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Original Article

Impact of the combined use of health-improving fitness methods ("Pilates" and "Bodyflex") on the level of functional and psychophysiological capabilities of students

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Abstract:
The aim is to determine the impact of combined use of health-improving fitness methods of Pilates and Bodyflex on the level of students' psychophysiological and functional capabilities. *Materials:* 46 high school students took part in the study. *Methods of the research* are psychophysiological (speed detection of simple and complex reaction in different test modes, level of functional mobility and strength of the nervous system). We measured the indicators: blood pressure, stroke volume of blood, heart rate during rest and exercising. There was determined the indices of submaximal workability and autonomic balance. We used also the methods of pedagogical experiment and mathematical statistics.
Results: We observed positive effect of the developed methods to the level of students' psychophysiological and functional capabilities. As a result of their application we saw significant decrease in the latent time of simple visual and motor reaction, complex visual and motor reaction, time duration of the test "level of functional mobility of nervous processes" in the feedback mode in the experimental group. The boys showed significant increase in stroke volume (from 58 ml to 62.1 ml, the threshold of anaerobic metabolism from 123.4 beats per min^{-1} to 141.4 beats per min^{-1}. The girls also showed significant increase in stroke volume (from 58.3 ml to 62.5 ml, the threshold of anaerobic metabolism from 123.7 beats per min^{-1} to 143.3 beats per min^{-1}. The indicators of energy-supply systems increased (S.A. Dushanin's technique). We marked the improvement in efficiency of the cardiovascular system (increased heart rate variability from 322.12 ms to 354.43 ms, reduction of mode amplitude of RR-intervals from 34.09% to 21.54%).
Conclusions: It is recommended to use complex "Pilates" and "Bodyflex" systems in learning process. It contributes to the functional and psychophysiological capabilities of students. The use of Bodyflex and Pilates improves strength of nervous processes and students' submaximal workability.
Keywords: students, preparedness, education, culture, health, technology, Bodyflex, Pilates, strength, mobility, nervous system, psychophysiology, capabilities, speed, reaction, rhythm.

Introduction

The results of a modern scientific research [1; 4; 5; 6; 9; 12; 14] show that the system-forming factor of students' healthy way of life is health-oriented physical activity. Therefore, the most urgent task is to attract students to regular exercising, to increase the motivation of the growing generation to physical activity and healthy lifestyle [15; 17; 20; 21; 25; 26; 27]. The need to solve this problem becomes stronger by the fact that the formation of the habits of regular exercising and physical activity of children, teenagers and young adults is a basic prevention strategy of chronic diseases in adulthood [12; 18; 19; 28; 29; 30; 31]. We know that prolonged limitation of physical activity leads to hypodynamia, which by itself is a hazard factor [2; 3; 22; 23; 24; 31]. It destroys body and leads to early disability. If mature organism has disorders caused by physical inactivity, they are reversible (they can be eliminated with the help of appropriate physical training). In part, growing organism can not compensate hypodynamia effect. This physical inactivity is particularly dangerous at early stages of ontogeny and during functional development of young organism. It leads to significant reduction of growth rates and body development, to some problems of biochemical processes, including the functions of cell genetic apparatus [12; 13; 14; 15; 16]. At the same time, there are significant functional abnormalities in brain development. We can see it through the disturbances of higher nervous activity and a low level of brain workability [34; 35]. Meanwhile, lack of exercises becomes the dominant position of the majority of students.

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Studying schedule and the achievements of modern civilization, creating comfort doom a young man to permanent "muscle starvation" and deprive him of physical activity [12; 18; 19; 32; 33; 34].

There are some problems in physical education of students. They are the following: low physical preparedness of boys and girls, almost complete lack of physical education, the need to improve students' health, the presence of accidents during lessons, the need to develop differentiated approach in physical education and its individualization, low attendance and others. The only solution to these problems is development and introduction of modern health systems with the use of informational and communicative technologies in the process of students' physical education at higher school [1; 4; 5; 6; 9; 12; 14].

We know that nowadays nearly 90% of young people have health problems. More than 50% of them are at low level of physical preparedness [15; 17; 20; 21; 25; 26; 27]. According to the authors [12; 18; 19; 28; 29; 30; 31], the majority of students have no generated need to take care of their health and no desire to make some physical exercises, including free time [22; 23; 24; 31]. Students are indifferent to the content of obligatory physical education classes [20; 21; 25].

