

Effects of mutual learning in physical education to improve health indicators of Ukrainian students

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

Abstract

Purpose: The problem of research and increasing of motor activity modes remains relevant, since motor activity is one of the main factors determining health and the level of physical condition of population. The aim of study was to analyze the impact of the mutual learning program of physical education for improvement the physical and mental fitness of students in Ukraine.

Material: Four groups were used for the survey: 2 experimental groups (male, n=31; female, n=33), which received 64 lessons of physical education, which included intra-subgroup interaction, changing of students, and control of knowledge and skills of each other, and 2 control groups (male, n=32; female, n=31), which received a traditional physical education lessons. Assessment of the somatic health (Kettle index, Robinson index, lifetime index, strength index) and physical preparedness (running tests, trunk from the lying position, throw of a medball). Efficiency of processing, speed of figuring out the work and mental stability were determined using Schultz-Platonov tables.

Results: The results suggest about an increase in the functional capacity of cardiovascular and respiratory system among male and female of experimental group. The growth of the physical fitness results was set in lifting the trunk from the lying position to the sitting and throw of medball. After the experiment, positive changes in cognitive parameters were observed in female and male of experimental group. Among control group students, the results were significantly stable.

Conclusions: The results suggest that program increased the level of physical and mental fitness of students of both gender and had a significant impact on the indicators of cardiovascular system.

Keywords: physical education, students, mutual learning, health.

Introduction

Preserving and improving of population health, prolonging the period of active healthy life, reducing premature mortality and increasing the average life expectancy are recognized among the priority tasks. The current state of health of Ukrainian population is formed under the influence of a number of factors, namely: biological, socio-economic, environmental and lifestyle factors and is characterized by a combination of pathologies with varying severity and prevalence [1]. The problem of research and increasing of motor activity modes remains relevant, since motor activity is one of the main factors determining health and the level of physical condition of population [2, 3]. The only way out is to increase the daily motor activity and to include special aerobic exercises of moderate intensity [4].

The formation of a new ideology and a culture of health promotion of young people appears to be a challenge. Unless the solution to this problem is found, society can suffer quite noticeable and irreversible losses in human resources, which will undoubtedly negatively affect the productive infrastructure, well-being and quality of life [5]. The analysis of this problem is an urgent task of modern pedagogics and teaching practice, because health belongs to prior human values [6].

The high level of academic load of students, which is over 36–40 hours per week, its uneven distribution during the day and week, the disordered organization of extracurricular activities – all this negatively affects the efficiency of students' organism [7, 8]. Study [9] showed that 15–20% of the Ukrainian students have some deviations in their health.

The need for an additional muscular activity becomes more required [10]. Specialists [11–13] emphasize that in order to improve the health of students of higher educational institutions, it is, first of all, necessary to use means of physical culture, aimed at improving the development of motor qualities. However, the health effect of exercising requires a clear and regulated organizational system and regular monitoring of basic indicators of students' functional state [14, 15]. At the same time, the issues of ways of attracting young people to physical education, improving physical conditions and health conditions remain unsolved.

We assume that physical education classes with the use of athletic gymnastics and mutual learning will improve indicators of health, the physical and mental fitness of young persons.

Aim of Study. The aim of study was to analyze the impact of the mutual learning program of physical education for improvement the physical and mental fitness of students in Ukraine

Material and Methods

Participants.

The study involved students of 1-st-3-rd courses aged 17–19 years. By random sampling, we have formed 2 experimental (male, n=31; female, n=33) and 2 control groups (male, n=32; female, n=31). Control groups (CG) were engaged in physical education in accordance with the traditional program of physical education, and those in experimental groups (EG) – in the program with the experimental program. This study was approved in advance by protocol proved by Lviv State University of Physical Culture. Each participant voluntarily provided written informed consent before participating.

Research Design.

All students attended obligatory (academic) physical education classes twice a week during the academic year (32 weeks). In both groups (CG and EG), classes were conducted by the same teacher of physical education. Duration of classes in both groups was 90 minutes. In both groups the priority was given to those means of physical education, which were of the highest health effect: athletics, athletic gymnastics, sports games.

The difference in classes in the conditions of forming experiment was in the methods and forms of organization of educational process (Table 1). We have introduced

educational-methodical cards with the technique of exercises for mutual training of students, as well as developed tasks for cooperation in subgroups aimed at improving physical fitness of students. The section “Self-monitoring of Health” included a lecture session to introduce students to the measurement of heart rate, blood pressure, filling questionnaires on the state of health.

