvin et al. (2020).

In the scientific works of Lithus (2017), Moroz and Mykytyuk (2019), Golenkova et al. (2021), the positive impact of fitness classes on the indicators of physical development of a person, improvement of the functional state of the body of those engaged in the study of the structure, content of activities of various types of fitness were proved.

The issue of the influence of recreational fitness on the indicators of motor abilities of students in secondary education requires more detailed study, which contributed to the choice of the research topic.

The purpose of study is to determine the effectiveness of the influence of strength fitness on the development of motor abilities of high school students.

Materials and methods

Study participants

The study was conducted on the basis of secondary school No. 55 of Kharkiv in the period from October 2021 to September 2022. During the study, two groups were created: experimental and control. The control and experimental group included 10 boys of the 10th grade, who set themselves the goal of increasing the level of physical fitness, recovery, acquisition of strength and endurance. Study participants and their parents were warned about participation in the experiment and gave their consent.

Organization of the study

Research methods: study, synthesis and comparative analysis of literature and other sources on the topic of research; observation; questionnaires, diagnosis of well-being, activity, mood according to the WAM method, testing of motor readiness, methods of mathematical statistics.

The study was conducted in several stages.

The first stage involved the study and analysis of scientific literature, analysis of regulatory documents on the organization of physical education in school and other materials. We offered to take part in the trial to 10 high school boys, received consent from their parents and through a questionnaire selected types of fitness and wellness programs for physical education lessons. At this stage, the participants of the trial were surveyed to determine the level of interest in recreational fitness classes in physical education classes at school. According to the survey (questionnaire) for the experimental group, a thematic plan was developed, and the content was selected for lessons from the chosen direction of "strength fitness". The lessons also used elements of aerobics in the preparatory part and stretching in the preparatory and final part of the lesson.

In the control and experimental groups, physical education lessons were held 3 times a week for 45 minutes. In the control group, lessons were held in accordance with the thematic plan for the "Gymnastics" module. And in the experimental group the lessons included: strength fitness, stretching exercises and aerobic combinations. And in the experimental group the lessons content included: strength fitness, stretching exercises and aerobic combinations. Strength programs in the experimental group included a set of strength exercises for all muscle groups:

- without weights;
- with stuffed balls;
- with rubber band;
- circular training;
- exercises in pairs;

The second stage was devoted to generalizing, comparing, and processing the obtained data using methods of mathematical statistics, studying and investigation of the effects of recreational fitness classes on the motor abilities of high school students, formulating conclusions.

Statistical analysis

The statistical analysis application SPSS 20 was used to analyze the results of the study. Elementary statistics, t-test for paired and independent comparisons were calculated.

The study protocol was approved by the University Ethics Committee. In addition, children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed consent document was received from all parents.

Results

Preliminary testing of students revealed an average level of physical fitness of the studied control and experimental groups. For the experimental group, a thematic plan for strength fitness classes was developed. The structure of each lesson consisted of three parts:

Preparatory part (aerobic exercises, stretching exercises – prestretching).

The main part consisted of five sets of strength training exercises, which were carried out consistently depending on the complexity of the exercises and the level of physical activity.

The final part (stretching exercises – deep stretching, meditation, visualization, breathing exercises).

Exercises for each lesson were selected considering the level of physical fitness of high school students.

At the beginning and at the end of the study, a questionnaire for the WAM test (well-being, activity, mood) was carried out to diagnose the prompt assessment of well-being, activity, and mood among the subjects of the control and experimental groups. At the beginning of the study, in the control and experimental group, we observed average assessments of the psycho-emotional state of students, namely well-being, activity and mood. This indicates that the students were not tired and were ready for a physical education lesson. And the data obtained in both groups did not differ statistically from each other (Table 1).

At the end of the trial, a repeated questionnaire was carried out, which revealed certain changes in the scores according to the WAM tests, both in the control and in the experimental group. Students who were engaged in gymnastics classes stated improvement of their psycho-emotional states.

Table 1. WAM test indicators of the control (n=10) and the experimental group (n=10) at the beginning of the trial

Indicators	At the beginning of classes CG	At the beginning of classes EG	t	p
Wellbeing, points	39.9 ± 1.94	37.9 ± 1.94	0.6	>0.05
Activity, points	39.7 ± 1.84	36.6 ± 2.12	1.1	>0.05
Mood, points	43.3 ± 3.60	41.8 ± 2.68	0.3	>0.05

As a result, we obtained an improvement in the assessment of well-being by 1.6 (p>0.05), mood – by 0.3 (p>0.05), activity – by 3.6 (p>0.05), but their increase is statistically unreliable (Table 2).

Table 2. The WAM test indicators of the test subjects of the control group at the beginning and end of the trial (n=10)

Indicators	Before	After	t	p
Wellbeing, points	39.9 ± 1.94	41.5 ± 2.07	0.6	>0.05
Activity, points	39.7 ± 1.84	43.3 ± 2.04	1.3	>0.05
Mood, points	43.3 ± 3.60	43.6 ± 2.59	0.1	>0.05

At the same time, the experimental group showed a likely improvement in the state of activity by 11.3 (p<0.01), and mood by 12.7 (p<0.01). This indicates the positive impact of strength fitness exercises, modern musical accompaniment, and the corresponding load on these indicators (Table 3).

Table 3. The WAM test indicators of subjects from the experimental group at the beginning and end of the trial (n=10)

Indicators	Before	After	t	p
Wellbeing, points	37.9 ± 2.63	41.7 ± 2.83	1.0	>0.05
Activity, points	36.6 ± 2.12	47.9 ± 2.14	3.8	<0.01
Mood, points	41.8 ± 2.68	54.1 ± 2.31	3.5	<0.01

When comparing the results according to the WAM test, we obtained a probable difference in mood indicators between the control and experimental groups (p<0.01) (Table 4).

During the study, a comparative analysis of the dynamics of changes in the indicators of motor abilities was also carried out in the experimental and control groups, as a result of the influence of strength fitness and gymnastics, respectively. This comparison made it possible to reveal the effectiveness of physical education lessons using different means.

As a result of the study of the control group under the program of the variable module "Gymnastics", we observed an improvement in strength abilities such as flexion and extension of the arms in the abutment at 3.8 (p<0.05), which is probable (Table 5).

In addition, other indicators of motor abilities improved: shuttle run 4×9 m by 0.5 sec. (p>0.05), flexion and extension of the arms in suspension by 0.9 times (p>0.05), bent suspension by 3.7 sec. (p>0.05), a jump in length from the place by 2.2 cm (p>0.05), flexibility (torso inclination) by 1.7 cm (p>0.05), but these indicators are not reliable (Table 5.).

Indicators of motor abilities of students in the experimental group at the end of the trial had probable shifts towards improvement: shuttle run 4×9 m by 0.9 sec. (p<0.01), flexion and extension of the arms in the abutment position by 3.9 times (p<0.05), flexion and extension of the arms in suspension by 1.5 (p<0.05), bent suspension by 7.4 sec. (p<0.001), jump in length from the place by 7.4 cm (p<0.05), flexibility (torso inclination) by 3.1 cm (p<0.001) (Table 6.).

Table 4. The WAM test indicators of the control (n=10) and experimental groups (n=10) at the end of the trial

Indicators	At the end of the classes CG	At the end of the classes EG	t	p
Wellbeing, points	41.5 ± 2.07	41.7 ± 2.83	0.1	>0.05
Activity, points	43.3 ± 2.04	47.9 ± 2.14	1.6	>0.05
Mood, points	43.6 ± 2.59	54.1 ± 2.31	3.0	<0.01

Table 5. Indicators of the level of development of motor abilities of the subjects from control group at baseline and end of study (n=10)

Indicators	Before	After	t	p
1. Shuttle run 4×9 m. (sec.)	11.1 ± 0.17	10.6 ± 0.16	2.1	>0.05
2. Flexion and extension of the arms in the abutment position (number of times)	12.2± 1.17	16.0 ± 1.09	2.4	<0.05
3. Flexion and extension of the arms in suspension (number of times)	7.4 ± 0.63	8.3 ± 0.52	1.1	>0.05
4. Bent suspension (sec.)	15.7 ± 1.60	19.4 ± 1.87	1.5	>0.05
5. Jump in length from place (cm)	196.2 ± 1.83	198.4 ± 1.29	1.0	>0.05
6. Torso inclination (cm)	2.3 ± 0.57	4.0 ± 0.52	2.2	>0.05

Table 6. Motor ability indicators of the subjects from experimental group at the beginning and end of the trial under the programm of "Strenght Fitness" (n=10)

Indicators	Before	After	t	p
1. Shuttle run 4×9 m. (sec.)	11.4 ± 0.14	10.5 ± 0.16	4.3	<0.01
2. Flexion and extension of the arms in the abutment position (number of times)	10.3± 0.93	14.2 ± 0.95	2.9	<0.05
3. Flexion and extension of the arms in suspension (number of times)	8.5 ± 0.36	10.0 ± 0.31	3.1	<0.05
4. Bent suspension (sec.)	16.7 ± 1.01	24.1 ± 0.94	5.4	<0.001
5. Jump in length from place (cm)	194.6 ± 2.35	202.0 ± 2.01	2.4	<0.05
6. Torso inclination (cm)	2.1 ± 0.40	5.2 ± 0.38	5.6	<0.001

Thus, the complexes of exercises of strength fitness, stretching, aerobic combinations were aimed at the development of all motor abilities, and especially at the development of strength and flexibility.

Discussion

The conducted trial suggested an improvement in a few indicators of motor abilities, an improvement in the psycho-emotional state of high school students. As a result of conducting physical education classes in high school by means of health-improving fitness, we observed likely shifts towards improving the indicators of strength testing, flexibility, and agility. At the same time, students noted an increase in mood.

We received confirmation of studies of Khudolii et al. (2012, 2019) on the peculiarities of the development of strength abilities in high school boys, namely the ability of students to develop strength abilities.

The obtained data complement the results of the study of Kravchuk et al. (2017) on the positive impact of the use of health fitness on the development of physical abilities of high school students.