In this regard, it is logical to assume that the introduction of new health-improving methods into the process of students' physical education is topical and appropriate. And studying the effect of this application to the level of students' psychophysiological and functional capabilities is a necessary condition for the scientific substantiation of their effectiveness.

The aim of our research is to determine the impact of combined use of health-improving fitness methods of Pilates and Bodyflex on the level of psychophysiological and functional capabilities of students at higher school.

Materials and methods

During the research, we used psychophysiological methods (speed detection of simple and complex reaction in different test modes, level of functional mobility and strength of the nervous system [12; 13]). It was made with the help of "Psychodiagnostic" program [3; 18]. The indices of the number of mistakes in the tests are taken as an indicator of nervous system strength. They were aimed at determining the latency time of a complex reaction in the feedback mode and the imposed rhythm (mistakes in the test "level of functional mobility of nervous processes" in the feedback mode and imposed rhythm). As an indicator of the nervous system mobility were the indices in the tests "Time for performing the test "level of functional mobility of nervous processes" in the feedback mode, s" and "Time for going to minimum exposition in the test "level of functional mobility of nervous processes" in the feedback mode, s". We used physiological methods (determining of blood pressure, stroke volume of blood, capacity of the energy-supply systems and heart rate during rest and exercising according to S.A. Dyshanin's method). There was determined the indices of submaximal workability and autonomic balance according to R.M. Baijevskiy's method. In addition, we applied pedagogical experiment and methods of mathematical statistics.

Forty-six students of G.S. Skovoroda Kharkiv National Pedagogical University took part in the research. Twenty-four of them were in control group and 22 were in experimental one. Both groups studied according to the standard program of higher physical education, which includes elements of athletics, sports games and gymnastics. We were applying the complex technique of Bodyflex and Pilates (during 30 minutes) in the experimental group. It was during two semesters, twice a week. The control group was engaged in the same amount of time, as well as experimental but without the use of this technique. Before the pedagogical experiment, control and experimental groups did not statistically differ.

All students were informed about the experiment. They agreed to participate in written form. All studies were held in accordance with the ethical standards of the Helsinki Declaration, 2008.

Results

As a result of the experiment, in experimental group we saw significant decrease in the latent time of a simple visual and motor reaction (from 32576±45.09 ms to 270.89±41.23 ms, $p<0.05$) (Table 3.4), latent time of a complex visual and motor reaction (from 566.87±54.43 ms to 456.44±51.45 ms, $p<0.05$), duration of the test "level of functional mobility of nervous processes" in the feedback mode (from 425.12±56.51 ms to 392.11±47.65 ms, $p<0.001$), time for going to minimum exposition in the test "level of functional mobility of nervous processes" in the feedback mode (from 74.54±15.43 ms to 58.21±12.55 ms, $p<0.001$). The data in the control group are unreliable ($p>0.05$).

We observed significant decrease of mistakes in experimental group in the tests "level of functional mobility of nervous processes" in the feedback mode and "level of functional mobility of nervous processes" in the imposed rhythm": from 2.78 to 0 at the first level ($p<0.001$), from 2.96 to 0 at the second level ($p<0.05$), from 3,56 to 0,23 at the third level ($p<0.05$), from 3.88 to 0.32 at the fourth level <0.05), from 10.45 to 4.52 at the fifth level ($p<0.001$) (Table 3.4, fig. 3.15). The data of changing in the control group are unreliable ($p>0.05$). Additionally, there was significant decrease of indices in the tests "Time for performing the test "level of functional mobility of nervous processes" in the feedback mode, s" and "Time for going to minimum exposition

in the test "level of functional mobility of nervous processes" in the feedback mode, s" ($p<0.001$). It confirms the mobility increase of nervous processes after the application of Bodyflex and Pilates on the lessons.

After this application, the boys of experimental group showed significant increase in stroke volume of blood (from 58 ml to 62.1 ml). The changes of indices in control group are unreliable.

There was also heart rate decrease during boys' rest in the experimental group. It was from 72.6 beats per min^{-1} to 63.5 beats per min^{-1} ($p<0.001$). The changes of indices in control group are unreliable ($p>0.05$): boys' heart rate remained at the level of 72-73 beats per min^{-1}. It should be noted that the quantity of the stroke volume of blood circulation and heart rate during rest are indicators of efficient working of the heart and vascular system. This is confirmed by the data of heart rate increase, when the threshold of anaerobic metabolism is achieved. We observed increasing of this indices in the experimental group. It was from 123.4 beats per min^{-1} to 141.4 beats per min^{-1} ($p <0.001$). Such changes in the male control group are unreliable. Heart rate before the experiment was 128.3 beats per min^{-1}. Heart rate after the experiment was 127.0 beats per min^{-1}, ($p>0.05$).

