

Psychophysiological aspects of work and health enhancement in physical education teachers (a randomized controlled study)

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Abstract

The leading factors associated with teachers' work are mental workload and stress, which reduce teachers' productivity. Some authors believe that a high workload leads to stress, while others consider stress as its component. The need to regularly perform a significant number of prescribed requirements results in stress reactions among teachers. A decrease in their functional reserves can manifest itself in cardiovascular and nervous system changes. Many remedial programs use relaxation as a means to restore mental balance. Despite the large number of works in this area the effect of relaxation on the body requires further comprehensive study. **The paper aims** to find changes in psychophysiological functions in female university teachers under relaxation exercises. **Materials and methods.** Two groups of female university teachers were examined: the first group (EG) participated in a 3-month relaxation program; the second group (CG) did not perform any relaxation exercises. Before and after a three-month training program, the indicators of heart rate and blood pressure were obtained, electroencephalogram and cardiac measurements were obtained, psychomotor reactions were recorded and psychological testing was carried out. **Results.** The results showed that in the experimental group, compared to the control group, there was an improvement in the performance of the cardiovascular and nervous systems, as well as a decrease in functional stress. Thus, the indicators of the stress index decreased from 96 ± 1.1 to 67 ± 3.5 ($P < 0.05$). In the control group, there were no significant changes in the above-mentioned indicators. EEG measurements showed that in the experimental group there was a significant predominance of α -activity in the frontal, central and temporal brain areas ($p < 0.01$). During immersive relaxation, generalization and synchronization of α -activity was observed with an increase in the alpha power in most areas (average frequency - 10.5 Hz). The improvement of psychoemotional state was also recorded. **A conclusion** was made on the efficacy of the program for university teachers.

Keywords: university teachers, heart, electroencephalography, functional stress, relaxation, working conditions.

Introduction.

A growing public health problem is mostly associated with the rhythm of life and environmental conditions. In modern society, the quality of human life depends on social and psychological security. If both social and ecological security is guaranteed by the state, psychological security completely depends on the person. In any social system, wellbeing, mood and health largely depend on the ability to defend oneself psychologically and to control one's emotions. The leading factors associated with teachers' work are mental workload and stress, which reduce teachers' productivity. Some authors believe that a high workload leads to stress, while others consider stress as its component [Bodrov, V.A., Temur, G.M.]. Since the discovery of stress by Hans Selye [Selye, H., 1979], medicine and other health-related sciences have advanced far ahead. So, scientists found out [Meerson, F.Z., 1988] that stress syndrome could be considered as a component of adaptation and was defined as the sum of nonspecific reactions that created conditions for activating the hypothalamic-pituitary adrenal system and producing adaptive hormones that stimulated homeostatic systems. The adaptive role of nonspecific reactions is an increase in resistance to various environmental factors.

The psychophysiology of work pays special attention to the psychophysiological aspects of work-related difficulties and indicates ways to solve the problem taking into account professional knowledge and psychophysical reserves of the body.

Adaptation to changing conditions, sometimes of an extreme nature, requires to be able to assess one's own capabilities and the situation in general so to choose an adequate strategy of behavior. Therefore, it is important to develop a training system for providing teachers with correct ideas about behavior in any, including extreme, life situations. The work of a university teacher is of interest to psychophysiologicalists as it is a single complex of educational, methodological, and scientific activities. Due to the need to regularly fulfill a significant number of prescribed requirements, such a teacher is often subjected to stress [Cherepov, E.A., 2016; Clérico, J. et al., 2019; Talaghir, L.G., et al., 2019; Kuzmina, N.V., 1990]. A decrease in functional reserves can manifest itself in the form of diseases of the cardiovascular and nervous systems [Voitenko, A.M., 2005]. According to

[Ilyin, E.P., 2008], psychophysiological states are associated with the mental and physiological structures of a person. The authors [Hasset, J., 2013] and [Selivanova, E.A. et al., 2019] note that when considering the psychophysiological characteristics of university teachers, special attention should be paid to the most frequently developing types of stress. Dotsenko, O.N. et al. [2008] believe that emotional stress and the associated fatigue can result in burnout. Linde, N.D. [2018] argues that the symptoms of professional burnout indicate the features of mental fatigue, which lead or can lead to the complete disintegration of various mental spheres, and above all emotional.