In contrast to the studies of Dubynska et al. (2019), which studied the influence of mental fitness on the psycho-emotional state of high school girls, the influence of the use of mental fitness elements on the psycho-emotional state of high school boys was studied.

Conclusions confirmed the study of Lithus (2017) on the effectiveness of various forms of strength fitness classes with high school students, the need for the development of strength abilities for the general physical fitness of young men has been proven.

Conclusions

The use of recreational fitness in physical education classes in high school students not only contributes to an increase in the level of motor abilities, but also improves the emotional state of students. Through a combination of physical education, aerobic exercise, stretching, strength fitness, breathing exercises, visualization, high school students noted an improvement in well-being, mood, and activity.

Conflict of interest

The authors declare that there is no conflict of interest.

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Вплив занять силовим фітнесом на розвиток рухових здібностей учнів старших класів

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 6 табл., 21 джерело.

Мета дослідження полягає у визначення ефективності впливу занять силовим фітнесом на розвиток рухових здібностей старшокласників.

Матеріали і методи. Дослідження проводилося на базі ЗОШ № 55 м. Харків у декілька етапів. У ході дослідження було створено дві групи: експериментальна та контрольна. До контрольної та експериментальної групи увійшли по 10 хлопців 10 класу. В контрольній групі проводились уроки за модулем «Гімнастика» згідно тематичного плану. А в експериментальній групі проводились уроки, до змісту яких були включені: силовий фітнес, вправи стречінгу та аеробні комбінації. Особлива увага приділялася підготовці м›язів до виконання вправ основної частини уроку – силового тренінгу. Методи дослідження: вивчення, синтез та порівняльний аналіз літератури та інших джерел за темою дослідження; спостереження; анкетування, діагностика самопочуття, активності, настрою за методикою САН, тестування рухової підготовленості, методи математичної статистики.

Результати. За результатами дослідження було виявлено в експериментальній групі, вірогідне покращення стану активності на 11,3 бали ($p<0,01$) та настрою на 12,7 балів ($p<0,01$). Що свідчить про позитивний вплив вправ силового фітнесу, сучасного музичного супроводу та відповідного навантаження на ці показники. В контрольній групі за програмою варіативного модулю «Гімнастика» ми спостерігали покращення силових здібностей таких як, згинання та розгинання рук в упорі лежачи на 3,8 ($p<0,05$). Показники рухових здібностей учнів експериментальної групи наприкінці експерименту мали вірогідні зрушення в бік покращення: човниковий біг 4×9 м на 0,9 сек. ($p<0,01$), згинання та розгинання рук в упорі лежачі на 3,9 раз ($p<0,05$), згинання та розгинання рук у висі на 1,5 рази ($p<0,05$), вис на зігнутих руках на 7,4сек. ($p<0,001$), стрибок у довжину з місця на 7,4см ($p<0,05$), гнучкість (нахил тулуба) на 3,1см ($p<0,001$).

Висновки. Використання оздоровчих видів фітнесу на уроках фізичної культури в учнів старших класів сприяє не тільки підвищенню рівня показників рухових здібностей, а й покращує емоційний стан учнів. Завдяки поєднанню на уроці фізичної культури аеробних вправ, стречингу, силового фітнесу, дихальних вправ, візуалізації учні старших класів відмітили покращення самопочуття, настрою та підйом активності.

Ключові слова: силова підготовленість, рухові здібності, старшокласники.

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Effectiveness of Inclusive Physical Education Classes on the Ability to Perform Rhythmic Activities of Students With Disabilities

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Abstract

The purpose of the study was to reveal the effectiveness of inclusive physical education classes on the ability to perform rhythmic activities and the state of health of students with disabilities in the process of implementing a differentiated physical education program.

Materials and methods. The experiment was attended by 30 students with disabilities. To determine the effectiveness of the differentiated program of physical education for students with disabilities, pedagogical testing has been used.

Results. According to the results of the experiment, it was established that the use of the developed differentiated program of physical education for students with disabilities made it possible to improve the level of ability to perform rhythmic activities during the period of the experiment. It was established that the implementation of the content of the test control provided by the differentiated program during the physical education of students with disabilities provides a positive effect (at the level of $p<0.05$) in solving the tasks, as evidenced by the test results. In conclusion, the average values with which the level of physical education correlates with health, of which corresponded to the "low" level, passed into the range of values that correspond to "below average" (72.4%), in others, indicators of physical health showed a tendency to improve.

Conclusions. It was determined that a special role in the context of solving the issue of inclusive education in institutions of higher education is assigned to physical education, which is aimed at eliminating existing negative trends in the physical development and health of students with disabilities. The analysis of the final data at the end of the experiment testifies to the benefit of the implemented development of pedagogical actions, which proves the need for the introduction of innovations, and fundamentally new approaches to the formation of programs of inclusive physical education based on a differentiated approach.

Keywords: inclusive, physical education, students with disabilities, health, ability to rhythmic activity, program.

Introduction

Ensuring the opportunity for students with disabilities to obtain quality education following their characteristics, needs, and opportunities is one of the key priorities of modern Ukrainian social and educational policy (Bondar, 2019). This question is considered in the national context, as it concerns the category of citizens who in the future should form the basis of the productive forces of society. In any country based on humanistic and democratic principles, human health is the highest value, the most important asset of the state, it is an indisputable priority, a guarantee of the sustainability and progress of society (Ainscow, 2020). Today, when the number of students with disabilities is constantly growing due to the long-term hostilities on the territory of Ukraine, the problem of their inclusion in the educational space of a higher school is extremely urgent.

There is no doubt that the process of inclusion of students with disabilities is complex and dynamic (Baglieri & Bacon, 2020), lasts throughout the study, and a prominent place in this process is given to physical education (PE) as a factor in realizing their physical development and improving health in learning conditions (Lidor & Hutzler, 2019). Inclusive PE, based on humanistic and democratic principles, positions the health of participants in the educational process as an indisputable priority (Overton, Wrench & Garrett, 2016).

In the literature, scientists are actively researching various aspects of the organization and functioning of inclusive PE. If the concept of inclusion is transferred to the field of PE, then inclusive PE is interpreted as providing additional support to students who, for one reason or another, cannot take an active and meaningful part in the educational process

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(Block & Obrusnikova, 2007). In scientific works, inclusive PE is considered a pedagogical process aimed at eliminating existing negative trends in the physical development and health of students with disabilities (Morley, Bailey, Tan & Cooke, 2005; Tant & Watelain, 2016).

According to the analysis, PE in higher education is positioned as the main means of creating an opportunity for students with disabilities to obtain a certain amount of knowledge and skills to apply in practice to counteract health disorders, aimed at improving social, mental, emotional, and physical measurements (Overton, Wrench & Garrett, 2016; Udych, 2018).

In scientific sources (Lidor & Hutzler, 2019; Smith, 2004; Tant & Watelain, 2016), attention is focused on the impact of PE classes on the motor and mental spheres of students with disabilities. The leading role of inclusive PE in the prevention of the progression of existing disorders in the state of health of students with disabilities, unsatisfactory state of health, as a consequence of adaptation to the learning process and subsequent appropriate correction of this process with adequate pedagogical means and methods has been proven (Barboza, Ramos, Abreu & Castro, 2019; Morley, Bailey, Tan & Cooke, 2005). In this context, the optimal organization of PE classes is relevant for solving the problem of health care in the process of studying in higher education (Fiorini & Manzini, 2018).

Scientists are united in the opinion (Bertills, Granlund, Dahlström & Augustine, 2018b; Ruscitti, Thomas & Bentley, 2017), that inclusive PE involves taking into account the maximum possible number of individual characteristics of students in the process of influencing their motor and mental spheres by means of PE to prevent the formation of inadequate adaptation in higher education institutions. The latter causes a decrease in the level of functioning of individual systems, the stress of regulatory mechanisms, and the loss of functional resources (Fiorini & Manzini, 2018). Accordingly, the result can be a deterioration in health, and therefore a general development different from the optimal one. It is also necessary to take into account the influence of several factors that caused students with disabilities to deviate from the norm by which specialists characterize health today, as a result of the introduction of quarantine security measures, and then martial law.

At the same time, the main priority of PE with students with special educational needs is the implementation of differentiated PE to individualize the process of PE (Blavt, 2022; Barboza, Ramos, Abreu & Castro, 2019; Iedynak et al., 2017). It is believed (Adilson et al., 2006; Gorla & Araujo, 2007), that the rational construction of the process of PE for ensuring the implementation of health improvement goals, requires systematic pedagogical and medical control over the physical development of students with disabilities, as well as the development of unified programs (Lidor & Hutzler, 2019; Smith, 2004) in the process of individual training, use of effective comprehensive assessment in accordance with the individual and gender characteristics of the body of students with disabilities (Ma, Wang & Wang, 2020).

At present, there is no comprehensive study of the indicators of PE influence on the correlation of disorders in the body of students with disabilities caused by the presence of a somatic disease, which greatly complicates the identification of regular trends and disease-related features of their changes.

The purpose of the study was to reveal the effectiveness of inclusive PE classes on the ability to perform rhythmic activities and the state of health of students with disabilities in the process of implementing a differentiated PE program.

Material and methods

Study participants

The research was conducted in the Department of PE of the National University "Lviv Polytechnic" during the one-year course of PE. 30 first-year students (an equal number of girls and boys) took part in the experiment. The study was conducted following the Helsinki Declaration of the World Medical Association (WMA-2013) WMA, Ethical Principles of Medical Research Involving Human Subjects.

PE of students with disabilities involves ethical issues and lengthy procedures. The sample size is determined by the number of enrolled students with disabilities. After they agreed to participate, consent was obtained from their classmates and PE teachers. The limited number of participants in this study suggests obtaining information about group patterns rather than significant values.

For the duration of the research, the research groups were formed on the principle of cluster analysis, with satisfaction of the requirements regarding the adequacy of the sample size at the probability level $p<0.05$. The number of students in the research groups is sufficient for the evidentiary evaluation of the results of the experiment.

