

Original Article

The influence of means of orienteering on the psychophysiological state of girls aged 15-16-years

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ABSTRACT

The article presents the results of a pedagogical experiment that lasted during 2016-2017 academic year, 52 girls aged 15-16 years took part in the study. According to the purpose of the study, it was revealed the influence of means of orienteering within the framework of the author's program of physical education on the psychophysiological state of girls aged 15-16 years. We found that during the pedagogical experiment, the positive dynamics of the majority of the studied indicators was observed. The indicators of the functional state, in particular, of the cardiovascular and respiratory systems, were significantly improved. In the 15-year-old girls the heart rate at rest decreased by 12.7 % ($p < 0.01$), in the 16 year-old girls - by 11.1 % ($p < 0.01$); the average indicators of the vital capacity of the lungs increased in the girls aged 15 years by 8.0 % ($p < 0.01$), in the girls aged 16 years - by 22.2 % ($p < 0.01$). The average statistical parameters of the Genchi test also were improved significantly, in the girls aged 15 years by 14.6 % ($p < 0.01$), in the girls aged 16 years by 11.8 % ($p < 0.01$). In addition, positive changes occurred in the indicators that characterize cognitive functions. It was significantly improved the short-term memory capacity: in the girls aged 15 and 16 years by 15.3 % ($p < 0.01$) and by 15.5 % ($p < 0.01$), respectively. The information processing capacity increased in the girls aged 15 years by 22.1 % ($p < 0.01$), in the girls aged 16 years - by 29.8 % ($p < 0.01$). Among the motor qualities, the parameters of the sharpened Romberg test have undergone the most positive changes, as in the case

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of the girls aged 15 years the average index was improved by 26.7 % ($p < 0.01$), in girls aged 16 years by 18.3 % ($p < 0.01$). Significant changes ($p < 0.05$ - $p < 0.01$) also occurred in the parameters of running 100 m race, shuttle running 4x9 m and running 1,500 m race, as well as sit-up from the back-lying position. **Key words:** ORIENTEERING, PSYCHOPHYSIOLOGICAL STATE, GIRLS.

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INTRODUCTION

At the present stage of the development of the national school in Ukraine, the important strategic task of the education content reforming is the need to promote the physical and mental health of young people, taking into account the needs of the person-oriented direction of teaching and educating students, and the establishment of priorities for a healthy lifestyle (Tymoshenko, 2011; Martins et al., 2017; Galan et al., 2017; Yarmak et al., 2017; Andrieieva et al., 2017).

Orienteering training is a social and pedagogical process aimed ultimately towards achieving physical perfection. It integrates such basic components as health, in the implementation of which the forms and functions of the human body are optimized, developing - the level of physical (motor) abilities and qualities is increased, educational - the volume of knowledge, motor skills and skills is expanded and improved (Blanchard et al., 2009; Korol, 2013; Kirihiyanen, 2014; Galan et al., 2016; Khimenes et al., 2016).

The effectiveness of orienteering training of schoolchildren is largely determined by priority approaches to the constituent components optimizing. The specific weight (ratio) of the health improving and developing components in the educational process should be first of all determined by physical health (the level of compliance with the norm of the indicators of the body's functional systems). In the normal state of the functional systems of the body of students, all three components can be realized in the educational process in the optimal volume (Kozina, 2007; Cheshykhyna).

Orienteering is a sport in which the participants of the competitions independently, using only the map of the terrain and the compass, overcome the distance with the control points located on it, using a large set of technical and tactical techniques during the running on the ground. That is why in orienteering the result depends equally on the physical and mental abilities and knowledge of an orienteer.

The main feature of teaching orienteering in the process of physical education is the distinction in the content of the physical training of schoolchildren. Unlike sports training, the main purpose of which is to achieve the maximum sporting result in competitions, physical education classes are aimed at the health strengthening of schoolchildren, providing comprehensive physical fitness, developing of the special physical qualities which are special to this type of activity, mastering technique and tactics of orientation. To solve the abovementioned issues, a large number of means of orienteering are used. In the preparation of orienteers, the main place is taken by the orienteering running, which is an integrating activity between physical exertion (running in its various varieties, skiing) and mental, aimed at performing technical and tactical actions. This means contributes to the development of general endurance, strength, coordination and speed abilities. Health-improving running, which is used for physical training of schoolchildren at the physical education lessons, in contrast to sports running, is characterized by less intensity, duration and biochemical changes in the body (Slonov, 2003; David, 2008; Honcharova, 2015; Galan et al., 2016; Berezovskyi, 2016).

