

The influence of table tennis training on the physical condition of schoolchildren aged 13-14 years

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Abstract. The article presents the results of the pedagogical experiment, in which 37 schoolchildren aged 13-14 years took part. The aim of the study was to determine the influence of recreational activity with table tennis means on the physical condition of schoolchildren. For the realization of the goal and the solution of the tasks we used general scientific methods (analysis, synthesis, generalization, comparison), anthropometric methods, physiological methods, psychophysiological methods, methods of mathematical statistics. The proposed recreational program with table tennis means was designed for the period of 10 months, and contained theoretical and practical sections. During the pedagogical experiment, the dynamics of changes in the morpho-functional state and psychophysiological state of schoolchildren aged 13-14 years were observed. During the classes, the anthropometric characteristics of boys and girls changed according to the natural biological processes. Statistical changes ($p < 0.05$) occurred only in the boys in the body mass index, this value increased by 5.6%. Significant changes ($p < 0.05$; $p < 0.01$) in boys and girls are observed in terms of the cardiovascular and respiratory systems. In the boys, at the end of the pedagogical experiment, the average result of the heart rate at rest decreased by 5.5 beats min⁻¹, that equals 6.5 % ($p < 0.05$); in the girls it decreased by 4.5 beats min⁻¹ that equals 5.2 % ($p < 0.05$). A significant increase is observed in the average result of vital lung capacity; in the boys it increased by 0.4 l that equals 17.4 % ($p < 0.01$); in the girls - by 0.3 l, that equals 15.0 % ($p < 0.01$). The latent time of simple reaction for visual and auditory stimuli in boys and girls decreased significantly ($p < 0.01$). The mean group indicator of the complex choice reaction, the short-term memory capacity, the volume of the processed information, and of the sharpened Romberg test, both in boys and girls, has improved significantly ($p < 0.01$).

Key words: table tennis, physical condition, schoolchildren

Introduction

One of the main directions of the state policy of Ukraine is to increase the level of health of schoolchildren and students. Today, an intensive search and development of activities aimed at the health improvement and correction of indicators of the physical condition of schoolchildren. Analysis of the scientific and methodological literature points out to the presence of a considerable number of publications on the organization of health-improving classes for schoolchildren aged 13-14 years (Galan, 2016; Yarmak, 2017; Bolotin, 2017; Denysova, 2018; Galan, 2018). The authors focus on the fact that the overwhelming majority of children of school age, due to significant intellectual loads and low level of physical activity, have motor function impairment, decline of physical and mental performance; and all these things hampers their learning considerably (Andrieieva, 2017; Kashuba, 2017; Imas, 2018).

Therefore, the correction of the components of the physical condition of students by means of physical education is an important area of the educational work of the secondary school. Currently, the most effective form of health improvement for schoolchildren is regular, interesting, and organized physical training activity in the off-school time (Andrieieva, 2017). Table tennis can be the best means of health-improving activity and effective physical and intellectual training. The game itself is a means of integrated physical loading on the body and recreational activity. The main advantages of table tennis are a variety of movements that affect the development of speed, speed-strength, agility and endurance. Play activity helps to strengthen the nervous system, motor system, improve metabolism, as well as the work of all body systems (Melnyk, 2017; Paliichuk, 2018).

In the scientific and methodological literature, there are quite a few works devoted to the study of the influence of table tennis means on the physical condition of schoolchildren aged 13-14 years and this fact has determined the relevance of our study.

Materials and Methods

During the research we used a set of methods. Theoretical methods: theoretical analysis and synthesis, generalization and systematization of biomedical, psychological and pedagogical literature. Empirical methods: assessment of anthropometric data, the functional state of the cardiovascular and respiratory systems, cognitive and neurodynamic functions of schoolchildren aged 13-14 years. We conducted pedagogical observation and experiment to test the effectiveness of the use of table tennis means in the extra-curricular activity. Statistical and mathematical methods: methods of descriptive statistics, methods of calculating integral assessments for quantitative and qualitative analysis of empirical data, and interpretation of the research results, which allowed us to prove the effectiveness of the implementation of table tennis means in the extra-curricular activities of schoolchildren aged 13-14 years. Experiment activity was carried out on the basis of general educational institution No.27 of the city of Chernivtsi. The study covered 37 schoolchildren aged 13-14 years.