Analogical changes were in experimental and control groups of girls. We saw significant increase in stroke volume of blood (from 58.3 ml to 62.5 ml ($p<0.001$)) in the experimental group. The changes of indices in control group are unreliable.

There was also heart rate decrease during the girls' rest in the experimental group. It was from 73.4 beats per min^{-1} to 61.5 beats per min^{-1} ($p<0.001$). The changes of indices in control group are unreliable ($p>0.05$): girls' heart rate remained at the level of 73 beats per min^{-1} (Fig.1). Derived results show improvement in efficiency of the functional systems during rest and increase of the body functionality. We confirmed this by data of heart rate increase, where the threshold of anaerobic metabolism is achieved. After the experiment, the girls of the experimental group show increase. It was from 123.7 beats per min^{-1} to 143.3 beats per min^{-1} ($p <0.001$) (Fig. 1). The changes in the control group are unreliable. Heart rate before the experiment was 128.5 beats per min^{-1}. After the experiment, it was 128.9 beats per min^{-1}, ($p> 0.05$) (Fig. 1). Thus, in our study, we determined the positive impact of lessons with applying Pilates and Bodyflex methods on the functional capabilities of students.

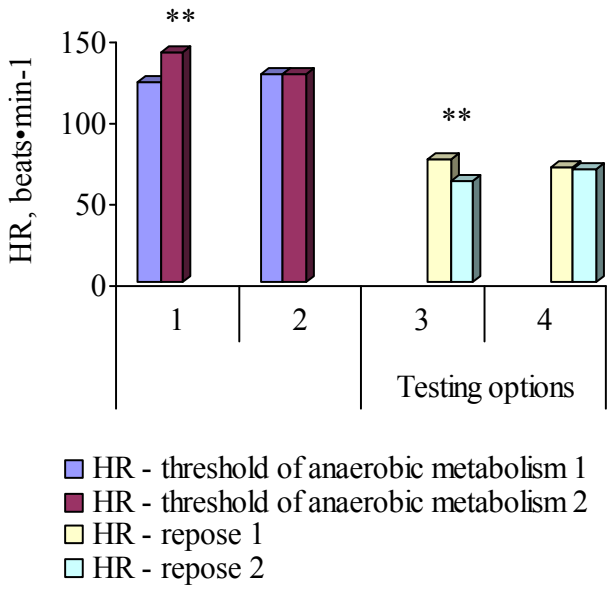

Fig. 1. The heart rate during rest and when it reaches the threshold of anaerobic metabolism in control (n = 24) and experimental (n = 22) groups before and after the experiment:
1 – experimental group, heart rate;
2 – control group, heart rate;
3 – experimental group, heart rate during rest;
4 – control group, heart rate during rest;
** – differences are reliable at $p<0.001$;
HR, beats•min-1 – heart rate, beats per min^{-1};
HR – threshold of anaerobic metabolism 1 – heart rate before the experiment;
HR – repose 1 – heart rate during rest before the experiment;
HR – threshold of anaerobic metabolism 2 – heart rate after the experiment;
HR – repose 2 – heart rate during rest after the experiment;

In this regard, we should note that the study identified the level of students' functionality and met modern requirements. It is regarding to the construction of educational process of physical training and experimental substantiation of the effectiveness of innovative technologies. They are attractive to young people and do not occupy a lot of time. They also quite affordable and effective in application. Some of these technologies are the "Bodyflex" and "Pilates" system. As a result of our experiment, we saw increase of physical work indicators of energy-supply systems. So, the boys of the experimental group showed the capacity increase of phosphocreatine system of energy-supply. It was from 27.2 c.u. (conditional units) to 31 c.u. ($p < 0.001$). The capacity lactacide system rose from 28.5 c.u. to 31 c.u. ($p < 0.001$). There was no similar improvement in the control group of boys. The capacity of phosphocreatine system of energy-supply remained at the level of 28.5-28.9 c.u. ($p > 0.05$), and the capacity lactacide system remained at the level of 28.6-28.7 c.u. ($p > 0.05$). Similar changes occurred in the experimental and control groups of girls. The girls of the experimental group showed the capacity increase of phosphocreatine system of energy-supply. It was from 27.0 c.u. to 30.5 c.u. ($p < 0.001$), the capacity of lactacide system of energy-supply rose from 27.3 c.u. to 29.5 c.u. ($p < 0.001$). Similar improvements were not observed in the control group of girls. The capacity of phosphocreatine system of energy-supply remained at the level of 28.4-28.6 c.u. ($p > 0.05$), and the capacity of lactacide system remained at the level of 28.2-28.4 c.u.