The topicality of the research is due to the lack of substantiation and the lack of developments aimed at increasing the level of the psychophysiological state of schoolchildren aged 15-16 years by means of orienteering. This problem is of the theoretical and practical importance for improving the system of physical education of schoolchildren of senior school age.

MATERIALS AND METHODS

The following methods were used in the study: analysis and generalization of special scientific and methodological literature and documentary materials, pedagogical research methods, anthropometric and physiological methods, methods of mathematical statistics.

For the purpose of determining the indicators of the physical development of girls aged 15-16 years, there were taken anthropometric measurements, which reflect the level of morphological features: body length (BL) and body weight (BW), wrist dynamometry. Physiological methods were used to assess the state of the cardiovascular system of girls: heart rate at rest (HR_{rest}), systolic blood pressure (SBP) and diastolic blood pressure (DBP); to assess the state of the respiratory system - vital lung capacity (VC), Genchi test, Shtange test; for the evaluation of the functional state of the central nervous system (CNS) there were determined the indicators of the short-term memory capacity (SMC), the information processing speed (IPS), the information processing capacity (IPC), the accuracy of size perception; to assess the physical performance, the Ruffier-Dicson Index was used. To characterize physical fitness there were used the following motor tests: running 100 m race, shuttle running 4x9 m, bending forward from the sitting position, flexion and extension of arms in front lying support, standing long jump, sit-up from the back-lying position, times in 1 min and the sharpened Romberg test. The performing of this set of tests covers many aspects of physical fitness.

The obtained results were processed using mathematical statistics methods. The pedagogical experiment was conducted on the basis of the Chernivtsi Specialized School of the I-III stages of the physical and mathematical profile No. 6, Chernivtsi Secondary School of the I-III of stages No. 27. The students of the 10th and 11th grades took part in the pedagogical experiment. The studies covered 52 girls: 24 girls aged 15 years and 28 girls aged 16 years.

RESULTS

The hypothesis about the positive influence of means of orienteering on the psychophysiological state of girls aged 15-16 years became the basis for the development and implementation of the variative Module "Orienteering" in the content of the curriculum on the physical education in high school. Evaluation of the effectiveness of the author's program was determined by conducting a pedagogical experiment during the 2016-2017 academic year. The basic means and methods that were included in the variative module "Orienteering" were selected considering the age, gender, morpho-functional and psychological features of the development of girls aged 15-16 years.

In September 2016, we conducted a study of the psycho-physiological state of girls aged 15-16 years. Considering the results obtained at the beginning of the pedagogical experiment, the intensity of the orienteering training sessions was limited by the level of tolerance of the cardiovascular and respiratory systems to physical loads, the frequency of classes was 4 mandatory hours per week and 2 optional hours at the request of girls at the out of school time.

In May 2017, a formative pedagogical experiment was conducted, the purpose of which was to test the effectiveness of the author's program developed by us (Galan et al., 2016). The number of subjects studied in each age group was sufficient for an objective interpretation of the obtained results. The average statistical results of the psychophysiological state of girls aged 15-16 years before and after the pedagogical experiment are presented in Tables 1-3.

The introduction of the author's program on the basis of the application of means of orienteering during the academic year, contributed to the positive dynamics of most of the studied indicators. In the study of the physical development of girls aged 15-16 years, the average values of anthropometric indicators were obtained, the distribution pattern of which was within the limits of age standards. The increase of BL in girls aged 15 years was 1.1 cm (or 0.7 %, $p<0.05$), in the girls aged 16 years - 1.0 cm (or 0.6 %, $p>0.05$). The average statistical parameters of BW in girls aged 15-16 years have also undergone insignificant changes, so in the girls of 15 years the weight gain was 1.1 kg (or 1.9 %, $p<0.05$), in the girls of 16 years the weight gain was 0.3 kg (or 0.5 %, $p>0.05$), this feature is natural, as the girls undergo natural biological changes. It should be noted that at the age of 15-16 years the rate of biological development is slowing down. The formation of the musculoskeletal system is coming to an end.