Relaxation classes are becoming vital in the face of increasing stress. It helps to restore energy and metabolic balance, stimulates the recovery processes and defense mechanisms of the body and is a means of preventing psychosomatic disorders [Scheufele, P.M., 2000].

It is known that improving working conditions increases productivity. The correction of psychophysical state, which is being introduced into professional training [Syrensky, V.I. et al., 2008; Cherepov, E. et al., 2017], also increases resistance to adverse environmental factors. Many remedial programs use relaxation as a means to restore mental balance. Despite the large number of works in this area [Mousley, S., 2015], the effect of relaxation on the body requires further comprehensive study.

The paper aims to study changes in psychophysiological functions in female university teachers under relaxation exercises.

Materials and methods.

During 2017-2018, female university teachers with similar conditions of activity aged from 25 to 50 years participated in the experiment. The subjects were divided into two groups of 15 people each: the experimental group (EG) performed relaxation exercises twice a week for three months; the control group (CG) did not perform such exercises. The groups did not include athletes, persons with health complaints or those, who differed significantly in anthropometric indicators. All subjects provided their informed consent in accordance with the protocol approved by the Ethics Committee of the Russian Academy of Sciences.

Our course of relaxation exercises [Popova, T.V. et al., 2016] includes three stages. The 1st stage provides theoretical knowledge about the functions of the body, the 2nd stage is a practical course on the use of relaxation exercises in professional and educational activities, the 3rd stage consists of a systematic approach to understanding professional tasks and creative abilities. It contains theoretical knowledge about relaxation in emergency situations and the principles of psychological defense.

Stress management techniques are different in their nature. However, there are three main ways to coping with stress, namely: avoiding unnecessary stimuli, regulating emotional outbursts (emotional education) and doing relaxation exercises. Our program of relaxation exercises [Popova, T.V., 2000] aims to achieve immediate and deep relaxation of the body. This relaxation is achieved by focusing on real or imaginary objects, such as the spine or other parts of the body. Classes were conducted under the guidance of an experienced instructor for 7-10 minutes, as well as independently at home.

Changes in heart rate (HR), blood pressure (BP), and neurodynamic indicators during and after relaxation exercises were recorded. The NS-PsychoTest Plus system developed by Marokko, D.A. et al. [2007], psychological tests, and a 5-minute ECG recording with heart rate variability and Stress Index (SI) measurements were used [Baevsky, R.M., 2004].

The adaptive reactions of the body and its functional status were assessed with the most informative indicators [Baevsky, R.M., 2004; Popova, T.V. et al., 2020] such as mode (Mo) - the most frequent value of RR intervals; variation range (ΔX) - the difference between the maximum and minimum R-R values, which reflects the activity of the parasympathetic system; the amplitude of the mode (AMo), which reflects the activity of the sympathetic system; stress index (SI) - an integral indicator reflecting the degree of centralization of heart rate control. Adaptation mechanisms provoke activation of higher levels of regulation under stress. Therefore, there is an increase in SI and AMo values and a decrease in Mo and ΔX values. Insufficient adaptation increases the activity of subcortical levels, as well as the activity of both the parasympathetic and sympathetic nervous systems. An electroencephalogram (EEG) was recorded with the 16-electrode system (10-20 system). Statistical data processing was performed using the IBM SPSS Statistics 22 software package. Spectral power parameters were calculated throughout the whole EEG frequency range from 0 to 40 Hz. The Wilcoxon signed-rank test for dependent samples was used to detect differences between EEG power levels, seeing as median values of the spectral power failed the normal distribution.

The research was carried out in accordance with the Declaration of Helsinki.

Results.

Psychological testing in the experimental group shows that, compared with the control group, significantly lower indicators of neuroticism were revealed (9 ± 1.7 and 15.3 ± 2.3 ($P < 0.05$), respectively), which apparently indicated emotional stability that contributed to adequate behavior at rest and under stress. The indicators of neuropsychic stress were also significantly lower in persons regularly practicing relaxation exercises (40.5 ± 2.4 and 49.5 ± 2.7) ($P < 0.05$).