Study organization

Methods of obtaining empirical data: pedagogical experiment, pedagogical testing, mathematical methods of processing digital arrays. An differentiated program of inclusive PE was used to conduct the empirical study. The defining difference of this program is the individualization of corrective and developmental means used in the process of PE of students with disabilities. The experiment was implemented during two academic semesters.

To control the level of development of the ability to perform rhythmic activities, the following tests were chosen:

"Clap your hands in a given rhythm": the student is left to repeat the given test exercise while preserving the rhythmic pattern. Overall assessment of the task in points.

"Walk with clapping your hands in a given rhythm": the test consists of one series of rhythmic tasks. After showing the test, the student should reproduce the clapping of the hands while walking. Evaluation in points for the performance of four tasks.

"Rhythmic tapping of your hands": indicators of rhythmic ability were determined and evaluated based on the results of performing rhythmic movements of the upper and lower limbs. The student stood in the corner of the sports hall facing the wall so that with straightened arms and legs it was possible to reach each of the two walls. On command, student performed a rhythmic cycle of movements for 20 seconds. The number of correctly performed complete cycles of rhythmic movements was determined.

"Rhythmic movements of the upper and lower limbs": the student must repeat the hand movements shown by the teacher in rhythm. The number of completed cycles in 20 seconds is estimated.

Correlation analysis proved the existence of relationships between the accuracy indicators of the reproduction of individual rhythms (Golle & Rymarcewicz, 2021; Gorla & Araujo, 2007; Hirtz, 1985). According to the results of the analysis, there is a strong statistical relationship between almost all indicators of the ability to perform the rhythmic activity, and the selected test exercises form a homogeneous complex (r_{tt} – 0.7–0.9).

The level of physical health (PHL) was determined by the sum of points proposed by H. L. Apanasenko: indicators of body weight, the vital capacity of the lungs (life Index), heart rate (ruffier index), blood pressure (index Robinson), hand dynamometry are used (strength index) (Hryban, 2008).

Statistical analysis

To characterize the results obtained, the indicators of descriptive statistics were used. The statistical significance of the results was determined using the methods of inductive statistics (Student's t-criterion). To determine the empirical reliability and validity coefficients of the tests, variance and correlation analysis were used. Quantitatively, the degree of reliability of the tests is expressed using the reliability coefficients, which are calculated using the intra-class correlation coefficient. The methods of mathematical statistics are used, it can be confirmed that the criteria of reliability adequately met.

All statistical analyzes were performed using SPSS Version 21. Results of descriptive statistics in this study were presented as percentages. The 0.05, 0.01 and 0.001 levels of probability were used to indicate statistical significance.

Results

We should note that in the proposed study of the implementation of a differentiated program, the key provisions were that regardless of the cause of the occurrence and development of the disease, the teacher's attention to students with disabilities during PE classes should be increased (Adilson et al., 2006; Fiorini & Manzini, 2018). First of all, this concerns the adequacy of the load parameters: they should be smaller for such students than for healthy ones, and also take into account the diagnosis (Lidor & Hutzler, 2019). Due to the fact that each student with disabilities has its dynamics and potential development opportunities, the implementation of the program's tasks depended on compliance with the set of PE tools used and the observance of hygienic principles in the organization of the educational process to the individual characteristics of the psychophysical development of students with disabilities. In the process of inclusive PE, we focused on the state of health of each specific student with a disability, taking into account the conclusions of medical examinations.

Our study took into account that one of the most important tasks of PE for students with disabilities is the development of motor function and the ability to control one's movements (Gorla & Araujo, 2007; Oliver et al., 2015). Therefore, it was considered appropriate to control the ability to perform rhythmic activities as a correlator of the development of coordination abilities of students with disabilities. It is also important that the sense of rhythm can be purposefully formed (Hirtz, 1985). In addition, the ability to perform rhythmic activities has a diagnostic ability: by monitoring their dynamics, it is possible to conclude the state of health of students to a certain extent (Gorla & Araujo, 2007). In addition, a high degree of development of the sense of rhythm determines the rapid mastery of new motor skills (Gorla, & Araujo, 2007).

The results of the testing conducted at the beginning of scientific research did not differ significantly, which is statistically confirmed ($p>0.05$) and indicates the homogeneity of the contingent of the studied sample of students (Tab. 1, 2). The lack of gender dependence in the development of a sense of rhythm among students with disabilities was experimentally proven ($p>0.05$). The majority of students complete the tests with satisfactory grades: 63.5% among boys and 65.7% among girls. A significant proportion of the studied sample of students was unable to pass the tests 21.3% among boys and 25.1% among girls at the beginning of the study.

At the end of the study, a small number of students with disabilities passed the tests with an "excellent" rating: 1.1% of boys and 1.5% of girls ($p<0.05$). There were no students with disabilities who were unable to perform the given tests. This effect is caused by at least several reasons: one of them is the low initial level of development of the functional characteristic of the sense of rhythm, and the other is the involvement in the implementation of the content of PE of mechanisms and systems of the body that require the involvement of various functional characteristics []. In general, positive changes in the indicators of students with disabilities according to the studied parameter testify to the improvement of the condition of the neuromuscular apparatus.

Table 1. Results of monitoring the ability to perform rhythmic activities (male)

Statistical parameters	Test tasks and measurement results							
	Clap your hands in a given rhythm (points)		Walk with clapping your hands in a given rhythm (points)		Rhythmic tapping of your hands (number of cycles)		Rhythmic movements of the upper and lower limbs (number of cycles)	
Period of the experiment	at the beginning	after	at the beginning	after	at the beginning	after	at the beginning	after
M	2.44	2.82	1.77	2.01	2.22	2.91	2.76	3.15
S	1.15	1.03	0.81	0.86	1.18	1.01	1.33	1.58
V (%)	44.5	46.8	52.3	49.4	37.5	48.4	58.1	41.2
reliability	0.899	0.913	0.723	0.789	0.811	0.867	0.766	0.818

Table 2. Results of monitoring the ability to perform rhythmic activities (girls).

Statistical parameters	Test tasks and measurement results							
	Clap your hands in a given rhythm (points)		Walk with clapping your hands in a given rhythm (points)		Rhythmic tapping of your hands (number of cycles)		Rhythmic movements of the upper and lower limbs (number of cycles)	
Period of the experiment	at the beginning	after	at the beginning	after	at the beginning	after	at the beginning	after
M	2.81	3.01	1.93	2.15	2.11	2.77	2.55	2.98
S	1.33	1.41	0.99	1.02	1.02	0.95	1.40	1.69
V (%)	42.1	41.6	48.7	50.1	40.1	43.8	49.8	40.5
reliability	0.721	0.871	0.788	0.811	0.803	0.875	0.791	0.831

Table 3. Results of physical health monitoring of students research group

Research stage /sex	Life Index	points	Strength Index	points	Index Robinson	points	Indicators of body weight	points	Ruffier Index	points	total PHL
up to/ boys	56.2±2.9	1	48.1±3.1	0	885.1±3.8	0	19.8±1.3	-1	8.1±1.1	2	2
after/boys	59.1±1.9	1	57.7±3.5	1	93.2±3.1	0	21.6±1.5	0	6.7±0.0	2	4
up to/ girls	42.4±2.7	0	41.1±3.2	0	92.7±5.2	0	21.1±2.3	0	7.4±1.2	2	2
after/ girls	47.1±2.1	1	53.9±3.1	1	87.7±3.1	0	19.3±1.4	0	6.8±1.1	2	4

*Note: PHL – level of physical health. The differences in the results are significant ($p<0.05–0.001$)

The results of the study showed that deficiencies in the development of the motor sphere, which is a consequence of the low level of physical development of students with disabilities, negatively affect the perception and reproduction of the given rhythm of performing motor actions. However, the development of the ability to perform rhythmic activities is determined by those biological and mental functions that may be physiologically impaired in students with disabilities due to the presence of certain deviations in the state of health. These violations, in turn, led to the inconsistency of various body functions, primarily motor, and the activity of other body systems (vestibular and visual analyzers, joint-muscle proprioception and higher departments of the central nervous system, etc.), which ensure the proper development of the sense of rhythm (Hirtz, 1985). In addition, the development of a sense of rhythm in many cases is determined by the strength of muscles, accordingly, this is their sharply expressed characteristic feature. Therefore, the testing process is accompanied by the difficulty of controlling the motor apparatus during rhythmic movement.

The study of the level of physical health (Tab. 3) showed, that during the experiment, boys and girls research group improved 2 of all 5 indicators of physical health, the others showed a tendency to improve.

Discussion

It was determined that the leading role of PE lies in the prevention of an unsatisfactory state of health of students, as a consequence of adaptation to the process of studying at universities (Koryahin et al., 2019). We support scientific approaches that PE as a powerful means of influencing the body, expands the range of opportunities, especially the motor area students with disabilities, affected by a persistent defect (Bertills et al., 2018b; Blavt et al., 2022).

Scientific data on the need to introduce special methods, pedagogical technologies, and differentiated programs into the process of inclusive PE have been expanded (Gorla & Araujo, 2007; Barboza et al., 2019). The research was based on the provisions (Serbetar, 2014; Zwierzchowska et al., 2004) about the dependence of the effectiveness of the PE process on taking into account the laws of rhythm, in a broad sense as the form of the course of certain processes in time, which is characterized by clearly defined temporal and spatial characteristics, and in a narrow sense as an integral characteristic of the technique of physical exercises (Schielke, 1989). It is a practically confirmed hypothesis that understanding and using in the process of PE psychological, biomechanical, physiological, and pedagogical regularities of the rhythm of exercises makes it possible to speed up the learning process.

The ability to perform rhythmic activity gradually changes with age, but to a greater extent depends on purposeful influence (Ivashchenko & Khudolii, 2016; Serbetar, 2014). In addition, under the age of 18, this ability can be purposefully influenced and developed (Hirtz, 1985). Therefore, we support the opinion of scientists that the control of this ability should take its proper place in the inclusive PE of students with disabilities (Gorla & Araujo, 2007; Dietz, 2002).