Analysis of the average statistical results of the dynamometry of the right and left hand indicates a slight increase, in girls aged 15 years it was from 1.0 kg to 0.8 kg (3.8 %, $p<0.05$, 3.3 %, $p>0.05$). In girls aged 16 years, the results improved from 0.3 kg to 0.6 kg (or 1.0 %, $p<0.05$, 2.6 %, $p>0.05$).

An indicator of the naturally determined process of adapting of the cardiovascular system to a training load is the decrease in heart rate at rest. The indicators of the respiratory system adaptation are an increase in VC and in the results of the functional tests with a breath holding. Analysis of the average statistical heart rate at rest in the girls aged 15-16 years testifies about statistically significant changes that have occurred under the influence of means of orienteering. In 15-year-old girls, the average result of heart rate at rest has decreased by 11.7 beats/min, which is 12.7 % ($p<0.01$), in girls aged 16 years by 10.3 beats/min, which makes up 11.1 % ($p<0.01$).

Table 1. The indicators of the morpho-functional state of girls aged 15-16 years (n = 52).

Indicators	Before the experiment					After the experiment					p
	\bar{x}	S	Me	25 %	75 %	\bar{x}	S	Me	25 %	75 %	
Girls aged 15 years (n=24)											
BL, cm	164.8	4.37	164.5	162.0	166.5	165.9	4.68	165.3	162.8	168.0	>0.05
BW, kg	57.5	6.17	57.8	54.0	60.3	58.6	3.73	57.0	54.5	58.5	>0.05
Dynamometry right, kg	26.4	3.49	26.0	24.0	28.5	27.4	3.72	27.3	25.2	29.9	>0.05
Dynamometry left, kg	24.0	3.64	24.0	22.0	26.0	24.8	3.71	25.0	23.0	26.4	>0.05
VC, l	2.5	0.33	2.4	2.3	2.6	2.7	0.28	2.7	2.5	2.9	<0.01
HR _{rest} , beats·min ⁻¹	92.1	16.44	91.0	80.0	98.0	80.4	5.26	81.0	80.0	84.0	<0.01
SBP, mmHg	117.3	11.84	120.0	108.0	126.5	116.4	7.94	117.0	110.0	120.0	>0.05
DBP, mmHg	71.8	11.10	67.5	65.0	80.0	70.9	5.88	67.5	65.0	80.0	>0.05
Genchi test, sec	19.9	8.71	18.5	13.5	23.0	22.8	8.66	22.0	15.6	25.5	<0.05
Shtange test, sec	31.5	15.11	29.0	24.0	34.5	33.0	6.54	31.5	28.0	35.0	>0.05
Ruffier index, nominal units	11.5	2.37	11.6	9.6	12.8	9.5	2.30	9.5	7.5	10.7	<0.01
Girls aged 16 years (n=28)											
BL, cm	167.0	6.28	166.5	163.2	172.4	168.0	6.36	167.6	164.6	173.3	>0.05
BW, kg	59.6	5.96	57.3	56.2	62.2	59.9	4.91	58.2	56.2	63.5	>0.05

Dynamometry right, kg	28.8	3.63	28.9	27.3	30.1	29.1	3.68	29.1	27.4	31.0	>0.05
Dynamometry left, kg	23.2	3.63	22.6	20.8	25.6	23.8	3.54	23.3	22.0	26.2	>0.05
VC, l	2.7	2.25	2.7	2.5	2.8	3.3	0.31	3.2	3.0	3.4	<0.01
HR _{rest} , beats·min ⁻¹	92.9	13.84	93.0	84.0	108.0	82.6	6.22	84.0	82.5	85.0	<0.01
SBP, mmHg	113.2	7.23	110.0	110.0	120.0	111.8	5.48	110.0	110.0	115.0	>0.05
DBP, mmHg	72.9	7.63	70.0	70.0	80.0	71.4	5.91	70.0	70.0	75.0	>0.05
Genchi test, sec	22.0	2.46	22.0	21.0	23.0	24.6	2.63	24.5	22.5	26.5	<0.01
Shtange test, sec	32.8	16.72	28.0	24.5	35.0	34.8	16.43	30.3	26.1	37.3	>0.05
Ruffier index, nominal units	10.8	1.63	11.1	10.3	11.9	9.3	1.77	9.6	7.5	10.4	<0.01