Results

To write a recreational program in table tennis, we took into account the anatomical and physiological features of schoolchildren aged 13-14 years. From literary sources it is known that the average school age is characterized by an intensive increase in body size. During the year, the average body length increases by 4-7 cm, mainly due to lengthening of the lower extremities. Body weight increases at an annual average rate of 3-6 kg. The muscular system is developing quite intensively. From the age of 13, there has been a significant increase in the total muscle mass, mainly due to an increase in the thickness of the muscle fibres. The adaptive capacity of the circulatory system in schoolchildren aged 12-15 years during muscular effort is significantly less than in adolescence. The circulatory system of school students aged 13-14 years responds to the load less economically. The heart reaches full morphological and functional improvement only at the age of 20 years. In the period from 12 to 15 years, the highest rate of development of the respiratory system is observed. The volume of the lungs almost doubles at the age from 11 to 14 years, the respiratory minute volume increases significantly, and the vital capacity indicator grows as well.

Thus, taking into account the peculiarities of the development of schoolchildren in this sensitive period, the recreational program on table tennis for schoolchildren aged 13–14 years was developed in compliance with all pedagogical principles. The program focuses on the enhancement of the health-improving influence of the educational process. The time frame of the programme is ten months with a load of six hours per week. The program consisted of the following blocks: theoretical training, general physical training, special physical training, technical training, tactical training, and psychological training. The main goal of the program was to strengthen the health of schoolchildren, to acquire motor experience by mastering the basics of the techniques and tactics of playing table tennis focused on the health improvement.

Table 1 presents the results of the dynamics of morpho-functional indicators of boys and girls aged 13-14 years during the pedagogical experiment.

Table 1. Dynamics of morpho-functional parameters of schoolchildren aged 13-14 years under the influence of table tennis classes (n = 37)

Indicators under study	Before the pedagogical experiment		After the pedagogical experiment		±Δ, %	p
	\bar{x}	S	\bar{x}	S		
Boys (n=22)						
Body length, cm	160.4	5.36	163.7	5.11	2.0	p>0.05
Body weight, kg	43.8	6.27	46.4*	4.12	5.6	p<0.05
Chest girth, cm	76.2	4.11	77.5	4.57	1.7	p>0.05
HR _{rest} , beats /min ⁻¹	90.6	7.33	85.1*	4.09	6.5	p<0.05
VC, l	1.9	0.12	2.3**	0.11	17.4	p<0.01
Shtange test, sec	37.8	6.27	41.5*	5.64	8.9	p<0.05
Genchi test, sec	18.3	4.26	23.6**	1.45	22.5	p<0.01
Ruffier index, nominal units	11.6	2.18	8.7**	0.98	33.3	p<0.01
Girls (n=15)						
Body length, cm	161.3	5.11	163.1	5.04	1.1	p>0.05
Body weight, kg	43.3	6.21	44.7	4.46	3.1	p>0.05
Chest girth, cm	74.2	5.17	75.9	4.33	2.2	p>0.05
HR _{rest} , beats /min ⁻¹	91.2	7.15	86.7*	5.27	5.2	p<0.05
VC, l	1.7	0.52	2.0**	0.38	15.0	p<0.01
Shtange test, sec	36.4	6.13	41.3*	5.86	11.9	p<0.05
Genchi test, sec	18.5	2.54	22.7**	1.51	18.5	p<0.01
Ruffier index, nominal units	11.2	2.46	8.8**	0.97	27.3	p<0.01

Note: ± Δ, % - the difference at the end of the experiment;

Note: * the difference is statistically significant at the level of p <0.05;

** the difference is statistically significant at the level of p <0.01

A statistically significant difference in anthropometric indicators is observed only in the boys; their body weight within 10 months increased by 5.6 % ($p < 0.05$). Such an increase in the average result of body weight is due to the peculiarity of the development of this age period in boys and is not associated with table tennis. All other indicators in the boys and girls developed in accordance with the natural biological changes. The average statistical indicators of body length, body weight, and chest circumference in boys and girls of 13-14 years corresponded to the age standards.