The sense of rhythm is quite specific (Winnick & Porretta, 2017), and its development is determined by the functional state of the nervous system, and its individual properties, at the same time it has a motor nature and depends on the sense of space, the sense of time, the sense of the accuracy of muscle efforts (Bertills et al., 2018b). The physiological basis of the development of the sense of rhythm is the individual features of the structure of the cerebral cortex, the level of development of sensory systems, the productivity of mental processes, and the ability to regulate the emotional state (Oliver et al., 2015; Serbetar, 2014). It is confirmed that the development of this ability in the process of inclusive PE

of students with disabilities is of considerable importance for improving their physical health.

Taking the above into account when forming and implementing the content of inclusive PE for students with disabilities will ensure an increase in its effectiveness in solving both the main and secondary, but also important tasks of improving health (Gorla & Araujo, 2007; Ruscitti et al., 2017). Information about changes in the functional characteristics of students with disabilities or those who exercise is important for PE teachers, as it allows them to adjust the content of this process to achieve the best positive result (Blavt, 2022; Iedynak et al., 2017; Morley et al., 2005).

The practical value of the obtained results lies in the fact that they indicate directions for improving the organization, and the content of PE of students with disabilities to increase their functional characteristics and improve the general state of health.

Conclusions

PE of students with disabilities due to a certain disease, at the current stage in higher education, is primarily considered inclusive – a social phenomenon, the main goal of which is to eliminate existing negative trends in the physical development and health of students with disabilities.

The importance of scientific developments in the field of inclusive PE is proven by information from literary sources and practical experience. The importance of developing and improving a sense of rhythm in the PE of students with disabilities is that they are a necessary prerequisite for the successful mastery of motor skills, which affect the pace, type and method of their acquisition, as well as further stabilization and situationally adequate diverse application.

Experimental verification of the differentiated program of inclusive PE proved its effectiveness. The practical implementation of the program ensured a positive effect of planned pedagogical corrective influences in the course of inclusive PE. The analysis of the final data at the end of the experiment testifies to the benefit of the implemented development of pedagogical actions since the studied indicators of the ability to perform rhythmic activities in students with disabilities are characterized by positive dynamics.

The results of the conducted research provide grounds for a conclusion regarding the possibility of purposeful correction by means of inclusive PE on the state of the ability to perform rhythmic activities of students with disabilities.

Conflicts of interest

No conflicts of interest exist.

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Ефективність інклюзивного фізичного виховання у розвитку здібності до ритмічної діяльності студентів з особливими освітніми проблемами

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 3 табл., 31 джерело.

Проблема організації інклюзивного фізичного виховання у закладах вищої освіти передбачає необхідність комплексного вивчення показників впливу фізичного виховання на кореляцію порушень в організмі, зумовлених наявністю соматичного захворювання.

Мета статті – виявити ефективність впливу занять інклюзивного фізичного виховання на здібність до ритмічної діяльності та стан здоров'я студентів з особливими освітніми проблемами у процесі реалізації диференційованої програми ФВ.

Матеріали та методи. У експерименті взяли участь 30 студентів Національного університету «Львівська політехніка» з особливими освітніми потребами, у рівній кількості хлопців та дівчат. Для визначення ефективності диференційованої програми інклюзивного фізичного виховання студентів з обмеженими можливостями використано педагогічне тестування.

Результати. Підсумками експерименту установлено, що застосування розробленої диференційованої програми фізичного виховання для студентів з особливими освітніми проблемами уможливило покращення впродовж періоду експерименту рівня здібності до ритмічної діяльності. Установлено, що реалізація передбаченого диференційованою програмою змісту тестового контролю у ході фізичного виховання студентів з особливими освітніми проблемами забезпечує позитивний ефект (на рівні $p<0,05$) у вирішенні поставлених завдань, про що свідчать результати тестування У підсумку, середні значення, з якими корелює рівень фізичного здоров'я, із таких, відповідали «низькому» рівню, перейшли у діапазон значень, які відповідають «нижчому за середній» (72,4 %), у інших показники фізичного здоров'я відзначалися тенденцією до поліпшення.

Висновки. Визначено, що особлива роль у контексті розв'язанні питання інклюзивного навчання у закладах вищої освіти відводиться фізичному вихованню, яке скероване на усунення наявних негативних тенденцій у фізичному розвитку та здоров›ї студентів з особливими освітніми проблемами. Аналіз підсумкових даних наприкінці експерименту свідчать

на користь упроваджених розробок педагогічних дій, що доводить необхідність впровадження нововведень, принципово нових підходів до формування програм інклюзивного фізичного виховання на основі диференційованого підходу/ Досліджено, що упровадження диференційованої програми забезпечує формування і вдосконалення рухових функцій, так от як здібності до ритмічної діяльності студентів з особливими освітніми проблемами, а, відтак, забезпечує певною мірою покращання стану фізичного здоров'я.

Ключові слова: інклюзія, фізичне виховання, студент з особливими освітніми проблемами, здоров'я, здібність до ритмічної діяльності, програма.

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Parameters of Physical Performance of Qualified Football Players in the Preparatory Period of Training

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Abstract

The purpose of the work: to determine the level of physical fitness of qualified football players in the preparatory period of the annual macrocycle based on test indicators for the formation of rational programs for their preparation for competitive activities.

Material and methods. Contingent: 25 qualified football players of MFC "Metalurg" (Zaporizhzhya): 15 athletes – application form "A" and 10 athletes – application form "B" of the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine. Methods: Analysis and systematization of data from scientific and methodical literature and the electronic resource of global information network "Internet"; pedagogical observations; pedagogical testing: PWC_{170} (Physical Working Capacity); Harvard Step-Test; pedagogical experiment of controlling orientation; methods of mathematical statistics.

Results. During the educational and training meetings, the test indicators had statistically significant differences in the direction of decreasing values of special physical capacity, from retractable microcycle to percussive microcycle ($p<0,05$): $aPWC_{170}$ – 1469.33 ± 50.11 and 1377.67 ± 49.11 ($kg•m•min^{-1}$), $rPWC_{170}$ – 20.87 ± 0.69 and 20.71 ± 0.71 (kgm•min-1•kg^{-1}), aVO_2 max – 4002.23 ± 115.23 and 3857.54 ± 117.34 ($ml•min^{-1}$), rVO_2 max – 61.57 ± 1.51 and 54.37 ± 1.67 ($ml•min^{-1}•kg^{-1}$), in accordance. Also, during the educational and training meetings, the test indicators had statistically significant differences in the direction of increment values of special physical capacity: from percussive microcycle to submersible microcycle ($p<0.05$): $aPWC_{170}$ – 1377.67 ± 49.11 and 1494.34 ± 51.78 ($kg•m•min^{-1}$), $rPWC_{170}$ – 20.71 ± 0.71 and 21.37 ± 0.85 ($kgm•min^{-1}•kg^{-1}$), aVO_2 max – 3857.54 ± 117.34 and 3997.09 ± 114.89 ($ml•min^{-1}$), rVO_2 max – 54.37 ± 1.67 and 63.67 ± 1.71 ($ml•min^{-1}•kg^{-1}$), in accordance.

Conclusion. The way to solve this problem is the proposed methodical approach, which allows, on the one hand, to comprehensively approach the solution of the issue of the complex orientation of the training process of qualified football players in the preparatory period of training, on the other hand, it provides for the differentiation of the team composition into typological groups of athletes, which allows to have a targeted influence on indicators of special physical capacity and technical and tactical potential of qualified football players.

Keywords: football, qualification, training, special physical capacity, functional readiness.

Introduction

The modern system of training qualified football players in the annual macrocycle assumes the main focus on the formation of basic mechanisms that ensure the manifestation of functional readiness and physical capacity. The construction of the training process for qualified football players is considered classic, when, in the preparatory period (Kokareva, Kokarev & Doroshenko, 2018), the foundations for the development and improvement of special motor skills are formed, the basis of functional readiness and physical capacity is formed (Lisenchuk, Zhigadlo, Tyshchenko, 2019). This is a necessary prerequisite for the effective implementation of the technical and tactical skills of football players in variable competitive activities (Mitova, 2020). It is also important to determine the current level of physical performance of

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qualified football players. Thus, issues of physical fitness in sports remain relevant while maintaining high competition between athletes and teams (Lisenchuk et al., 2023; Nurimov, 2021; Pertsukhov & Shalenko, 2021).

Individual issues of this issue have repeatedly been in the focus of researchers' attention. In particular, (Balsom, Hawkins, & Strudwick, 2022) emphasized the importance of rationalizing the physical training of modern elite football players for national and international competitions with an emphasis on avoiding physical overload according to the parameters of the intensity of special game exercises. At the same time, the issue of using models of maximum power exercises with dynamic external resistance is significant (Bergstrom et al., 2021). The researchers note (Permadi, 2019) that the development of models of physical and psychological training has an applied orientation – to increase the effectiveness of competitive activities in football and for modeling and analysis of specific physical capabilities of soccer players based on the training evaluation index (Li & Zeng, 2021). This situation creates the basis for a comparative analysis of the physical and anthropometric qualities of football players, which systematizes the search for sports talents in elite junior football (Woods et al., 2017) and regarding the physiological aspects of identifying sports talents in football (Dodd & Newans, 2018). Similar trends were recorded in the study, on the material of testing football players of other qualifications (Kaczorowska, Tota, & Pałka, 2022)

The issue of the relationship between indicators of physical performance and bioenergetic mechanisms of ensuring the playing activity of qualified football players is significant, they note (Lyzohub et al, 2020). This situation is reinforced by the variability of indicators of cumulative load and anaerobic power in youth elite football in the context of taking into account indicators of biological maturation of their organism (Nobari, Gorouhi & Mallo, 2023).