The results of the RWC_{170} test indicate the increased submaximal students' workability in the experimental group. So, the indicators of the RWC_{170} test increased from 705.5 $kg \cdot m \cdot min^{-1}$ to 790.4 $kg \cdot m \cdot min^{-1}$ ($p < 0.001$). The indicators of relative RWC_{170} values increased from 10.9 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ to 12.0 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ ($p < 0.01$). The control group of boys showed the declination these indicators at the end of the experiment. It was from 705.3 $kg \cdot m \cdot min^{-1}$ to 695.0 $kg \cdot m \cdot min^{-1}$ ($p > 0.05$). The same was with the relative values of RWC_{170}. The data suggest that aerobic endurance is reduced without aimed training impact. Which is a negative factor for the students. Similar changes are typical for relative RWC_{170} of girls. There is a tendency of these values to increase in the experimental group. This index, after application of the developed technique, increased by 2.23 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ ($p < 0.01$). The relative index of RWC_{170} decreased by 3.68 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ in the control group. There is more RWC_{170} indices increasing in the girls' experimental group in comparison with the boys'one. Thus, the index of RWC_{170} of absolute value of the female experimental group rose from 445.8 $kg \cdot m \cdot min^{-1}$ to 517.2 $kg \cdot m \cdot min^{-1}$ ($p < 0.001$), whereas this value remained practically unchanged in the control group ($p > 0.05$).

The indicator of the relative RWC_{170} values increased from 8.2 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ to 9.7 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ in the female experimental group. This is a reliable change ($p < 0.01$). The change of the relative RWC_{170} values in the control group is not significant ($p > 0.05$). The received data show the positive impact of developed methods of using interactive technologies for students' healthy lifestyle, since improvement of submaximal workability is one of the basic indicators of the organism functional state. As a result of the experiment, the male and female experimental groups showed decrease in systolic and diastolic blood pressure to normal values during rest. It was from 129.5 / 84.1 mm Hg to 125.7 / 78.7 mm Hg ($p < 0.001$) for boys and from 133.7 / 86.2 mm Hg to 122.2 / 77.4 mm Hg ($p < 0.001$) for girls.

The blood pressure changed insignificantly in the control group ($p > 0.05$). The students in the experimental group showed the increase of the level of parasympathotonia during rest. Increase of heart rate variability (from 322.12 ms to 354.43 ms), decrease of the amplitude values mode of RR-intervals (from 34.09% to 21.54 %) ($p<0.001$), decrease of heart rate during rest (from 72.00 beats per min^{-1} to 63.52 beats per min^{-1}) ($p<0.001$). This shows the improving of work efficiency of the cardiovascular system during rest in the experimental group. There are no changes in the control group ($p>0.05$).

Discussion

Thus, the study showed the advisability of the developed technique to improve the quality of psychophysiological and functional processes of students. Obviously, one of the main elements of the influence of this technique to physiological indicators is the emphasis on conscious perception of the process elements of physical education. In particular, the activation of perceptive elements of "Pilates" and "Bodyflex" methods and the use of special breathing exercises that require a high level of concentration are meaningful for workability activation [1; 4; 7; 8].

In this regard, we can conclude that the developed method has a positive effect not only on the level of physical preparedness and functional capabilities of students, but also on their physiological capabilities. We recommend it for physical education process.

