

Efficiency evaluation and experimental verification of the programme aimed at correcting schoolchildren' psycho-physical condition using sports orienteering

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Abstract:

Today, many studies prove the fact that learning in the modern school is a multifaceted phenomenon, as this process is marked by the cognitive ability of learners to perceive and process large amounts of information in a short period. The article aimed to study the impact of a comprehensive programme on sports orienteering on the psychophysical condition of schoolchildren aged 13-14 and experimentally test its effectiveness. *Material and methods:* Theoretical analysis, pedagogical, sociological, anthropometric, physiological, psychophysiological techniques, health assessment and statistical methods. *Results:* The results demonstrated a positive dynamic of most of the research indicators. The results showed that after conducting the pedagogical experiment the dynamics of average results of the girls and boys in experimental group (EG) were significantly higher than the ones showed by the boys and girls in the control group (CG). *Conclusions:* Thus, the positive changes in the indicators of the psychophysical condition of learners prove the effectiveness of the proposed programme.

Key words: Orienteering, Schoolchildren, Psychological Condition, Physical Development, Fitness.

Introduction

The learning process in a modern school presupposes the assimilation of a large amount of information in a short time, technical education, frequent innovations in teaching, which affects the psycho-emotional and psycho-physical state of learners (Sainchuk, 2013; Galan et al., 2016; Bakayev, Vasilyeva, Kalmykova & Razinkina, 2018; Osipov et al., 2018; Prontenko et al., 2019). The consequences are chronic fatigue, frequent morbidity, low mental capacity, change in psycho-emotional state, low adaptation to high workload, learners' poor physical health (Mykhaylova & Grygus, 2013; Galan et al., 2017; Grihan et al., 2018; Pasichnyk et al., 2018). The state policy of Ukraine and world organizations consider it necessary to improve the health of schoolchildren, as evidenced by the development and implementation of relevant programmes and projects, especially during the Covid-19 period.

Orienteering tools provide not only a health-improving effect but also are aimed at developing schoolchildren's physical and mental abilities (Khimenes et al., 2016; Paliichuk et al., 2017; Melnikova, Melnikov, Zakharova & Kiselev, 2020; Kashuba et al., 2020). This activity requires additional physical and technical skills and abilities. In addition, learners develop the following qualities: observation, courage, perseverance, ability to navigate in difficult situations. They will need them in their future activities. Thus, it is of high importance for the orienteering sportsmen to have well developed memory and attention.

According to scientific studies, interesting, regular, organized exercises are the most affordable and effective means of improving children's psycho-physical condition. It is the best form of recovery that evokes children's desire to exercise more (Palchuk, 2012; Yarmak et al., 2017; Cherepov, Kalugina & Khafizova, 2019). Today, one of the optimal means of health-improving training, as well as effective physical and intellectual training is sports orienteering (Ratray & Roberts, 2012; Fedorova, 2014; Sirakov & Belomazheva-Dimitrova, 2018). It combines two activities, in particular: cross-country running and specialized mental activity. In combination, this process includes a set of operations aimed at performing purposeful movement through unfamiliar terrain using a sports map and compass (Alexandrova, 2011; Korol, 2013; Zagorodnikova & Guseva, 2020).

The guidance programme follows the one existing in the education system, however the programme under analysis is modified and includes psychophysical training.

Therefore, the objective of the article is to investigate the impact of a comprehensive sports orienteering programme on the psychophysical state of schoolchildren aged 13-14 and experimentally test its effectiveness.

Material & methods

Participants

The experiment was conducted in Chernivtsi specialized school № 6 (physical and mathematical profile). 44 learners representing 8 grade's learners who took part in the experiment (experimental group (EG) included 22 learners; control group (CG) – 22 learners). The average age of schoolchildren ranged between 13 and 14. The age of the participants is justified by the fact that schoolchildren display positive results and changes when being involved in regular extracurricular activities. The participants of the study are members of the extracurricular sports club, which operates within school system and applied to the state regulations and ethical norms. Therefore, the consent of the students and their guardians, as well as authorization from the school was granted before the initiation stage of the study.