A significant group of researchers emphasizes the need to use the most rational approaches to planning significant physical exertion. Failure to comply with the methodological requirements for the ratio of volume and intensity of training loads can significantly increase the rates of injuries of the musculoskeletal system of qualified football players and the risks of the development of accompanying pathologies (Dambroz, Clemente & Teoldo, 2022; Doroshenko, 2015; Doroshenko et al., 2019; Garrett et al., 2019; Griffin et al.., 2020; Sirenko et al., 2022).

This problem is actualized in the context of the age-related development of athletes' bodies, psychophysiological features, gender differences, etc. (Chau, 2021; Hanapiah et al., 2020; Kalinowski et al., 2021). The accounting of this complex of issues allows us to state that the scientific problems related to the physical performance of qualified football players remain relevant and timely, and the implementation of the results of experimental studies will allow to increase the effectiveness of competitive activities (Hoff, 2005; Kapelman, Kızılet & Bozdogan, 2022).

The above allows us to assert the presence of a problematic situation, which contains a contradiction between the classical system of sports training of qualified football players in the annual macrocycle and the need to modify existing approaches to improving physical performance (Kostiukevych, Shchepotina & Vozniuk, 2020; Kostiukevich et al., 2017; Shchepotina et al., 2021).

Hypothesis. The study of indicators of the dynamics of the physical working capacity of qualified football players will contribute to the development of new approaches to improving their physical and functional fitness in the preparatory period of the annual training macrocycle.

The purpose of the work: to determine the level of physical fitness of qualified football players in the preparatory period of the annual macrocycle based on test indicators for the formation of rational programs for their preparation for competitive activities.

Material and methods

Participants

25 qualified football players of MFC "Metalurg" (Zaporizhzhya): 15 athletes – application form "A" and 10 athletes – application form "B" of the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine. Age range: 18-36. Term of preparatory training period: 09.03.2023 – 08.04.2023 (Morshyn of the Lviv region).

Methods of research

Analysis and systematization of data from scientific and methodical literature and the electronic resource of global information network "Internet"; pedagogical observations; pedagogical testing: PWC_{170} (Physical Working Capacity); Harvard Step-Test; pedagogical experiment of controlling orientation; methods of mathematical statistics.

Organization of research

Experimental studies were carried out during the preparatory period to the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine. The educational and training meetings of MFC "Metalurg" (Zaporizhzhya) contained 5 training microcycles: retractable microcycle (4 days); basic microcycle (7 days); percussive microcycle (7 days); restorative microcycle (7 days); submersible microcycle (6 days).

PWC_{170} (Physical Working Capacity). Athletes perform three consecutive workloads on a cycle ergometer. Begin by setting up subject on bike to ensure correct seat height (knee slightly bent at bottom of cycle). Place heart rate monitor on the subject. Check their exercise history to determine the starting workload (estimated to achieve a heart rate between 100-115). Start the test and measure heart rate each minute and continue for 3-4 minutes (until a steady heart rate is achieved). Continue the test for 2nd and 3rd workloads, set to achieve a HR between 115-130 and 130-145 beats per minute respectively. Each steady-state heart rate and workload are graphed, with the line of best fit for the three points extrapolated to estimate the workload that would elicit a heart rate of 170 beats per minute. This workload value then be compared to norms.

Harvard Step-Test. The football players steps up and down on the platform at a rate of 30 steps per minute (every two seconds) for 5 minutes or until exhaustion. Exhaustion is defined as when the athlete cannot maintain the stepping rate for 15 seconds. The football players immediately sits down on

Table 1. The scale of qualitative assessment of the level of indicators of PWC_{170} and VO_2 max of male athletes 18-35 years old (Malikov, Bogdanovs'ka, & Svatiev, 2006)

Level	PWC_{170}		VO_2 max	
	$aPWC_{170}$ (kg•m•min^{-1})	$rPWC_{170}$ (kgm•min^{-1}•kg^{-1})	aVO_2 max (ml•min-1)	rVO_2 max (ml•min^{-1}•kg^{-1})
Low	≤ 1067.50	≤15.25	≤ 3.50	≤ 50.00
Below average	1067.51 – 1294.50	15.26 – 18.49	3.51 – 3.85	50.01 – 54.99
Average	1294.51 – 1750.00	18.50 – 25.00	3.86 – 4.55	55.00 – 65.00
Above average	1750.01 – 1995.00	25.01-28.25	4.56 – 4.90	65.01 – 70.00
High	> 1995.00	> 28.25	> 4.90	> 70.00

completion of the test, and the total number of heart beats are counted between 1 to 1,5 minutes after finishing. This is the only measure required if using the short form of the test. If the long form of the test is being conducted, there is an additional heart rate measures at between 2 to 2,5 minutes, and between 3 to 3,5 minutes.

The results of testing the level of physical performance of qualified football players are differentiated into 5 levels in accordance with the data in the table 1.

During the experimental studies, the participants gave informed consent to the processing of personal data in accordance with the requirements of the Declaration of Helsinki of the World Medical Association "Ethical principles of medical research with the participation of a person as an object of research".

Statistical analysis

The obtained experimental materials were processed by the package of application programs "IBM SPSS Statistics" with the calculation of the following indicators: arithmetic mean (X); arithmetic mean error (S); σ – mean square deviation; Student's t-test, which is a test of the reliability of the normal distribution for equal and unequal samples with (n-1) degrees of freedom. Statistically reliable differences are accepted as significant at a 5% significance level of $p<0,05$.

Results

Experimental studies were carried out during the educational and training gathering of qualified football players of MFC "Metalurg" (Zaporizhzhya) taking into account the direction of training loads, which is presented in table 2.

The predominant focus of the training process is the comprehensive development of technical and tactical preparedness and physical capacity of qualified football players. The main task of the educational and training camp of qualified football players MFC "Metalurg" (Zaporizhzhya) is integral preparation for official competitions – to the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine.

Table 3 shows the indicators of the physical performance of qualified football players, which were recorded by control tests at the end of the retracting, impact and subduction microcycles in the preparatory period of training

Analysis of the dynamics of indicators of special physical performance of qualified footballers according to tests PWC_{170} and VO_2 max allows us to state that the proposed methodical approach is sufficiently effective. During the educational and training meetings, the test indicators (PWC_{170} and VO_2 max) had statistically significant differences in the direction of decreasing values of special physical capacity, from retractable microcycle to percussive microcycle ($p<0,05$): $aPWC_{170}$ – 1469,33 ± 50,11 and 1377,67 ± 49,11 (kg•m•min^{-1}), $rPWC_{170}$ – 20,87 ± 0,69 and 20,71 ± 0,71 (kgm•min^{-1}•kg^{-1}), aVO_2 max – 4002,23 ± 115,23 and 3857,54 ± 117,34 (ml•min^{-1}), rVO_2 max – 61,57 ± 1,51 and 54,37 ± 1,67 (ml•min^{-1}•kg^{-1}), in accordance.

Also, during the educational and training meetings, the test indicators had statistically significant differences in the direction of increment values of special physical capacity: from percussive microcycle to submersible microcycle

Table 2. Orientation of training loads of qualified football players of MFC "Metalurg" (Zaporizhzhya) in microcycles of the preparatory period, %

Types of sports training	Types of microcycles				
	retractable	basic	percussive	restorative	submersible
general physical training	15	15	10	0	0
special physical training	0	10	15	5	10
technical and tactical training	20	20	20	30	30
integrated training	0	0	0	30	35
psychological preparation	5	5	5	5	5
control game	40	30	30	0	0
MFR and stretching	5	5	5	10	5
restorative measures	5	5	5	10	5
theoretical training	5	5	5	5	5
testing	5	5	5	5	5
total	100	100	100	100	100

Table 3. Dynamics of indicators of physical performance of qualified football players MFC "Metalurg" (Zaporizhzhya), n=25

Tests & Indicators	Types of microcycles & Levels		
	retractable	percussive	submersible
$aPWC_{170}$ ($kg•m•min^{-1}$)	1469.33 ± 50.11 average	1377.67 ± 49.11* average	1494.34 ± 51.78** average
$rPWC_{170}$ ($kgm•min^{-1}•kg^{-1}$)	20.87 ± 0.69 average	20.71 ± 0.71* average	21.37 ± 0.85** average
aVO_2 max ($ml•min^{-1}$)	4002.23 ± 115.23 average	3857.54 ± 117.34* average	3997.09 ± 114.89** average
rVO_2 max ($ml•min^{-1}•kg^{-1}$)	61.57 ± 1.51 average	54.37 ± 1.67* average	63.67 ± 1.71** average

Notes: * – statistically significant differences between indicators at retractable and percussive microcycles (p<0,05); ** – statistically significant differences between indicators at percussive and submersible microcycles (p<0,05);

(p<0,05): $aPWC_{170}$ – 1377,67 ± 49,11 and 1494,34 ± 51,78 ($kg•m•min^{-1}$), $rPWC_{170}$ – 20,71 ± 0,71 and 21,37 ± 0,85 ($kgm•min^{-1}•kg^{-1}$), aVO_2 max – 3857,54 ± 117,34 and 3997,09 ± 114,89 (ml•min-1), rVO_2 max – 54,37 ± 1,67 and 63,67 ± 1,71 ($ml•min^{-1}•kg^{-1}$), in accordance.

In addition, during the retractable, basic and percussive microcycles, six control games were held:

- 11.03.2023. MFC "Metalurg" (Zaporizhzhya) – FC "Scala-1911" (Morshyn) – 1:0;
- 12.03.2023. MFC "Metalurg" (Zaporizhzhya) – FC "Mykolaiv" (Mykolaiv) – 0:2;
- 18.03.2023. MFC "Metalurg" (Zaporizhzhya) – FC "LNZ" (Chercasy) – 1:1;
- 22.03.2023. MFC "Metalurg" (Zaporizhzhya) – FC "Bukovina" (Chernivtsi) – 1:1;
- 24.03.2023. MFC "Metalurg" (Zaporizhzhya) – FC "Ruh" (Lviv) – 1:0;
- 25.03.2023. MFC "Metalurg" (Zaporizhzhya) – FC "Prykarpattya" (Ivano-Frankivsk) – 0:3.