The average statistical results of the systolic and diastolic blood pressure in the girls aged 15-16 years almost did not undergo significant changes and remained within the age standards. The average statistical indicator of VC in the girls aged 15 years increased by 0.2 l (or 8.0 %, $p<0.01$), in the 16-year-old girls - by 0.6 l (or 22.2 %, $p<0.01$). The average statistical parameters of the breath holding tests also received positive changes. In the 15-year-old girls, the results of Genchi test and Shtange test improved by 2.9 s and 1.5 s (or 14.6 %, $p<0.01$, 4.8 %, $p<0.05$), in girls ages 16 years - by 2.6 s and 2.0 s (or 11.8 %, $p<0.01$, 6.1 %, $p>0.05$). It can be affirmed that aerobic exercise had a positive effect on the functional state of the cardiovascular and respiratory systems.

By the end of the pedagogical experiment, the girls aged 15-16 years had a significant decrease in the average value of the Ruffier-Dicson index, which indicates an improvement in the response of the cardiovascular system to the dynamic load. In the girls aged 15 years the average indicator decreased by 2.0 nominal units (or 17.4 %, $p<0.01$), in the girls aged 16 years - by 1.5 nominal unit (or 13.9 %, $p<0.01$).

The biggest positive changes occurred in the indicators characterizing the cognitive functions. The average statistical results are shown in Table 2.

Table 2. The indicators of the cognitive functions of girls aged 15-17 years ($n = 52$).

Indicators	Before the experiment					After the experiment					p
	\bar{x}	S	Me	25 %	75 %	\bar{x}	S	Me	25 %	75 %	
Girls aged 15 years ($n=24$)											
SMC, %	29.5	6.00	29.1	25.0	33.3	44.8	14.31	41.7	33.3	58.4	<0.01
IPC, bit	335.6	35.90	321.3	319.7	327.7	409.6	34.71	394.4	393.4	401.2	<0.01
IPS, bit s ⁻¹	15.5	1.00	14.8	14.6	16.3	15.0	0.99	14.9	14.3	15.8	>0.05
Accuracy of size perception, %	58.9	8.15	62.0	50.0	62.0	64.9	5.61	65.5	63.3	66.5	<0.05
Girls aged 16 years ($n=28$)											
SMC, %	24.7	12.31	25.0	16.7	33.3	40.2	9.66	41.7	33.3	41.7	<0.01
IPC, bit	320.5	17.74	315.5	304.4	329.0	416.0	51.91	408.3	393.6	476.2	<0.01
IPS, bit ·s ⁻¹	16.4	0.82	16.6	15.8	16.8	14.2	0.87	14.2	13.3	14.4	<0.01

Accuracy of size perception, %	57.8	12.52	56.8	45.6	70.5	64.1	10.01	68.4	56.5	71.3	<0.05
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Comparative analysis of the SMC indicator testifies about statistically significant changes, so in 15-year-old girls the short-term memory capacity increased by 15.3 % ($p < 0.01$), in girls of 16 years this indicator improved by 15.5 % ($p < 0.01$). The information processing capacity in the girls aged 15 years improved by 74.0 bits, which makes up 22.1 % ($p < 0.01$); in the girls aged 16 years - by 95.5 bits or 29.8 % ($p < 0.01$). The indicator of the information processing speed in the girls of 15 years did not undergo significant changes at the end of the pedagogical experiment, the difference was 0.5 bit s^{-1} or 3.2 % ($p > 0.05$), in the girls aged 16 years, on the contrary, there was a statistically significant decrease of the indicator by 2.2 bits s^{-1} or 15.5 % ($p < 0.01$). There are also significant changes in the results of the test for the accuracy of size perception, in the girls of 15 years it has improved by 6.0 % ($p < 0.05$), in the girls aged 16 years by 6.3 % ($p < 0.05$). So, the means and methods of orienteering provide intense mental activity, which in its turn requires the development of such psycho-physiological parameters of higher nervous activity as attention and memory.

Positive changes have occurred in motor tests, characterizing speed, agility, strength, speed-strength qualities and endurance. The average statistical results are shown in Table 3.

Table 3. The indicators of physical fitness of the girls aged 15-16 ($n = 52$).