Students of CG underwent the usual scheme in academic groups and performed the same tasks. Students of EG were engaged in subgroups, which included changing of students, in constant interaction and control of knowledge and skills of each other, in addition, the tasks were separately worked out in microgroups. The subject-subjective interaction of students was based on the tasks of physical culture, taking into account the unity of the principles of harmonious development of personality and integration of targeted health and educational activities of students. The organizational structure of mutual learning was complex, which combined the group work of students (one teaches many), pair and individual ones. The program contained tasks of varying degrees of complexity for the gradual formation of ability to conduct classes by each student as a teacher; mutual learning of students while doing home tasks (assembling various complexes of exercises); students were involved in mutual analysis

Table 1. The program of mutual learning of students

Forms of classes	Contents of educational material	Methodological approaches to organization
Theoretical	Means and methods of physical condition restoration Presentation of favourite sport. Advertising for physical education and sports	Discussion and mutual analysis. Front, frontal-group method Interpersonal surveys of students, discussion, mutual evaluation of material quality. Presentation (in microgroup of 3–5 people)
Practical	Medical-biological basis of a healthy lifestyle. Influence of physical exercises on activity of basic functional systems of the body Mutual studying of athletic exercises performance technique with the use of educational-methodical cards Mastering methods of assessing physical health. Methods of regulation of emotional state by physical exercises Development of underdeveloped physical qualities	Interpersonal control of heart rate of students. Work in pairs and groups of three Mutual check-up of exercises performance. Group work (3–5 people) Autotraining, relaxation. Mutual analysis and evaluation by participants of the subgroup (5–7 people) Mutual control of exercises performing (microgroup 5–7 people, depending on the level of fitness)
Independent	Preparation and performance of a game for the development of certain physical quality Preparation for classes using educational-methodical cards on athletics Compiling complexes of exercises and programs for development of physical qualities Using and analyzing self-monitoring cards Compiling of exercise complexes for underdeveloped physical qualities	Mutual control and analysis. Work in pairs and groups of three Selfcontrol, mutual control, work in microgroups of 3–5 people Self and mutual analysis of the subgroup (5–7 people); brainstorming, round table, mosaic Self and mutual analysis. Individual method Search for methodical material, compiling teacher’s notes. Work in microgroups (3–5 people)

of the exercises. Mutual studying also took place during extracurricular classes. Groups were formed depending on the level of development of individual physical qualities, which were of changing nature for the constant exchange of experience. Under supervision of teacher, students compiled exercise complexes to improve the underdeveloped physical qualities and, according to personally developed programs, engaged in training in their free time.

Students worked in groups of 5–7 people for the development of physical qualities and mastery of physical exercise techniques. At the beginning of the year, students were tested for physical fitness. Formation of groups was based on the levels of physical fitness and physical qualities that were not well developed. Among the members of microgroups, one leader of the group was chosen, who had higher than average or high level of fitness. Leaders of groups on the development of each physical quality changed groups for the harmonious physical development of students. Subsequently, students who showed the growth of physical qualities led the group. As the development of physical qualities among students of one subgroup was uneven, each participant of the experiment was in the role of both the leader and the student. At the end of academic year, physical fitness of students was retested.

Assessment of the somatic health and physical preparedness

The calculation of the Kettle index (body mass, kg \times height⁻¹, cm), Robinson index (heart rate \times blood pressure_{max} \times 100⁻¹), lifetime index (lungs capacity, ml \times mass⁻¹, kg), strength (100 \times dynamometry of hand, kg \times body mass⁻¹, kg) and integral assessment of physical health level was carried out according to generally accepted methods [15]. General endurance was assessed by the 3000 m (male) or 2000 m (female) running test (scoring in minutes); for evaluating of strength endurance lifting the trunk from the lying position to the sitting one per 1 min was used (scoring in number of times); agility was tested by running 30 m in a “snake mode” between 5 racks; strength of muscles of the upper shoulder girdle was tested by throw of a medball (result in meters).

Cognitive indices

The effectiveness of cognitive processes was determined using Schultz-Platonov tables. A person under study was in turn offered five tables, which showed random numbers from 1 to 25. The task was to look for, show and name the numbers in order of their growth. The sample was repeated using five different tables. The results were determined on three scales – efficiency of processing the tables, speed of figuring out the work and mental stability.

Efficiency of processing (EP) was calculated by the formula:

$$EP = (T_1 + T_2 + T_3 + T_4 + T_5) / 5,$$

where T_n is the time of working with a certain table.