As a result of the control games, the quantitative and qualitative indicators of the competitive practice of qualified footballers were taken into account: the level of the rival team (Premier League, I, II league, amateur team) and the main typological groups of athletes were determined (the main composition of the team; protocol lineup for the game; entry list for the competition).

As a result of the complex application of methods of developing technical and tactical preparedness and special working capacity of qualified footballers MFC "Metalurg" (Zaporizhzhya) in the preparatory period of training, a methodical approach has been determined that allows to effectively combine these areas during the training camp.

Thus, the methodical approach to the complex development of technical and tactical preparation and physical capacity of qualified football players MFC "Metalurg" (Zaporizhzhya), which is applied in the preparatory period of training qualified football players for official competitions to the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine, contains the following components:

- determination of a promising group of professional footballers to be included in the main team, taking into account game specialization;
- comparative analysis of quantitative and qualitative indicators of the level of competitive practice (national or international competitions; friendly or official; starting lineup or substitution; indicators of time played; chronological development of the game, etc.);
- differentiation of the team composition into typological groups with appropriate individualization of their training: main team (11 footballers); protocol squad for the game (18 footballers); application squad for the competition (25 footballers);
- special analysis, assessment and interpretation of indicators of competitive activity of footballers (performance, efficiency of technical and tactical actions in different zones of the playground, chronological segments of time, etc.);
- differentiated analysis, assessment and interpretation of indicators of competitive activity of footballers according to certain typological groups: the main composition of the team; protocol lineup for the game; entry list for the competition (efficiency, effectiveness of technical and tactical actions).

Discussion

In the experimental researchers, a scientific problem with elements of scientific novelty was raised: added data on the training of qualified football players (Hoff, 2005; Kaczorowska, et al., 2022), testing of their special physical performance indicators using instrumental methods: PWC_{170} and VO_2 max (Kokareva et al., 2018; Lisenchuk et al., 2019). Problematic issues concerning the adequacy of determining the indicators of special preparedness among young football players based on taking into account the age-related features of the development of their bodies have gained further development (Chau, 2021; Hanapiah et al., 2020; Kalinowski et al., 2021).

Modern scientific concepts regarding testing of functional readiness, development and improvement of special physical capacity of qualified football players have been expanded (Kostiukevych et al., 2020; Kostiukevich et al., 2017; Shchepotina et al., 2021).

In the course of experimental studies, it has been shown that long-term maximum physical exertion, including high-intensity test exercises, can provoke increased traumatism of the musculoskeletal system of athletes (Dambroz et al., 2022; Doroshenko, 2015; Doroshenko et al., 2019).

The researchers note that, in this context, the problems of interrelationship of the mechanisms of energy supply for the muscular activity of qualified football players and the functional diagnosis of their current physical condition are significant (Lyzohub et al., 2020; Malikov et al., 2006).

This creates the necessary prerequisites for effective implementation of the existing technical and tactical potential of qualified football players in competitive activities, management of long-term training of athletes and control of the main parameters of their preparation: special physical capacity and integral playing qualities (Lisenchuk et al., 2023; Mitova, 2020; Nobari et al., 2023).

In further generalization, this indicates the need to differentiate the composition of the team into typological groups for effective sports training for official competitions at the national or international levels (Hoff, 2005; Kaczorowska et al., 2022; Kokareva et al., 2018; Lisenchuk et al., 2019).

Prospects for further research in this direction relate to the improvement of instrumental testing technologies for the special physical performance of qualified football players (testing protocols, evaluation and interpretation of the obtained indicators). Also promising are the issues related to the improvement of modern methodological approaches to determining the effectiveness of the complex application of training directions: to the development and improvement of special physical capacity and the maximum realization of the available technical and tactical potential of a football player in competitive activities.

Conclusions

Analysis and systematization of data from scientific and methodical literature and the electronic resource of global information network "Internet" indicates the final non-completion of this problem.

The way to solve this problem is the proposed methodical approach, which allows, on the one hand, to comprehensively approach the solution of the issue of the complex orientation of the training process of qualified football players in the preparatory period of training, on the other hand, it provides for the differentiation of the team composition into typological groups of athletes, which allows to have a targeted influence on indicators of special physical capacity and technical and tactical potential of qualified football players.

Analysis of the dynamics of indicators of special physical performance of qualified footballers according to tests PWC_{170} and VO_2 max allows us to state that the proposed methodical approach is sufficiently effective. During the educational and training meetings, the test indicators (PWC_{170} and VO_2 max) had statistically significant differences in the direction of decreasing values of special physical capacity: from retractable microcycle to percussive microcycle ($p<0,05$). In accordance, during the educational and training meetings, the test indicators had statistically significant differences in the direction of increment values of special physical capacity: from percussive microcycle to submersible microcycle ($p<0,05$).

Conflict of interest

The authors state no conflict of interest.

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Параметри фізичної роботоздатності кваліфікованих футболістів у підготовчий період підготовки

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 3 табл., 32 джерела.

Мета роботи: визначити рівень фізичної підготовленості кваліфікованих футболістів у підготовчий період річного макроциклу за тестовими показниками для формування раціональних програм їх підготовки до змагальної діяльності.

Матеріал і методи. Контингент: 25 кваліфікованих футболістів МФК «Металург» (Запоріжжя): 15 спортсменів – заявковий лист «А» і 10 спортсменів заявковий лист «В» до II етапу групи «Чемпіон» VBET UA 2022-2023 сезону Професіональної Футбольної Ліги України. Методи: аналіз та систематизація даних науково-методичної літератури та електронних ресурсів глобальної інформаційної мережі «Інтернет»; педагогічні спостереження; педагогічне тестування: PWC_{170} (Physical Working Capacity); Гарвардський степ-тест; педагогічний експеримент контролюючої спрямованості; методи математичної статистики.

Результати. Під час навчально-тренувальних зборів показники тестів мали статистично значущі відмінності у бік зменшення значень спеціальної фізичної працездатності з втягувального до ударного мікроциклу ($p<0,05$): $aPWC_{170}$ – 1469,33±50,11 та 1377,67 ± 49,11 (кг•м•хв$^{-1}$), $rPWC_{170}$ – 20,87 ± 0,69 і 20,71 ± 0,71 (кгм•хв$^{-1}$•кг$^{-1}$), aVO_2 max – 4002,23 ± 115,23 і 3857,54 ± 117,34 (мл•хв$^{-1}$), rVO_2 max – 61,57 ± 1,51 і 54,37 ± 1,67 (мл•хв$^{-1}$•кг$^{-1}$), відповідно. Також під час навчально-тренувальних зборів показники тестів мали статистично значущі відмінності за напрямом приросту значень спеціальної фізичної працездатності: від ударного до підвідного мікроциклу ($p<0,05$): $aPWC_{170}$ – 1377,67 ± 49,11 і 1494,34 ± 51,78 (кг•м•хв-1), $rPWC_{170}$ – 20,71 ± 0,71 і 21,37 ± 0,85 (кгм•хв$^{-1}$•кг-1), aVO_2 max – 3857,54 ± 117,34 і 3997,09 ± 114,89 (мл•хв-1), rVO_2 max – 54,37 ± 1,67 і 63,67 ± 1,71 (мл•хв$^{-1}$•кг$^{-1}$), відповідно.

Висновок. Шляхом реалізації мети дослідження є запропонований методичний підхід, який дозволяє, з одного боку, комплексно підійти до вирішення питання комплексної спрямованості тренувального процесу кваліфікованих футболістів у підготовчий період підготовки, з іншого боку, передбачається диференціація складу команди на типологічні групи спортсменів, що дозволяє цілеспрямовано впливати на показники спеціальної фізичної працездатності та техніко-тактичного потенціалу кваліфікованих футболістів.

Ключові слова: футбол, кваліфікація, підготовленість, спеціальна фізична працездатність, функціональна підготовленість.

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The Dependence of Physical Fitness on the Functional Capabilities of Girls During Education at the Military Academy

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Abstract

The purpose of the study is to study the statistical relationship between physical fitness and functional capabilities of girls – future officers at the stages of training at the military academy.

Materials and methods. The research subjects were 108 girls who started studying at military academies at the beginning of the experiment; their age ranges from 17 years and 3 months to 18 years and 5 months. The experiment took place over four academic years with the participation of the same girls. The main means of obtaining data were pedagogical testing and diagnosis of physiological characteristics, which took place every year.

Results. Every year there is a weak but statistically significant dependence of changes in the general physical fitness of girls on changes in their functional capabilities. At the same time, with each new year of study, this dependence only increases. Changes in general physical fitness depend somewhat more on changes in functional capabilities than on special ones. The latter is characterized by a tendency towards a slightly greater dependence in the 2nd and 4th years of study, compared to the results in the 1st and 3rd years.

Conclusions. Data from sources of information prove the need to take into account the results obtained in practical activities regarding the dependence of physical fitness on the functional capabilities of those who perform physical activity. This will contribute to increasing the effectiveness of the organization and the content of girls' physical activity in solving the defined tasks of professional training at the military academy.

Keywords: girls, physical activity, military academy, functional capabilities, physical fitness, the dependence of indicators.

Introduction

At the current stage, improving the organization, content and methods of physical activity of future officers during their training to improve their physical fitness and functional capabilities continues to be relevant. Effective here is the use of multivariate statistical methods. However, such studies are characterized by their isolated nature, which makes their conduct necessary.

Taking into account the information from current documentary sources (Instruction on physical training, 2014), today one of the promising directions for improving the organization, the content of the physical activity and methods of their implementation during the training of future officers in military academies continues to be related to improving their physical fitness and functional characteristics.

One of the leading reasons for such a position is that these characteristics are an important component of the readiness of future officers to solve the tasks defined by the military (Romanchuk & Boyarchuk, 2008; Sliusarchuk & Iedynak, 2015). In this regard, the attention of researchers to the formation of the most rational parameters of physical activity of future officers (and both young men and women) in terms of successfully solving the assigned tasks is increasing (Gonshovskyi, 2011; Anatskii, 2021). At the same time, one of the effective approaches involves the use of multivariate statistics methods (Ovcharuk, 2007; Gonshovskyi, 2010; Melnykov et al., 2018). However, we note the isolated nature of studies (Sliusarchuk et al., 2023) aimed at shaping the content of the physical activity of girls – future officers based on the results of the implementation of the specified methods. Taking into account the above, we state the need to conduct research in the specified scientific direction.