It was found out that before taking part in the experiment the schoolchildren had been practising sports orienteering for 1 year.

Procedure

The proposed programme aimed at correcting the psycho-physical condition of schoolchildren aged 13-14 through sports orientation. Its effectiveness was tested through the comparison of the results demonstrated by the schoolchildren in the control and experimental groups. The control group followed a typical programme designed for orienteering clubs (Narovlyanskaya & Tyapkina, 2014); the experimental group trained according to the proposed programme, which is considered to generally accepted for incorporating in the extracurricular club activities in Ukraine.

However, the programme under study included psychophysical training which, as a result, increased the number of training hours – from 216 to 234 hours in total. Thus, the psychophysical component accounted for 18 hours, which will have a positive impact on the psychophysical state of schoolchildren, in particular, considerable improvements in memory and attention, as well as physical performance.

It should be noted that at the beginning of the experiment there was no statistically significant difference between the control and experimental groups ($p > 0.05$) in terms of their physical performance.

Methods

Multiple methods were used for evaluating efficiency of the introduced programme within pedagogical experiment. Among them: pedagogical observation, pedagogical testing and anthropometric research methods. In particular, anthropometric measurements were used to study the main somatometric features of the schoolchildren's (aged 13-14) morphological status.

Pedagogical testing of physical fitness was based on the set of motor tests and aimed at identifying the level of basic physical qualities development. To assess physical fitness, the tests of the school programme "Physical Education. Grades 5-9" were used (Krutsevych et al., 2012). Psychophysiological research methods were used to estimate the speed of reaction, speed of information processing, level of attention and memory, mental capacity and static coordination.

Data analysis

At the beginning of the experiment there was no statistically significant difference between the control and experimental groups ($p > 0.05$) in terms of their physical performance. The results of the research were subjected to mathematical processing using the following statistical methods: descriptive statistics, sampling method, Wilkie-Shapiro consistency criterion, Student's t-test, Wilcoxon's and Mann-Whitney's nonparametric criteria. Statistical processing of the obtained data was carried out using the data analysis and visualization programme "Statistica 13.0" and spreadsheets "Excel 2019" (Microsoft, USA), which allowed the analysis of measurements and calculation of baseline values. It is worth mentioning that the data are separated by sex because the sports orienteering training programme in Ukraine is different for both girls and boys, which stipulated the differentiation between training requirements for both sexes.

Results

Results showed that the vast majority of indicators of length and body weight, the girth of chest, the amount of skin and fat folds, dynamometry of the right and left hands and muscle strength of the flexors of the fingers of the girls in EG probably do not differ ($p > 0.05$) from the girls in CG (Table 1).

Table 1. Comparison of the indicators of physical development of schoolchildren in EG and CG before and after the pedagogical experiment (n = 44)

Research indicators	Results before the experiment EG (n = 22)	Results after experiment EG (n = 22)	p	Results before the experiment CG (n = 22)	Results after the experiment CG (n = 22)	p
	$\bar{x} \pm S$	$\bar{x} \pm S$		$\bar{x} \pm S$	$\bar{x} \pm S$	
Girls						
Body length (BL), cm	161,4±6,42	162,8±5,21	>0,05	159,2±5,21	162,1±3,78	>0,05
Body weight (BW), kg	41,2±4,19	43,7±3,12	>0,01	41,2±3,59	43,4±4,24	>0,01
The girth of chest (GC), cm	73,4±5,21	75,1±2,98	>0,05	70,2±4,12	74,1±4,21	>0,05
The amount of skin and fat folds, cm	2,6±0,89	2,7±0,39	>0,05	2,2±0,59	2,6±0,71	>0,05
Dynamometry of the right hand, kg	16,4±5,31	18,1±3,24	>0,05	17,4±4,34	18,0±5,12	>0,05
Dynamometry of the left hand, kg	14,9±4,12	16,2±3,89	>0,05	16,2±4,31	16,6±3,54	>0,05
Boys						
Body length (BL), cm	163,1±5,89	166,1±4,98	>0,05	165,4±3,12	166,8±4,21	>0,05
Body weight (BW), kg	45,1±4,85	49,1±4,11	>0,01	43,1±5,12	48,7±4,10	>0,01
The girth of chest (GC), cm	75,9±6,41	77,9±5,02	>0,05	77,4±5,12	79,8±4,25	>0,05
The amount of skin and fat folds, cm	3,2±0,78	3,1±1,26	>0,05	3,6±0,58	3,4±0,75	>0,05
Dynamometry of the right hand, kg	22,3±4,95	24,3±3,78	>0,05	22,9±4,36	23,7±3,68	>0,05
Dynamometry of the left hand, kg	17,5±5,80	19,1±5,10	>0,05	20,5±3,85	20,1±4,29	>0,05