Indicators	Before the experiment					After the experiment					p
	\bar{x}	S	Me	25 %	75 %	\bar{x}	S	Me	25 %	75 %	
Girls aged 15 years ($n=24$)											
Running 100 m race, sec	17.9	1.11	17.6	17.1	18.7	17.0	0.87	16.8	16.5	17.7	<0.01
Shuttle running 4 × 9 m, sec	11.4	0.51	11.5	11.1	11.6	10.6	0.57	10.6	10.3	10.9	<0.01
Standing long jump, cm	160.3	18.49	161.4	154.6	174.6	168.1	11.67	165.5	159.7	179.4	>0.05
Sit-up from the back-lying position, times / 1 min	35.5	2.96	35.2	33.6	37.1	37.3	2.97	37.0	34.8	38.6	<0.05
Running 1,500 m race, min sec	8.53	0.25	8.45	8.38	8.56	8.21	0.10	8.18	8.14	8.25	<0.01
Romberg test, sec	12.0	3.85	12.0	9.1	14.3	15.2	2.58	14.7	12.9	16.5	<0.01
Girls aged 16 years ($n=28$)											
Running 100 m race, sec	17.4	0.98	17.4	16.9	18.0	16.0	1.23	15.8	15.2	16.8	<0.01
Shuttle running 4 × 9 m, sec	10.5	0.42	10.6	10.3	10.8	10.0	0.75	10.2	9.5	10.6	<0.05

Standing long jump, cm	162.8	15.79	163.0	157.0	175.5	164.8	15.65	164.1	165.4	177.0	>0.05
Sit-up from the back-lying position, times / 1 min	34.3	4.81	34.4	33.0	36.7	38.9	3.26	38.8	37.6	40.2	<0.01
Running 1,500 m race, min sec	8.54	0.25	8.45	8.38	8.57	8.20	0.17	8.21	8.14	8.28	<0.01
Romberg test, sec	15.3	5.11	15.5	11.5	18.5	18.1	4.54	18.1	14.5	21.0	<0.05

Under the influence of the author's program on orienteering, in the girls of 15 years statistically significant changes are observed when running 100 m race, the result was improved by 0.9 s. that was 5.0 % ($p < 0.01$); the result of the shuttle running 4x9 m was improved by 0.8 s, which was 7.0 % ($p < 0.01$). The average result of sit-up from the back-lying position per 1 min was improved by 5,1 % ($p < 0.05$), and the result in running 1,500 m race was improved by 32.0 s, which makes up 3.8 % ($p < 0.01$). The average result in performing a sharpened Romberg's test was improved by 3.2 seconds, or 26.7 % ($p < 0.01$).

The 16-year-old girls demonstrated similar dynamics of the studied indicators. The result of running 100 m race was improved by 1.4 s, which is 8.0 % ($p < 0.01$), the result of the shuttle running 4x9 m was improved by 0.5 s, which is 4.8 % ($p < 0.05$). The average result of sit-up from the back-lying position per 1 min was improved by 13.4 % ($p < 0.01$); and the result in running 1,500 m race was improved by 34.0 s, which is 4.0 % ($p < 0.01$). The average result in performing a sharpened Romberg's test was improved by 2.8 seconds, which is 18.3 % ($p < 0.01$).

Our study shows that the implementation of orienteering training in the teaching and educational process of the general education school makes it possible to tackle the numerous issues that are topical for the modern school. Means and methods of orienteering help to improve the functional state of the cardiovascular and respiratory systems. They bring a vast improvement to the cognitive functions of students, and contribute to a positive dynamics of motor qualities, in particular: speed, agility, endurance, strength and coordination of movements.

DISCUSSION

At the present stage of the educational system development, there is a rethinking of conceptual approaches to the education and upbringing of adolescents and young men, to the correction of their psychophysiological state and to the improvement of their physical and mental capabilities (Korol, 2013; Proios et al., 2015; Yarmak et al., 2017; Sánchez-Jover et al., 2017; Alatzoglou et al., 2017). Nowadays, in conditions of increased informational loads, schoolchildren experience significant psychoemotional stress, as well as a manifestation of the chronic adaptive overstrain syndrome caused by the conditions of the educational process (Maksymenko et al., 2011; Palchuk, 2012; Dutchak et al., 2012; Palchuk, 2015). The overloading of the educational process causes a strain of the functional systems of the body.