Table tennis classes have a positive effect on the cardiovascular and respiratory systems. By the end of the pedagogical experiment, we observed significant ($p < 0.05$; $p < 0.01$) changes in the studied indicators of both sex groups. The average heart rate in the boys decreased by 6.5 % ($p < 0.05$); in the girls - by 5.2 % ($p < 0.05$). The average group result of volume capacity in the boys increased by 17.4 % ($p < 0.01$); in the girls - by 15.0 % ($p < 0.01$). The average group results with breath holding improved significantly. In the boys, the result of the Shtange test improved by 8.9 % ($p < 0.05$), in the girls - by 11.9 % ($p < 0.05$). The result of the Genchi test in the boys increased by 22.5 % ($p < 0.01$), in the girls - by 18.5 % ($p < 0.01$).

In the boys and girls, the ability of the cardiovascular system to respond to dynamic stress received significant positive changes. The average group result of the Ruffier index in the boys improved by 33.3 % ($p < 0.01$) and in the girls by - 27.3 % ($p < 0.01$). In our opinion, the positive dynamics of the studied parameters of the cardiovascular and respiratory systems are due to the use of a significant number of action games during recreational classes. Games are an effective means of physical recreation and contribute to the development of physical efficiency. The game of table tennis includes an active physical component that solves a complex of important tasks in working with students of 13-14 years. First of all, it satisfies the need for motor activity, stabilization of emotions, improves the adaptive properties of the body.

The next stage of our work was the analysis of the influence of table tennis on the psycho-physiological state of schoolchildren aged 13-14 years. The results presented in Table 2 indicate significant positive dynamics of cognitive and neurodynamic functions and coordination abilities of schoolchildren.

The game of table tennis is characterized by insignificant muscular effort, but at the same time it contains a variety of physical motor activity, observation, attention and reaction, efficiency in taking tactical actions, as well as the ability to mobilize.

At the end of the pedagogical experiment, the average group result of the short-term memory capacity in the boys improved by 42.9 % ($p < 0.01$) and in the girls - by 55.2 % ($p < 0.01$). It should be pointed out that the girls have a significantly higher indicator of the volume of processed information ($p < 0.01$) than the boys. The analysis of neurodynamic functions also indicates that the girls have significantly better average results than the boys. This specific result was also observed at the end of the pedagogical experiment. The average group result of the volume of the processed information in the boys improved by 24.4 % ($p < 0.01$) and in the girls - by 10.5 % ($p < 0.01$).

Table 2. Dynamics of indicators of the psychophysiological state of schoolchildren aged 13-14 years under the influence of table tennis classes ($n = 37$)

Indicators under study	Before the pedagogical experiment		After the pedagogical experiment		$\pm\Delta$, %	p
	\bar{x}	S	\bar{x}	S		
Boys ($n=22$)						
Short-term memory capacity (STMC),%	23.8	9.64	41.7**	6.4	42.9	$p < 0.01$
Volume of the processed information (VPI), bit	275.2	58.4	364.1**	40.8	24.4	$p < 0.01$
Simple reaction for visual stimuli, millisecond	389.7	53.47	331.1**	31.28	17.7	$p < 0.01$
Simple reaction for auditory stimuli, millisecond	392.4	49.25	341.1**	42.11	15.0	$p < 0.01$
Complex choice reaction, millisecond	495.1	58.32	427.9**	28.54	15.7	$p < 0.01$
Sharpened Romberg test, second	6.1	3.27	14.7**	3.15	58.5	$p < 0.01$
Girls ($n=15$)						
Short-term memory capacity (STMC),%	21.6	11.17	48.2**	5.22	55.2	$p < 0.01$
Volume of the processed information (VPI), bit	387.1	43.71	432.7**	31.51	10.5	$p < 0.01$
Simple reaction for visual stimuli, millisecond	371.3	52.12	325.1**	32.18	14.2	$p < 0.01$
Simple reaction for auditory stimuli, millisecond	370.2	41.23	331.1**	33.14	11.8	$p < 0.01$
Complex choice reaction, millisecond	490.2	44.27	425.2**	31.64	15.3	$p < 0.01$
Sharpened Romberg test, second	9.7	5.29	15.3**	2.16	36.6	$p < 0.01$