It is worth mentioning that while conducting the pedagogical experiment we observed a positive dynamic of indicators, which testifies to the physical development of the girls in both EG and CG.

The body length of the girls in EG increased by 1.4 cm, their body weight by 2.5 kg, the girth of chest by 1.7 cm. The same indicators of the girls in CG increased by 2.9 cm and 2.2 kg, and 3.9 cm, respectively. The average results meet the age norms given in the literature in this field.

The analysis of the results at the end of the pedagogical experiment showed that the indicators of length and body weight, the girth of chest, the amount of skin and fat folds, dynamometry of the right and left hands, and muscle strength of the flexors of the fingers of the boys in EG do not differ ($p > 0,05$) from the boys in CG.

We can observe gradual dynamics of the increased indicators of boys' physical development in both EG and CG during the pedagogical experiment. The average results correspond to the age norms given in the special literature.

The data obtained show that the indicators of hand dynamometry, the amount of skin and fat folds, muscle strength of the flexors of the fingers at the end of the pedagogical experiment of the girls and boys in EG and CG did not differ significantly, although there is a positive trend in improving results.

Analysis of the reaction of the nervous system through psychophysiological testing showed that at the end of the pedagogical experiment, the girls and the boys in EG were statistically significantly ($p < 0,05$) different from the girls and boys in CG.

The girls in EG demonstrated significantly ($p < 0,05$) higher results of a simple visual-motor response to sound and light, a complex choice reaction, and the speed of information processing. Thus, they were more reactive and consistent with age norms than those of the girls in CG (Table 2).

The boys in EG demonstrated significantly ($p < 0,05$) higher results of a simple visual-motor reaction to sound and light of a complex selection reaction, and the speed of information processing. They corresponded to age norms and were significantly ($p < 0,05$) more reactive than the same indicators of the boys in CG.

This fact points out to the presence of a velocity component, which determines the high efficiency of neuro-dynamic characteristics demonstrated by the girls and boys in EG.

At the end of the pedagogical experiment, the EG girls' and boys' results of the Romberg test, which is used to determine static coordination, were significantly higher ($p < 0,05$) and complied with the age norms.

Table 2. Comparison of the indicators of the psychological state of learners in both EG and CG before and after the pedagogical experiment (n = 44)