The psychological and informational shock of modern schoolchildren should be discussed in the educational process today. The consequences of the shock are as follows: chronic fatigue, morbidity and passivity; and these facts may be called as manifestations of chronic adaptive overstrain, and sometimes even the

disruption of adaptation. That in the process of the terminal adaptation the organism could cope with changes in the conditions of modern life (stress, poor ecology, information loads), it should several times increase the mass of mitochondria (energy structures of the cell). Prevention of chronic adaptive overstrain syndrome is possible through increased physical activity (Tomenko, 2013, Galan et al., 2017).

It has been found out that the psychophysiological development of young people is deteriorating lately, so the search for integrated means of effective solution of the issue under investigation is in the sphere of scientific interests of specialists in various fields: pedagogy, medicine, rehabilitation (Palchuk, 2012; Sainchuk, 2012). A number of scientific works are devoted to the problems of studying the features of psychophysiological development of children of senior school age (Maksymenko, 2011; Berezovskyi, 2016; Nakonechnyi et al., 2017). The authors assert that in children from the middle school age there are violations in the sphere of emotional-volitional manifestations, motor disorders, slackness, which make their teaching and education much more difficult (Yarmak et al., 2016). Therefore, the correction of the psychophysical development of students by means of physical education is an important direction of the educational work of the general education school.

The results of the conducted research confirmed and supplemented already known developments in the aspect of the studied issue.

The results of our studies confirm the data (Berezovskyi, 2016) that as a result of the implementation of the means of orienteering in the teaching and educational process of the upper grades students, there is a positive dynamic of indicators of the psychophysiological state.

There were complemented the data on the positive influence of the means of orienteering on the cognitive functions of schoolchildren and youth, athletes (Slonov, 2003, Kolomiets, 2008, Dotsenko 2013, Voronov, 2014, Midtbø, 2014, Blahii, 2015; Korol, 2015; Celestino et al., 2015; Berezovskyi, 2016; Galan et al., 2016), on raising the level of motor qualities, in particular: speed, agility, strength, endurance and coordination of movements. (Korol, 2013; Blahii, 2015; Berezovskyi, 2016; Galan et al., 2016).

CONCLUSIONS

At the end of the pedagogical experiment, there were obtained results that indicated positive changes in the psychophysiological state. The improvement is largely due to the reliable changes of the indicators of functioning of the cardiovascular system, in particular, a decrease in heart rate at rest by 11.7 beats per min, which is 12.7 % ($p < 0.01$) in the girls aged 15 years and by 10.3 beats per min, which is 11.1 % ($p < 0.01$) in the girls aged 16 years. The reaction of the cardiovascular system to the dynamic load was significantly improved, as evidenced by the results of the Ruffier-Dicson test, in the girls aged 15 years by 2.0 nominal units (or 17.4 %, $p < 0.01$), in the girls aged 16 years - by 1.5 nominal units (or 13.9 %, $p < 0.01$). This fact indicates an increase in the economy of the cardiovascular system. Under the influence of the means of orienteering, the parameters of the respiratory system were significantly improved, in particular: in the girls aged 15 years VC indicator was increased by 0.2 l (or 8.0 %, $p < 0.01$), in the girls aged 16 years - by 0.6 l (or 2.2 %, $p < 0.01$); Genchi test results were improved in the girls aged 15 years by 2.9 s (or 14.6 %, $p < 0.01$), in the 16-year-old girls - by 2.6 s (which makes up 11.8 %, $p < 0.01$); the indicators of the cognitive functions were as well significantly improved, in particular, SMC parameters in the girls aged 15 years increased by 15.3 % ($p < 0.01$), in the girls of 16 years - by 15.5 % ($p < 0.01$); IPC parameters in the girls aged 15 years improved by 74.0 bits, is 22.1 % ($p < 0.01$), in girls aged 16 years by 95.5 bits, is 29.8 % ($p < 0.01$).

So, under the influence of the means of orienteering, the overwhelming majority of the studied indicators of the psychophysiological state of the girls aged 15-16 years have been improved in the framework of the author's program of physical training with a significant difference ($p < 0.05$, $p < 0.01$).

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