Speed of figuring out the work (SF) was calculated by the formula:

$$SF = T_1 / EP$$

A score of less than 1.0 was considered as indicator of good figuring out the work; the higher this figure than 1.0 was, the more the person under study needs preparation for the main work.

Mental Stability (MS) was calculated by the formula:

$$MS = T_4 / EP$$

A score of less than 1.0 showed good mental health; the higher this indicator was, the worse psychological stability of the person under study.

Statistical Analysis.

The characteristics of subjects were described analyzed by mean value (M), mean square deviation (m). The normal distribution was checked by the Shapiro-Wilk test, for statistical verification of the hypothesis about the probability of differences between the indicators of different groups W-criterion of Wilcoxon was used; the level of significance was set at least to $p < 0.05$. Statistic processing was performed using SPSS software.

Results

There was no difference in the data of functional preparedness of male and female, both in experimental and control groups at the beginning of experiment ($p > 0.05$). The study of weight-height Kettle index gives the right to conclude that male and female of EG and CG do not have significant difference in the indices ($p > 0.05$) (Table 2).

There was an increase in lifetime index of male in EG; it became significantly higher than at the beginning of the experiment at 4.36 ml/kg ($p < 0.01$). At the same time, its value at the beginning of the experiment was considered to be lower than the average level, and at the end of experiment – as the average one. Among male of CG, the results of this index were lower than the average level, which was significantly confirmed ($p < 0.05$). Female of EG have a typical situation ($p < 0.01$), as well, which indicates an increase in the functional capacity of respiratory system.

Before the experiment the strength index value corresponded to a level below the average, and till the end of the experiment reached an average level. Among female of CG, the strength index remained unchanged ($p > 0.05$). Among female of CG no static changes were found at the end of the experiment ($p > 0.05$), we clearly observed statistical differences between female of EG and CG ($p < 0.01$) (Table 3).

After analyzing the value of Robinson index in male of EG and CG at the end of the experiment, a significant difference was found in the indices, as the index of EG students was above the index of CG students at 5.35 units ($p < 0.05$). In EG female, the functional capacity of cardiovascular system increased at 6.47 units ($p < 0.01$), in students of CG – the values of Robinson index were reliably stable ($p > 0.05$).

At the beginning of the experiment male and female students both of control (CG) and experimental (EG) groups did not show any significant differences regarding the level of physical fitness ($p < 0.05$). Practically in all exercises after the experiment, both male and female from

Table 2. Dynamics of indices of somatic health of students

Indices	Groups	M ± m (before experiment)	M ± m (after experiment)	pCG & EG
<i>Male</i>				
Kettle index	CG	385.43 ± 31.34	389.56 ± 32.05*	> 0.05
	EG	389.76 ± 22.77	390.79 ± 22.03	
Lifetime index	CG	50.80 ± 6.34	51.35 ± 6.18	< 0.01
	EG	52.49 ± 7.46	56.85 ± 5.72†	
Strength	CG	62.42 ± 10.35	63.70 ± 10.01	< 0.05
	EG	61.39 ± 9.49	67.99 ± 6.31†	
Robinson index	CG	90.94 ± 10.97	87.56 ± 10.32*	< 0.05
	EG	93.50 ± 10.53	82.21 ± 8.22†	
<i>Female</i>				
Kettle index	CG	367.57 ± 17.66	367.44 ± 17.74	> 0.05
	EG	358.07 ± 21.65	360.81 ± 20.83	
Lifetime index	CG	42.05 ± 3.57	43.97 ± 4.28*	< 0.01
	EG	42.81 ± 5.57	47.46 ± 4.58†	
Strength	CG	39.53 ± 5.61	41.56 ± 5.75	< 0.01
	EG	41.15 ± 6.55	47.46 ± 6.58†	
Robinson index	CG	87.78 ± 9.11	86.17 ± 8.53	< 0.05
	EG	87.81 ± 10.18	81.34 ± 8.98†	

Note. *p < 0.05, †p < 0.01

the EG experienced significant statistical positive changes (Table 3).

The growth of the results among female of EG was set in lifting the trunk from the lying position to the sitting one at 9.3%, and throw of medball from the sitting position with two hands from behind the head 12.2%, among male of EG in lifting the trunk from the lying position to the sitting one at 10.1%. Insignificant statistical changes occurred among female of EG in exercises: running “in a snake mode” 30 m (4.5%); among male – in throw of medball from the sitting position with two hands from behind the head (4.4%). The result of running at 3000 m among EG male improved by 3.8% (14 s), while those of CG improved at 0.7% (10 s). Among female of EG it has been noticed an increase in the results of running at 2000 m by 3.1%.