Note: $\pm \Delta$, % - the difference at the end of the experiment;

Note: ** the difference is statistically significant at $p < 0.01$

The game of table tennis provides for tactical actions that form the ability of students to fight a rival, to think quickly, to process information and to make decisions. Therefore, the ability to respond to changes in the situation while playing table tennis contributed to the development of neurodynamic functions in school students.

The simple reaction for visual stimuli in the boys improved by 17.7 % ($p < 0.01$) and in the girls - by 14.2 % ($p < 0.01$). The simple reaction for auditory stimuli in the boys improved by 15.0 % ($p < 0.01$) and in the girls - by 11.8 % ($p < 0.01$). The average group indicator of the complex reaction in the boys improved by 15.7 % ($p < 0.01$) and in the girls - by 15.3 % ($p < 0.01$).

The boys and girls, under the influence of table tennis classes, have significantly improved their coordination abilities. Analysis of the average group indicator of the sharpened Romberg test in the boys and in the girls at the end of the pedagogical experiment indicates a significant positive trend. In the boys, the average group result increased by 58.5% ($p < 0.01$) and in the girls by 36.6% ($p < 0.01$).

So, table tennis classes develop not only coordination of movements and reaction speed, but also memory and volume of the processed information. The ability to regulate physical and mental loads, to determine the intensity of loads and the duration of training individually, are some of the main advantages of table tennis classes.

Discussion

Targeted use of play means in recreational and health-improving activity of schoolchildren may help in solving the optimization of the motor mode. The use of team sports by specialists in the field of physical culture and sports enable increasing the possibilities of pedagogical influence on the formation of motor skills and abilities (Likhachev, 2005; Dvorkina 2013). The collective nature of play activity contributes to the development of moral qualities in school students, such as responsibility, respect for a partner and a rival, and discipline. In the play activity, schoolchildren can show their personal qualities: independence, initiative, and creative approach.

Table tennis provides for some requirements for the personality of school students. The play activity results are not only physical fitness, tactical and technical competence, but also psychological changes.

However, the school age of 13-14 years is characterized as the main stage in the development of personality. At this age period, a stable system of personal qualities is formed, in particular self-esteem. Play activity contributes to the development of the personality of the student. Teenagers who play sports are characterized by an increased level of motivation, a higher level of intellectual development, a stable nervous system, and a high level of socialization (Gordon, 2003).

The theoretical significance of this research is presented by the fact that we have supplemented the information on the health-improving influence of table tennis means on the physical condition of schoolchildren. The research has revealed the positive dynamics of morpho-functional parameters and the psycho-physiological state of schoolchildren aged 13-14 years. The data obtained will complement the section of recreational and health-improving activity in secondary school.

The results of our research have supplemented the data (Zhuravleva, 2011; Rebryna, 2011; Ioannis, 2015) on the positive influence of table tennis classes on the physical development of schoolchildren. As well, the results obtained have supplemented the data (Loboda, 2012; Ganotsky, 2016; Xavier, 2017; Ansodi, 2017) on the effectiveness of the application of table tennis means for the development of coordination abilities of schoolchildren.

Conclusions

The results obtained during the pedagogical experiment, indicate the effectiveness of the use of table tennis means in the recreational activity of schoolchildren aged 13-14. In the boys and girls, the indicators of the cardiovascular and respiratory systems improved significantly ($p < 0.05$; $p < 0.01$). The level of physical performance increased significantly ($p < 0.01$), both in the boys and in the girls and at the end of the pedagogical experiment began to correspond to the average level. Table tennis classes contributed to the speed and accuracy of visual reactions, the volume of the processed information and the short-term memory capacity. The positive influence of play activity is observed in the improvement of the coordination abilities of schoolchildren; the indicator of the sharpened Romberg test improved significantly ($p < 0.01$).

Competing Interests

The authors declare that they have no competing interests.

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