Considering the given information, it was noted that the use of data on the degree of dependence of physical fitness on the functional capabilities of girls will allow for an increase in the effectiveness of the content of the physical activity.

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This can help influence these capabilities and improve the first specified characteristic. This is one of the leading tasks of the specified pedagogical process in the military academy. Based on the above, the goal of the study was formulated: to study the statistical relationship between physical fitness and functional capabilities of girls – future officers at the stages of training at the military academy.

Materials and methods

Research participants

They were 108 girls (54 each), who started studying at one of the two military academies, which were research bases, at the beginning of the study. The age of all girls at the beginning of the study ranged from 17 years and 3 months to 18 years and 5 months.

Research organization

The research took place during four academic years with the participation of the same girls. The method of pedagogical testing and diagnosis of physiological characteristics was used to obtain the necessary empirical data. Both methods were implemented every year, in particular at the beginning and end of the first year of study, as well as at the end of the second, third, and fourth years of study. The testing took place during free time from training, the form of organization of this physical activity was a competition under the leadership of an experimenter and a teacher of physical education at the military academy. Tests were used to assess the state of development of the main motor qualities of the girls, who were divided into groups: the first – motor qualities that were part of general physical fitness (GPF), the second – qualities that were considered as components of special physical fitness (SPF). The first group included tests that made it possible to assess the state of development of the following motor qualities: speed (running 30 m), muscle strength (dynamometry of the hand of the leading hand), explosive strength of the muscles of the lower limbs (long jump from a standing position), mobility in the lumbar spine (leaning forward while sitting), coordination in cyclic locomotion (shuttle run 4x9 m), aerobic endurance (12 minute run) and static strength endurance (stand on bent arms). All these tests are widely used by domestic and foreign specialists in physical education research.

The second group included tests determined by documentary sources (Instruction on physical training, 2014) and recommended by specialists in military physical education (Romanchuk, 2008; Larkin, 2010; Bradley, 2016). The tests used made it possible to assess the state of development of aerobic– anaerobic endurance (1000 m run), power endurance in dynamic mode (control strength exercise), speed endurance (100 m run), and coordination endurance (shuttle run 10×10 m). The method of conducting each test did not differ from the traditional one, which is widely presented in the special literature.

To assess the functional capabilities of the girls in the above periods, diagnostic procedures were carried out, which made it possible to determine the necessary physiological characteristics. Such was the state of functioning of the cardiovascular, respiratory, and neuromuscular systems of the body and the physical capacity of the girls. The procedures used are samples and tests recommended by specialists (Bar–Or, Rowland, 2004; Sokołowski, 2014; American College of Sports Medicine, 2017). With their help, the following characteristics were evaluated: blood pressure (BP – namely systolic (SBP) and diastolic (DBP)); heart rate at rest (HR); vital capacity (VC); Ruffier index (RTI), Robinson index (RI), vital capacity index (VCI), and index maximum isometric strength (IMIS). The value of HR testified to the state of heart activity, and together with BP and RI, the state of the cardiovascular system at rest. The value of the VC indicated the ability of the lungs to receive oxygen, and the value of the vital capacity index – the state of the respiratory system in conditions of a full supply of the body with oxygen. The value of the IMIS made it possible to assess the state of development of the skeletal muscles of the girls, which indirectly indicated the state of excess accumulation of structural and energy potentials in the muscles, which increase their working capacity. The RTI value made it possible to assess the physical performance of girls. The following certified equipment was used: to determine BP – Santamedical Adult Deluxe Aneroid Sphygmomanometer, IMIS – handgrip Camry dynamometer, VCI – spirometer NDD EasyOne Plus System 2000 – 2.

Data for the study were quantitative values obtained during testing and functional tests. Such values were compared with each other, which made it possible to determine the increase or decrease in the value of a certain indicator or its detection at the achieved level. At the same time, during the organization of the study, the provisions of the World Medical Association (WMA – 2013) on the ethical principles of medical research with human participation were taken into account. In this regard, an appropriate protocol was approved, and each girl consented to participate in the study.

Statistical analysis

All statistical analyzes were performed using SPSS Version 21. For each assessment, the following calculations were performed: arithmetic mean (M), standard deviation (SD), error of the mean (m), and Kolmogorov– Smirnov Test (KS). The latter made it possible to establish a normal distribution of individual values in a sample of females (Vincent, 2005). Multiple regression analysis was used to obtain the necessary data. This ensured the establishment of the statistical nature of the change in the following indicators: a complex of motor qualities that are part of general physical fitness (7 indicators) and physiological characteristics (8 indicators); a complex of motor qualities that are part of special physical fitness (4 indicators) and physiological characteristics (8 indicators).

Results

Before starting the analysis of the obtained data, the conformity of the values of each indicator of physical fitness and physiological characteristics to the normal distribution was determined. For this, the K–S Test was applied and a normal distribution of values in indicators of general physical fitness was found (Tab. 1). Moreover, this was characteristic not only for the beginning of the education of girls in the military academy but also for other studied periods.

Table 1. Results of general physical fitness of girls in different periods of the study

The name of the parameter	M	SD	m	K– S, p
at the beginning of study				
30 meter sprint, s	6.8	0.61	0.06	> 0.20
Handgrip strength test, kg	22.6	3.08	0.30	> 0.20
Standing long jump, cm	181.1	10.5	1.01	> 0.20
Forward bend, cm	12.3	2.76	0.27	> 0.20
Shuttle run 4×9 m, s	11.67	0.46	0.04	> 0.20
12 minute run, m	1882.6	144.7	13.9	> 0.20
Flexed – arm hang, s	15.95	6.06	0.58	< 0.15
at the end of the first year of study				
30 meter sprint, s	7.02	0.59	0.06	> 0.20
Handgrip strength test, kg	24.0	3.95	0.38	> 0.20
Standing long jump, cm	183.7	12.52	1.20	> 0.20
Forward bend, cm	15.5	3.43	0.33	> 0.20
Shuttle run 4×9 m, s	11.1	0.54	0.05	> 0.20
12 minute run, m	2047.9	203.88	19.62	> 0.20
Flexed – arm hang, s	17.73	6.21	0.60	> 0.20
at the end of the second year of study				
30 meter sprint, s	7.01	0.55	0.05	> 0.20
Handgrip strength test, kg	25.8	4.43	0.43	> 0.20
Standing long jump, cm	186.2	13.38	1.29	> 0.20
Forward bend, cm	17.6	3.08	0.30	> 0.20
Shuttle run 4×9 m, s	11.02	0.58	0.06	> 0.20
12 minute run, m	2057.1	195.26	18.79	> 0.20
Flexed – arm hang, s	19.13	8.1	0.78	> 0.20
at the end of the third year of study				
30 meter sprint, s	7.48	0.68	0.07	< 0.20
Handgrip strength test, kg	27.9	4.29	0.41	> 0.20
Standing long jump, cm	188.4	13.19	1.27	> 0.20
Forward bend, cm	17.4	2.87	0.28	> 0.20
Shuttle run 4×9 m, s	11.59	0.70	0.07	> 0.20
12 minute run, m	2021.7	189.69	18.25	> 0.20
Flexed – arm hang, s	15.68	4.96	0.48	> 0.20
at the end of the fourth year of study				
30 meter sprint, s	7.78	0.55	0.05	> 0.20
Handgrip strength test, kg	27.3	4.42	0.43	> 0.20
Standing long jump, cm	182.1	13.59	1.31	< 0.20
Forward bend, cm	16.8	2.85	0.37	< 0.15
Shuttle run 4×9 m, s	11.88	0.67	0.06	< 0.20
12 minute run, m	2151.1	164.76	15.85	> 0,20
Flexed – arm hang, s	13.21	5.19	0.50	> 0.20

A similar result was obtained when processing the values of the K–S Test, which indicated indicators of special physical fitness (Tab. 2).

Taking into account the data of both tables, it was ascertained the possibility to use parametric criteria in the future, as well as methods of mathematical statistics adequate to this result.

At the same time, it was noted that the studied physiological characteristics had certain features and similar trends. Thus, in the latter case, regardless of the year of study, in most physiological characteristics, the distribution of the individual results of the girls corresponded to the normal range (Tab. 3).

Table 2. Results of special physical training of girls in different periods of the study

The name of the parameter	M	SD	m	K– S, p
at the beginning of study				
Complex strength exercise, number	26.80	4.88	0.47	< 0.15
100 meter sprint, s	17.61	0.98	0.09	> 0.20
Shuttle run 10×10 m, s	34.18	2.07	0.20	> 0.20
1000 meter run, s	283.1	31.39	3.02	< 0.15
at the end of the first year of study				
Complex strength exercise, number	29.60	4.57	0.44	> 0.20
100 meter sprint, s	16.37	1.03	0.10	> 0.20
Shuttle run 10×10 m, s	34.77	2.22	0.21	> 0.20
1000 meter run, s	242.8	28.17	2.71	> 0.20
at the end of the second year of study				
Complex strength exercise, number	31.40	4.82	0.46	> 0.20
100 meter sprint, s	16.06	0.87	0.08	< 0.15
Shuttle run 10×10 m, s	35.51	2.16	0.21	> 0.20
1000 meter run, s	252.4	27.02	2.60	> 0.20
at the end of the third year of study				
Complex strength exercise, number	33.68	4.46	0.43	> 0.20
100 meter sprint, s	16.04	0.86	0.08	> 0.20
Shuttle run 10×10 m, s	35.67	2.32	0.22	> 0.20
1000– meter run, s	254.5	26.64	2.56	> 0.20
at the end of the fourth year of study				
Complex strength exercise, number	36.11	4.27	0.41	< 0.15
100 meter sprint, s	15.75	0.79	0.08	> 0.20
Shuttle run 10×10 m, s	35.45	2.58	0.25	< 0.20
1000 meter run, s	244.5	25.11	2.42	> 0.20

The exception in all years of study was the VC indicator, in some years of study as follows: at the beginning of the study – SBP and DBP, at the end of the first year – only DBP, at the end of the third – HR and SBP, at the end of the fourth – the most, namely HR, DBP, VC, and VCI. In this regard, they noted the need to take into account the obtained data in the statistical analysis of the values of such indicators.