The results of throw of medball from the sitting position with two hands from behind the head among EG male increased by 4.4% (31 cm) (p < 0.001), while EG female improved the result by 14.3% (53 cm) (p < 0.001). Significant differences were detected between female of both groups (p < 0.001).

Among EG male, the overall level of fitness increased from an average level with 2.81 ± 0.70 to above the average one with 3.77 ± 0.88 points (p < 0.001). Among EG female level of fitness increased from 2.61 ± 0.79 to 3.58 ± 0.79 points, which corresponds to the average level (p = 0.001). There were no statistically significant changes in CG male and female.

After the experiment, positive changes in cognitive

parameters were observed both in female and male of EG (p < 0.05) (Table 3). The efficiency of processing the tables among EG male at the beginning of the experiment was at satisfactory level, the average time for processing each table was within 51.85 ± 18.95 s. After the pedagogical experiment, the efficiency of processing was 41.89 ± 8.40 s (p < 0.05), which corresponds to sufficient level.

At the end of the experiment among CG male we have also revealed an increase in the efficiency of processing the tables (p < 0.05). Nevertheless, there were significant differences between EG and CG students: male of EG at 7.88 s faster processed the tables than those of CG (p < 0.05).

Analyzing the tendencies of spatial distribution and amount of attention among EG female, we have observed improvement in the efficiency of processing the tables at 9.26 s (p < 0.01), in CG – significant differences were not found (p > 0.05). The difference in rates between female CG and EG after the experiment was 8.51 (p < 0.001).

Speed of figuring out the work at the beginning of the experiment among female and male both in EG and CG was low (> 1.0). Among EG male results in the course of experiment increased by 0.12 s (p ≤ 0.01), in CG – no differences were found. Among EG female we have revealed a statistically significant improvement in the speed of figuring out the work (at the beginning of the experiment the result was 1.07 ± 0.18, and at the end – 0.97 ± 0.10, p < 0.01). Among CG female, the results were significantly stable (p > 0.05) (Table 4). After the experiment among male of EG, the value of mental

Table 3. Changes in physical fitness and cognitive indices of students

Qualities	Groups	M ± m (before experiment)	M ± m (after experiment)	p	pCG & EG
<i>Physical fitness</i>					
<i>Male</i>					
General endurance	CG	14.30 ± 1.04	14.20 ± 0.91	> 0.05	< 0.05
	EG	14.10 ± 0.81	13.56 ± 0.67	< 0.05	
Strength endurance	CG	40.63 ± 4.53	43.22 ± 4.11	< 0.05	< 0.01
	EG	41.94 ± 4.10	46.68 ± 4.54	< 0.001	
Strength of muscles of the upper shoulder girdle	CG	6.96 ± 0.47	7.01 ± 0.45	> 0.05	< 0.05
	EG	7.00 ± 0.54	7.31 ± 0.53	< 0.001	
Agility	CG	5.15 ± 0.14	5.09 ± 0.16	> 0.05	< 0.01
	EG	5.11 ± 0.15	4.95 ± 0.14	< 0.001	
<i>Female</i>					
General endurance	CG	11.53 ± 0.81	11.51 ± 0.71	> 0.05	< 0.05
	EG	11.52 ± 0.67	11.16 ± 0.53	< 0.05	
Strength endurance	CG	38.03 ± 5.08	40.26 ± 3.74	< 0.05	< 0.05
	EG	38.70 ± 4.46	42.30 ± 2.72	< 0.001	
Strength of muscles of the upper shoulder girdle	CG	5.43 ± 0.66	5.54 ± 0.66	> 0.05	< 0.01
	EG	5.31 ± 0.53	5.96 ± 0.40	< 0.001	
Agility	CG	6.21 ± 0.29	6.10 ± 0.23	< 0.05	< 0.05
	EG	6.26 ± 0.28	5.98 ± 0.26	< 0.001	
<i>Cognitive indices</i>					
<i>Male</i>					
Efficiency of processing the tables	CG	51.61 ± 17.61	49.77 ± 19.22	< 0.05	< 0.05
	EG	51.85 ± 18.95	41.89 ± 8.40	< 0.05	
Speed of figuring out the work	CG	1.02 ± 0.25	1.01 ± 0.29	> 0.05	> 0.05
	EG	1.05 ± 0.25	0.93 ± 0.18	≤ 0.01	
Mental stability	CG	1.04 ± 0.17	1.07 ± 0.17	> 0.05	< 0.05
	EG	1.09 ± 0.20	0.99 ± 0.13	< 0.05	
<i>Female</i>					
Efficiency of processing the tables	CG	50.09 ± 9.78	50.01 ± 11.05	> 0.05	< 0.001
	EG	50.76 ± 8.52	41.50 ± 6.55	< 0.01	
Speed of figuring out the work	CG	1.09 ± 0.25	1.10 ± 0.23	> 0.05	< 0.01
	EG	1.07 ± 0.18	0.97 ± 0.15	< 0.01	
Mental stability	CG	1.03 ± 0.16	1.09 ± 0.17	> 0.05	< 0.01
	EG	1.06 ± 0.11	0.97 ± 0.10	< 0.001	