Research indicators	Results before the experiment		P	Results after the experiment		P
	EG (n = 22)	EG (n = 22)		CG (n = 22)	CG (n = 22)	
	$\bar{x} \pm S$	$\bar{x} \pm S$		$\bar{x} \pm S$	$\bar{x} \pm S$	
Girls						
SVMR light, ms	to 347,2±29,21	257,2±22,14	<0,05	351,2±27,18	329,2±31,54	<0,05
SVMR sound, ms	to 358,1±34,23	259,5±24,20	<0,05	354,2±22,52	332,7±29,14	<0,05
Complex reaction choice, ms	of 489,1±5,19	421,1±14,09	<0,05	476,2±24,33	467,1±12,31	>0,05
Information processing speed, bits·s ⁻¹	9,2±1,20	7,0±0,05	<0,05	8,9±1,32	8,6±1,31	>0,01
Romberg's test, s	10,8±5,20	16,6±4,15	<0,05	8,9±5,07	10,1±7,12	>0,05
CSM, %	33,3±11,1	56,1±5,12	<0,05	31,9±14,2	34,8±6,18	>0,05
CIP, bit	419,4±29,4	452,0±10,1	<0,05	415,8±29,2	421,2±30,1	>0,05
Boys						
SVMR light, ms	to 357±21,41	262,2±22,12	<0,05	403,1±21,43	335,2±21,17	<0,05
SVMR sound, ms	to 367,1±26,91	246,2±14,25	<0,05	369,5±21,44	311,3±24,15	<0,05
Complex reaction choice, ms	of 485,2±19,81	414,3±9,37	<0,05	494,5±3,11	467,5±5,41	>0,05
Information processing speed, bits·s ⁻¹	8,7±0,45	7,2±0,48	<0,05	8,6±0,36	8,1±0,17	>0,01
Romberg's test, s	8,7±5,12	17,1±4,05	<0,05	8,9±4,12	10,1±4,19	>0,05
CSM, %	29,6±11,2	41,4±5,8	<0,05	28,2±14,1	31,2±8,1	>0,05
CIP, bit	361,1±50,2	421,1±12,7	<0,05	359,2±39,4	364,2±30,16	>0,05

Analysis of the state of cognitive functions at the end of the pedagogical experiment revealed significantly higher (p <0.05) average results in the capacity of short-term memory (CSM) and the capacity of information processing (CIP) in girls and boys in the EG.

Analysis of the average results simple visual-motor response (SVMR) of the girls in EG to light and sound revealed an improvement at the end of the pedagogical experiment. Thus, the simple visual-motor response to light decreased by 90 ms, which was 25.9 %, simple visual-motor response (SVMR) to sound decreased by 98.6 ms, which amounted to 27.5 %. The CG girls' rate of simple visual-motor response to light decreased by 22 ms, which was 6.3 %, and the rate of simple visual-motor response to sound decreased by 21.5 ms, which amounted to 6.1%. The EG girls' complex choice reaction at the end of the pedagogical experiment decreased by 68 ms, which amounted to 15.5 %, the CG girls' complex choice reaction decreased by 9.1 ms, which amounted to 1.9 %. The EG girls' average result of the speed of information processing at the end of the pedagogical experiment decreased by 2.2 bits s⁻¹, which amounted to 23.9 %. The CG girls' indicators decreased by 0.3 bits s⁻¹, which amounted to 3, 4 %. Analysis of the average result of the Romberg test conducted among the girls in EG at the end of the pedagogical experiment revealed an improvement of 5.8 s, which amounted to 53.7 %. The CG girls' indicators increased by 1.2 s, which amounted to 13.5 %. The

dynamics of average indicators of the EG girls' capacity of short-term memory increased by 68.5 %, the CG girls' indicators improved by 9.1 %. The EG girls' rate of information processing increased by 32.6 bits, which was 7, 8 %, the CG girls' indicators increased by 5.4 bits, which was 1.3 % (Fig.1).

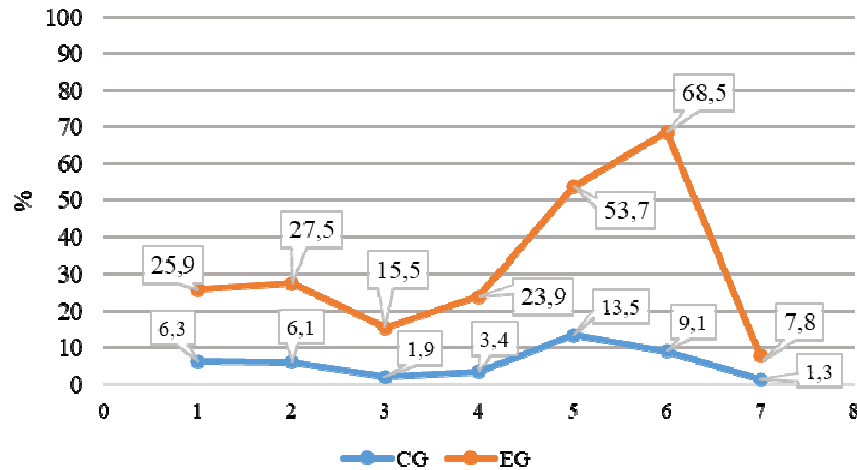


Fig.1. The dynamics of average results of the girls in control (CG) and experimental group (EG) in %, after conducting the pedagogical experiment