When solving another task, data were obtained regarding the degree of statistical dependence of changes in the general physical fitness of girls on changes in their functional capabilities during each year of study. Thus, the value of the coefficient of multiple regression during the 1st year of study was at the level of 0.294, during the 2nd year of study – at the level of 0.330, during the 3rd – 0.342, and during the 4th – 0.367. In other words, in all cases, there was a weak but statistically significant dependence of the change in the general physical fitness of girls on the state of change in their physiological characteristics. The obtained data were interpreted as follows: with each new year of study, the dependence of the change in their general physical fitness on the change in functional capabilities increases.

As for the dependence of changes in the special physical fitness of these girls on the studied functional capabilities, a somewhat different result was obtained here. In particular, the value of the coefficient of multiple regression during the

Table 3. Results of physiological characteristics of girls in different periods of the study

The name of the parameter	M	SD	m	K– S, p
at the beginning of study				
HR at rest, bpm^{-1}	80.7	5.29	0.51	< 0.20
SBP, mmHg	114.6	5.02	0.48	< 0.01
DBP, mmHg	74.7	4.78	0.46	< 0.01
VC, l	1.94	0.24	0.02	< 0.05
VCI, ml·kg^{-1}	34.86	5.68	0.55	< 0.10
IMIS, %	30.51	5.55	0.53	> 0.20
RTI, conditional units	10.84	0.7	0.07	> 0.20
RI, conditional units	92.64	5.89	0.56	> 0.20
at the end of the first year of study				
HR at rest, bpm^{-1}	74.5	4.99	0.48	> 0.20
SBP, mmHg	117.4	4.68	0.45	> 0.20
DBP, mmHg	78.2	4.73	0.46	< 0.05
VC, l	2.69	0.25	0.02	< 0.05
VCI, ml·kg^{-1}	41.18	5.63	0.54	> 0.20
IMIS, %	41.66	6.14	0.59	> 0.20
RTI, conditional units	9.76	0.81	0.08	> 0.20
RI, conditional units	84.42	5.61	0.54	> 0.20
at the end of the second year of study				
HR at rest, bpm^{-1}	73.5	4.08	0.39	> 0.20
SBP, mmHg	119.3	4.01	0.39	< 0.20
DBP, mmHg	78.3	3.27	0.31	< 0.10
VC, l	2.7	0.25	0.02	< 0.05
VCI, ml·kg^{-1}	40.01	5.13	0.49	> 0.20
IMIS, %	44.83	5.89	0.57	> 0.20
RTI, conditional units	9.72	0.71	0.07	> 0.20
RI, conditional units	83.81	5.29	0.51	> 0.20
at the end of the third year of study				
HR at rest, bpm^{-1}	76.1	3.96	0.38	< 0.01
SBP, mmHg	122.3	3.57	0.34	< 0.05
DBP, mmHg	78.5	2.92	0.28	> 0.20
VC, l	2.65	0.29	0.03	< 0.05
VCI, ml·kg^{-1}	37.74	4.84	0.47	> 0.20
IMIS, %	44.99	5.64	0.54	> 0.20
RTI, conditional units	9.95	0.71	0.07	< 0.20
RI, conditional units	84.7	5.54	0.53	> 0.20
at the end of the fourth year of study				
HR at rest, bpm^{-1}	75.4	3.42	0.33	< 0.01
SBP, mmHg	122.6	2.75	0.26	< 0.10
DBP, mmHg	77.8	3.41	0.33	< 0.05
VC, l	2.97	0.31	0.03	< 0.05
VCI, ml·kg^{-1}	38.6	4.83	0.46	< 0.05
IMIS, %	45.86	5.54	0.53	> 0.20
RTI, conditional units	9.17	0.60	0.06	> 0.20
RI, conditional units	83.65	5.50	0.53	> 0.20

1st year of study was 0.229, during the 2nd year – 0.298, during the 3rd year – 0.228, and the 4th year – 0.242. The interpretation of established data testified to the existence of a dependence of changes in the special physical fitness of girls on changes in their functional capabilities. At the same time, the comparison showed a tendency towards a slightly greater effect in the 2nd and 4th years of study, compared to achievements during the 1st and 3rd years of study.

In addition, it was noted that a change in general physical fitness depends somewhat more on changes in functional capabilities than on changes in special physical fitness.

Discussion

The issue of improving the organization, content and methods of physical activity of future officers during training at the military academy remains important. The direction of such improvement is primarily related to the task of improving the physical fitness and functional capabilities of such girls (Vogt, 2011; Instruction on physical training, 2014). One of the promising directions in solving this problem continues to be the use of the results obtained using the methods of multivariate statistics (Melnykov et al., 2018; Sliusarchuk et al., 2022).

Some of the reasons for this are the formation of the most rational parameters of physical activity at the stages of training in the VA (Gonshovskyi, 2011; Sliusarchuk, 2016; Anatskii, 2021). It is they that make it possible to achieve a highly positive result in increasing the level of physical fitness. The determining reason is that the latter is one of the important components of the future officer's readiness to solve tasks defined by military and professional duties (Romanchuk & Boyarchuk, 2008; Sliusarchuk & Iedynak, 2015).

When studying the statistical dependence between physical fitness and functional capabilities of girls – future officers at the stages of training in the VA, the existence of such dependence was revealed. Confirmation of the existence of a certain dependence between the specified characteristics of future officers can be found in other researchers (Ovcharuk, 2007; Gonshovskyi, 2010; Melnykov, 2018). In our case, the result showed that influencing the functional capabilities of girls during various forms of physical activity can also improve physical fitness. This is consistent with the information that the use of physical activities of a certain orientation at a young age in some cases stimulates, in others, on the contrary, inhibits the development of a specific functional capacity (Banah, 2020). This is due to the fact that significant morphological and functional changes occur during physical activity, each of which is different for different body systems and depends on the period of ontogenesis. Components of the body's morphology and functions, depending on the reaction to physical exertion, are divided into conservative and labile. The impact on the latter during physical activity is a stimulator and regulator of the body's development. Taking into account the available information (Sands & Sands, 2012; Schmidt & Lee, 2014), intensification of development is the basis for increasing the level of manifestation of various motor qualities; the latter in general physical fitness and special physical fitness are combined. Here it is necessary to take into account that the existing types of endurance are based on the features of the energy supply of the work being performed – anaerobic, aerobic, and mixed (Romanchuk et al., 2019; Wilmore, Costill & Kenney, 2022). Muscular strength occurs when skeletal muscles are maximally tensed at minimal speed, while explosive power is the opposite at the maximal possible speed (Ruppole, 2017). Different types of coordination are caused by different psychophysiological mechanisms and functions of ensuring action (Schmidt & Lee, 2014). Expression of speed qualities is provided by inde-

pendent functional systems, namely for the realization of the speed of a single movement, frequency of movements, motor reaction (simple and complex), and rhythm as a complex characteristic (Silverman & Deuster, 2014; Di Tore, 2016). Flexibility is considered in connection with the morphological and functional properties of the apparatus of movement and support, which determine the amplitude of movements, as well as to a certain extent – with strength capabilities, the effectiveness of nervous regulation of movements, inter– and intra– muscular interactions (Alter, 2004).

Conclusions

1. Data from sources of information prove the need to take into account data on the dependence of physical fitness on the functional capabilities of those who engage in physical activity in practical activities. However, until now there are no data on such dependence in girls – future officers during their physical activity at the military academy.

2. Every year there is a weak but statistically significant dependence of changes in the general physical fitness of girls on changes in their functional capabilities. At the same time, with each new year of study, this dependence only increases.

3. Changes in general physical fitness depend somewhat more on changes in functional capabilities than on special ones. The latter is characterized by a tendency towards slightly greater dependence in the 2nd and 4th years of study, compared to the results in the 1st and 3rd years.

Conflict of interest

The authors state no conflict of interest.

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Залежність фізичної підготовленості від функціональних можливостей дівчат під час навчання у військовій академії

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 3 табл., 27 джерел.

Мета дослідження – вивчити статистичну залежність між фізичною підготовленістю та функціональними можливостями дівчат – майбутніх офіцерів на етапах навчання у військовій академії.

Матеріали і методи. Досліджуваними були 108 дівчат, які з початком експерименту розпочали навчання у військових академіях; їхній вік – від 17 років і 3 місяців до 18 років і 5 місяців. Відбувався експеримент протягом чотирьох навчальних років за участі тих самих дівчат. Основними засобами одержання даних були педагогічне тестування і діагностика фізіологічних характеристик, відбувалися вони щороку.

Результати. Щорічно має місце слабка, але статистично значуща залежність зміни у загальній фізичній підготовленості дівчат від змін у їхніх функціональних можливостях. При цьому, з кожним новим роком навчання така залежність лише посилюється. Від змін у функціональних можливостях дещо більшою мірою залежать зміни у загальній фізичній підготовленості, ніж у спеціальній. Для останньої характерна тенденція до дещо більшої залежності в 2-ий і 4-ий роки навчання, порівняно з результатами у 1-ий та 3-ій роки.

Висновки. Дані джерел інформації засвідчують необхідність ураховувати у практичній діяльності одержані результати щодо залежності фізичної підготовленості від функціональних можливостей тих, хто здійснює фізичну активність. Це сприятиме підвищенню ефективності організації та змісту фізичної активності дівчат у вирішенні визначених завдань професійної підготовки у військовій академії.

Ключові слова: дівчата, фізична активність, військова академія, функціональні можливості, фізична підготовленість, залежність показників

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