stability increased to 0.99 ± 0.13 ($p < 0.05$), and in CG – decreased to 1.07 ± 0.17 , but statistically, changes in CG were not confirmed ($p > 0.05$).

Discussion

An assessment of the functional state of body and its reserve capacities is important for determining the effectiveness of physical education classes [16, 17]. Good

functional state can be considered as a prerequisite for high physical working efficiency and potential ability of the body to adapt to physical activity [10, 18].

The Kettle index of CG and EG students is on the average level of completeness for both female and male [8]. However, an individual analysis of the results showed that in 11.3% of male there is a shortage of body mass, and 3.8% are overweight, whereas in female the figures

are 14.2% and 10.6%, respectively.

The level of musculoskeletal system functions reserve of female in EG is estimated to be lower than the average, an increase in the strength index was noted ($p < 0.01$), but the initial data were too low. According to Robinson index (in a state of rest), we characterized reserves criteria and economization of cardiovascular system functions. Reduction of this index indicates an improvement in the work of the abovementioned system. Characteristics of the functional capacity of cardiovascular system of EG male (Robinson index) was at a level higher than the average, in CG male— indices also significantly improved ($p < 0.05$) and corresponded to the average level [8].

As a result of the experiment, the values of this index for EG female were higher than the average level, and in CG those values were the average. The study of the dynamics of Robinson index results shows that due to the implementation of aerobic exercises, we observe the improvement of the cardiovascular system both in male and female of EG [18, 19].

After the experiment, positive progress was observed among students of EG viewing the level of physical fitness. The progress of CG students did not have such a distinctive character and was the result of natural human development [20]. Improvement of physical fitness indices among students of EG was achieved, first of all, due to the use of means and methodical techniques aimed at attracting students to self-study and mutual studying during academic classes on physical education. They included compilation, conducting and performing of exercise complexes, analysis of exercise techniques and adjustment of loading according to heart rate figures. Also, during independent performing of exercise complexes while extracurricular forms of physical education, which contributed to the deepening of knowledge, abilities, skills, positive changes in motivation to regular physical activity, and thus increase in the volume of motor activity of students.

Strength indices have increased among students due to the use of exercises with weights, overcoming resistance of the partner, with equipment and on gymnastic devices. Among male of EG, increase in results of strength endurance (in lifting the trunk from the lying position to the sitting one) increased by 11.3% from the average to above the average, and among EG female – 9.3% from below the average to the average. Such increase can be explained by the fact that strength is the fastest growing quality, but if one does not maintain the level achieved by systematic exercising, it will soon be lost [21].

The results of the experiment confirm the effectiveness of the program in terms of improving cognitive indices. After the pedagogical experiment, a positive growth of indices was established, in particular, the efficiency of processing corresponded to sufficient level.

Conclusions

The results suggest that experimental program of mutual learning can help to improve the fitness level and adaptation abilities of an organism. The program had a significant impact on the indicators of the cardiovascular system and mental abilities of students of both gender. These findings also indicate that such pedagogical program with the special emphasis on mutual learning could serve as an effective health-preserving means of physical education.

Funding

This research received no external funding.

Acknowledgments

We acknowledge the time and effort of all participants in this study.

Conflicts of Interest

The authors declare no conflict of interest.

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Cite this article as:

Bodnar I, Pavlova lu, Dukh T, Wąsik J, Mosler D, Svysch Y. Effects of mutual learning in physical education to improve health indicators of Ukrainian students. *Physical education of students*, 2019;23(5):229–235. <https://doi.org/10.15561/20755279.2019.0503>

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Received: 12.09.2019

Accepted: 17.10.2019; Published: 26.10.2019