1 – SVMR to light, 2 – SVMR to sound, 3 – Complex reaction of choice, 4 – Information processing speed, 5 – Romberg's test, 6 – CSM, 7 – CIP.

At the end of the pedagogical experiment, the boys in EG demonstrated the following changes of indicators: simple visual-motor reaction to light decreased by 94.8 ms, which amounted to 26.6 %; simple visual-motor response to sound decreased by 120.9 ms, which was 32.9 %; the complex reaction of choice decreased by 70.9 ms, which was 14.6 %; information processing speed decreased by 1.5 bits · s⁻¹, which amounted to 17.2 %, Romberg's sample increased by 8.4 s, which amounted to 96.5 %, the capacity of short-term memory increased by 39.9 %, the capacity of information processing increased by 60.0 bits, which was 16.6 %.

At the end of the pedagogical experiment, the boys in CG demonstrated the following changes of indicators: simple visual-motor reaction to light decreased by 67.9 ms, which amounted to 16.8 %; simple visual-motor response to sound decreased by 58.2 ms, which was 15.8 %; the complex choice reaction decreased by 27 ms, which was 5.5 %; the speed of information processing decreased by 0.5 bit s⁻¹, which amounted to 5.8 %, Romberg's sample increased by 1.2 s, which amounted to 13.5 %, the capacity of short-term memory increased by 10.6 %, the capacity information processing increased by 5 bits, which was 1.4 % (Fig. 2).

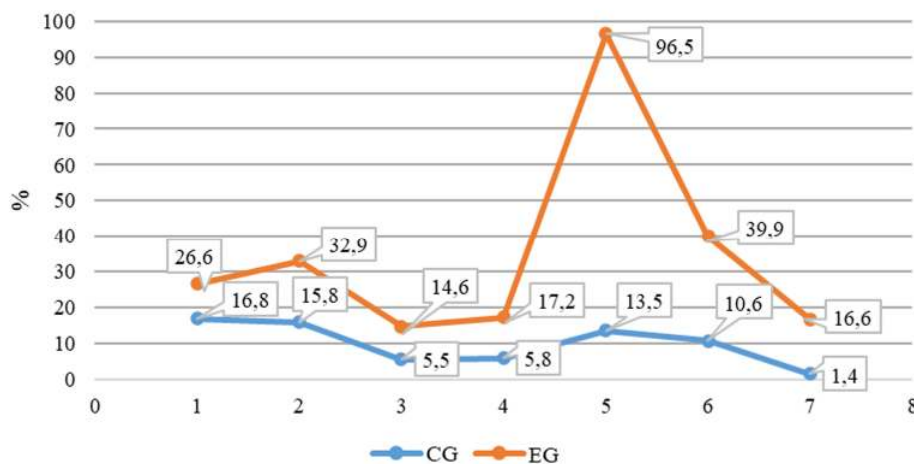


Fig.1. The dynamics of average results of the girls in control (CG) and experimental group (EG) in %, after conducting the pedagogical experiment

1 – SVMR to light, 2 – SVMR to sound, 3 – Complex reaction of choice, 4 – Information processing speed, 5 – Romberg's test, 6 – CSM, 7 – CIP.

Analysing the above, we can conclude that the positive changes in the indicators that characterize the functioning of higher nervous activity observed schoolchildren of the EG, confirm the effectiveness of the proposed programme of correcting psychophysical condition by means of sports orienteering.