The results of our research of identifying students' psychophysiological state give a basis for creation theoretical and methodological theses for the harmonious physical and spiritual development of any human. Which have great prospects for science and practice at present [8; 32; 33; 34; 35]. It can be effective for psychophysiology, physiology, pedagogy, psychology, cybernetics, etc. Because physical training improves any person. But, according to most experts in the sphere of evolution, the human development as a biological substance has already been completed, and his further development is possible by improving the mental and intellectual qualities. These theses also apply to physical education as well as physical and spiritual perfection are associated with the development of psychophysiological functions. First, it concerns the activities with

changing circumstances. Nowadays they are very important for person's adaptation in society. After all, for situational activities is typical constant change in situations that require instant reaction. We observe constant growth of quantity and quality of researches on this issue. This indicates high topicality and potential of this problem. Person's formation at all stages of his development has its own characteristics and great value. Each step is a step forward into improvement of human's psychomotor. The clarification of the features of manifestation of psychophysiological states is very important. Modern physical education requires the development of techniques that allow you to optimize learning process. It is quite a challenge, since the construction of the educational process of physical education requires not only searching for new forms of organization, but also new forms and means. Therefore, our study confirms the necessity to define the features of manifestation of psychophysiological and functional state for harmonious construction of students' learning process.

Mental workability and mental endurance are one of the indicators of general endurance. The psychophysiological indicators are used as indicators of mental health. It is well known [7; 8; 10; 11; 12; 14], psychophysiological indicators are difficult to develop. That is why obtaining of statistically significant differences between them before and after the experiment show the positive impact of our developed methods not only on the level of functional preparedness, but also on the level of psychophysiological capabilities.

Conclusions

1. We showed positive effect of the developed methods to the level of students' psychophysiological and functional capabilities. As a result of this application in the experimental group we saw significant decrease in the latent time of simple visual and motor reaction (from 32576±45.09 ms to 270.89±41.23 ms, $p<0.05$) (Table 3.4), latent time of a complex visual and motor reaction (from 566.87±54.43 ms to 456.44±51.45 ms, $p<0.05$), duration of the test "level of functional mobility of nervous processes" in the feedback mode (from 425.12±56.51 ms to 392.11±47.65 ms, $p<0.001$).We observed increase of mobility of nervous processes of the use of the methodic. In the experimental group we saw decrease of time for going to minimum exposition in the test "level of functional mobility of nervous processes" in the feedback mode (from 74.54±15.43 ms to 58.21±12.55 ms, $p<0.001$). Additionally, there was significant decrease of indices in the tests "Time for performing the test "level of functional mobility of nervous processes" in the feedback mode, s" and "Time for going to minimum exposition in the test "level of functional mobility of nervous processes" in the feedback mode, s" ($p<0.001$).

2. We proved the positive impact of the application of Bodyflex and Pilates methods in the author's modifying on the functional capabilities of students. It is evidenced by significant increase in stroke volume of blood ($p <0.001$), decreased heart rate parameters during rest ($p <0.001$), increased heart rate, when we see the achievement of threshold of anaerobic exchange ($p <0.001$) in the experimental groups of boys and girls. We found reduction in systolic and diastolic blood pressure to normal values in male and female experimental groups ($p <0.001$). We marked the improvement in efficiency of the cardiovascular system (increased heart rate variability from 322.12 ms to 354.43 ms, reduction of mode amplitude of RR-intervals) in the experimental group of the students. Such changes in the control groups are not significant ($p> 0.05$).

3. It is established that the application of Bodyflex and Pilates in complex promotes increase of mobility of nervous processes. There was significant decrease of mistakes in the tests "level of functional mobility of nervous processes" in the feedback mode and "level of functional mobility of nervous processes" in the imposed rhythm" in experimental group. It was from 2.78 to 0 at the first level ($p<0.001$), from 2.96 to 0 at the second level ($p<0.05$), from 3,56 to 0,23 at the third level ($p<0.05$), from 3.88 to 0.32 at the fourth level <0.05), from 10.45 to 4.52 at the fifth level ($p<0.001$). The data of changing in the control group are unreliable ($p>0.05$).

4. We demonstrated that after the experiment, there was increase of indicators of energy-supply systems of physical work according to S.A. Dushanin's technique. The results of the RWC_{170} test indicate the increased submaximal students' workability in the experimental group. So, the indicators of the RWC_{170} test increased from 705.5 kg m min^{-1} to 790.4 $kg \cdot m \cdot min^{-1}$ ($p <0.001$). The value of the female experimental group rose from 445.8 $kg \cdot m \cdot min^{-1}$ to 517.2 $kg \cdot m \cdot min^{-1}$ ($p <0.001$). The indicators of relative RWC_{170} values increased from 10.9 kg m min^{-1} to 12.0 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ ($p <0.01$). These values increased from 8.2 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ to 9.7 $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ in the female experimental group. The changes are unreliable in the control group ($p>0.05$).

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