Analysis of learners' physical fitness at the end of the pedagogical experiment revealed significantly higher ($p < 0.05$) average results in shuttle running (4x9 m), sit-ups for 30 s, and 1000 m running demonstrated by the girls in EG than the same results if the girls in CG. At the end of the pedagogical experiment, the boys in EG demonstrated significantly higher ($p < 0.05$) average results in the shuttle running (4x9 m) and the 1000 m running than the boys CG (Table 3).

We found no significant differences ($p > 0.05$) at the end of the pedagogical experiment between the girls and boys in both EG and in CG in the following indicators of physical fitness: pulling up, tilting the torso forward from a sitting position, long jump and sit-ups for 30 seconds.

Table 3. Comparison of the indicators of physical fitness of the schoolchildren in EG and CG before and after the pedagogical experiment ($n = 44$)

Research indicators	Results before the experiment EG ($n = 22$)	Results after the experiment EG ($n = 22$)	P	Results before the experiment CG ($n = 22$)	Results after the experiment CG ($n = 22$)	P
	$\bar{x} \pm S$	$\bar{x} \pm S$		$\bar{x} \pm S$	$\bar{x} \pm S$	
Girls						
Running 30 m,s	6,4±0,64	6,2±0,24	>0,05	6,8±1,21	6,7±0,34	>0,05
Shuttle running 4x9 m,s	12,4±1,12	11,6±0,81	<0,05	12,3±1,4	12,2±0,51	>0,05
Pull-ups, times	6,1±1,56	8,2±1,54	<0,05	6,2±3,12	7,1±2,17	>0,05
Tilt of the torso forward from a sitting position, cm	8,4±4,25	10,1±3,19	>0,01	8,5±3,47	8,9±2,13	>0,05
Long jump, cm	148,1±16,52	157,1±09,10	>0,05	150,7±16,10	152,7±11,10	>0,05
Sit-ups for 30 seconds, times	12,7±3,12	15,4±2,31	<0,05	11,2±3,47	12,2±2,31	>0,05
Running 1000 m, min, s	5,40±4,21	5,21±1,12	<0,05	5,46±2,11	5,39±2,01	>0,05
Boys						
Running 30 m,s	6,2±1,12	5,9±1,10	>0,05	6,1±0,79	6,0±0,64	>0,05
Shuttle running 4x9 m,s	11,4±2,14	10,5±0,45	<0,05	11,8±1,10	11,1±1,12	>0,05
Pull-ups, times	6,1±1,56	8,2±1,54	>0,05	6,2±3,12	7,1±2,17	>0,05
Tilt of the torso forward from a sitting position, cm	3,6±3,12	4,9±2,14	>0,05	3,4±2,45	4,2±2,21	>0,05
Long jump, cm	154,2±21,15	164,1±12,15	>0,05	154,9±17,51	160,4±14,12	>0,05
Sit-ups for 30 seconds, times	17,1±2,15	21,7±4,14	>0,05	18,4±5,12	19,7±6,41	>0,05
Running 1000 m, min, s	4,54±2,42	4,29±0,54	<0,05	4,53±2,41	4,46±2,21	>0,05

Let's analyse the obtained results at the end of the pedagogical experiment. The girls in EG: the average result of the shuttle run (4x9 m) decreased by 0.8 s, which was 6.5 %, the average result of sit-ups for 30 s, increased by 2 times, which was 20.2 %, and the average result in the 1000 m run decreased by 19.0 s, which was 3.5 %. The girls in CG: the average result of the shuttle run (4x9 m), decreased by 0.1 s, which was 0.8 %, the average result of sit-ups for 30 s, increased by 1.3 times, which was 4.7 %, and the average result in the 1000 m run decreased by 10.0 s, which was 1.3%. The boys in EG: the average result from the shuttle run (4x9 m) improved by 0.9 s, which was 9.7%, the average result in the 1000 m run improved by 25.0 s, which was 5.5 %. The boys in CG: the average result from the shuttle run (4x9 m) improved by 0.7 s, which was 5.9 %, the average result in the 1000 m run improved by 7.0 s, which was 1.5 %.

The obtained positive changes in the indicators that characterize the psychophysical state of the learners in EG confirmed the effectiveness of our proposed program.

Discussion

At the present stage of the educational system development there is the need to rethink conceptual approaches to teaching and educating learners, to correct their psychophysiological state and improve their physical and mental capabilities (Korol, 2013; Galan, Zoriy, Briskin, & Pityn, 2016; Yarmak et al., 2017; Radziejowski et al., 2021). Today's realities affect the increase of information load, which causes significant psycho-emotional stress and may result in chronic adaptive stress syndrome (Palchuk, 2012; Dutchak, & Trachuk, 2012; Andrieieva, Galan, Hakman, & Holovach, 2017; Paliichuk et al., 2018). Recent studies show that the psychophysiological development of learners is deteriorating, so a number of specialists in various fields, including pedagogy, medicine, rehabilitation (Sainchuk, 2012; Castro Lemus, & Gómez García, 2015; de Juan, García Martínez, & Valero, 2021) are searching for comprehensive and effective solutions to this problem.

According to research, schoolchildren, starting from middle school age, have emotional, volitional and motor disorders. The results of our work confirm the recently obtained results obtained by Ukrainian and foreign studies (Berezovskyi, 2016; Celestino et al., 2015; Selcuk et al., 2017; Blagii et al., 2018; Paliichuk et al., 2018; Escaravajal Rodríguez, 2020; Lamonedá, González-Villora, & Fernández-Río, 2020). Thus, through the introduction of sports orienteering into the educational process PE teachers can observe a positive dynamics of psychophysiological condition indicators. In addition, a number of studies have already proved the positive effect of orienteering on the cognitive functions of learners (Slonov, 2003, Kolomiets, 2009; Dotsenko, 2013; Voronov & Yakushev, 2014; Midtbø, 2014; Rosen, & Heijne, 2018; Yaroslav Galan, Olena Andrieieva, & Olenayarmak, 2019), as well as the increase of their motor skills, namely speed, agility, strength, and endurance (Galan, Zoriy, Briskin, & Pityn, 2016).

As a form of active leisure, orienteering is an affordable means of physical activity for different age groups. It fosters the formation of various skills, as it is accompanied by physical activity of medium, high and maximum intensity. The results of the study confirm that orienteering has a positive effect on the development and formation of the body's central functional systems (Voronov, 2012; Voronov, & Korenevsky, 2012; Selcuk et al., 2017; Sirakov, & Belomazheva-Dimitrova, 2018). This paper also summarized the results of the positive effects of orienteering on the functioning of the schoolchildren's central nervous system and the increase of the level of their overall physical performance (Celestino, Leitão, & Pereira, 2015).

Nevertheless, there are plenty of different studies in the field of sports orienteering, the results of the proposed investigation differ in terms of incorporating a specific programme of psychophysical trading aimed at correcting psychophysical state of schoolchildren, in particular in the framework of school extracurricular activities. The obtained results of the proposed research confirm to the previous studies (Galan, Zoriy, Briskin, & Pityn, 2016).

Conclusions

As a result of our research, we have developed the structure and content of a comprehensive programme aimed at the correction of psychophysical condition of schoolchildren aged 13-14 through sports orienteering, which consists of theoretical and practical blocks with additional use of psychophysical training. The effectiveness of the proposed programme is confirmed by the data of the formative experiment. Thus, the analysis of the state of cognitive functions at the end of the pedagogical experiment revealed significantly higher ($p < 0.05$) average results of short-term memory and information processing observed in the girls and boys in EG. The average results of the Romberg's test, which is used to determine static coordination, at the end of the pedagogical experiment, were significantly higher ($p < 0.05$) in girls and boys in EG, and corresponded to age norms. The obtained positive changes in the indicators that characterize the psychophysical state of the learners in EG confirmed the effectiveness of the proposed in this research programme. The developed programme aimed at correcting schoolchildren' psycho-physical condition could be used in educational and training process in sports orienteering.

Conflict of interest

Authors state no conflict of interest.

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