All subjects from the experimental group showed a decrease in heart rate and blood pressure (Table 1). Their indicators of heart rate structure significantly differed from those of the subjects of the control group in terms of a decrease in the activity of sympathetic and central influences and an increase in parasympathetic influences. Thus, the indicators of AMo in the experimental group decreased from 43 ± 2.8 to $37 \pm 4.9\%$, and that of the stress index from 96 ± 1.1 to 67 ± 3.5 ($P < 0.05$). In the control group, there were no significant changes in the above mentioned indicators.

Table 1 – Heart rate and blood pressure dynamics after 3 months of the experiment

Group n=15	Indicator		
	HR, bpm	Systolic BP, mmHg	Diastolic BP, mmHg
Before relaxation exercises			
EG	82.3±2.1	119.4±3.1	68.2±2.2
CG	79.3±3.2	122.5±4.3	71.4±1.2
After 3 months			
EG	77.2±1.8*	115.5±1.4	63.1±1.4*
CG	81.5±2.2	119.4±3.1	68.2±2.2

Note: * – significant differences with baseline indicators at $P < 0.05$

After a 10-minute relaxation session there were changes in the results of computer testing. Most of the indicators of psychomotor reactions improved significantly ($P < 0.05$), which confirmed a favorable effect of relaxation exercises on attention and mobility of nervous processes (Fig. 1). The exception was a simple visual-motor reaction.

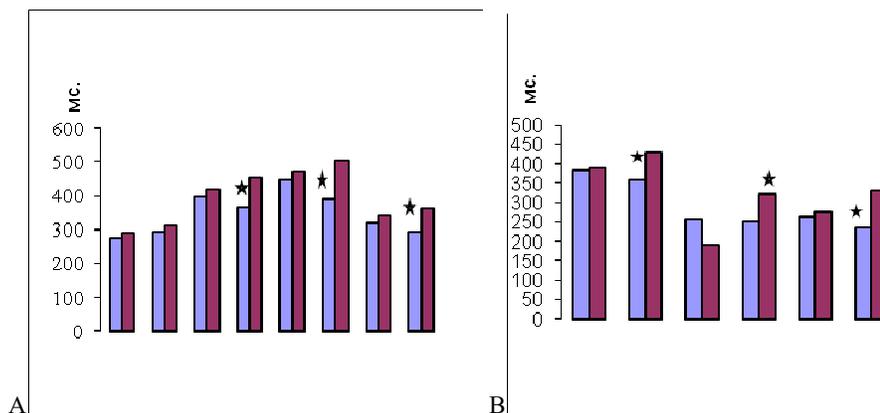


Fig. 1 Changes in neurodynamics in the experimental and control groups

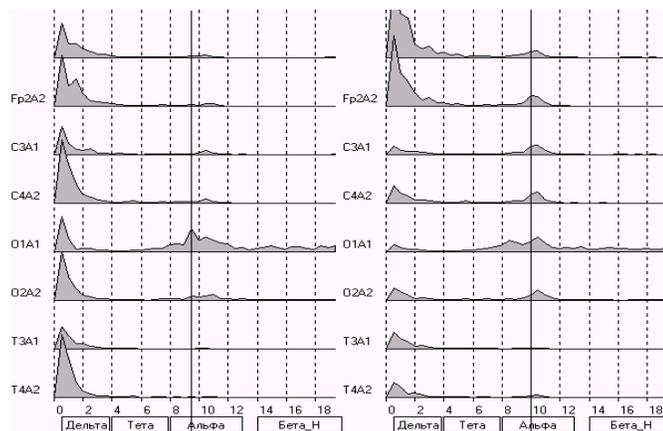
Note: First column - EG; second column - CG; each test includes 4 columns; the first two columns in each test – before relaxation exercises, the second – after relaxation exercises; * - significant differences compared to baseline indicators ($P < 0.05$); Fig. A - 1st test (4 columns) - simple visual-motor reaction; 2nd test — choice reaction; 3rd test — discrimination reaction; 4th test - simple visual-motor reaction under interference; Fig. B - 1st test (4 columns) - simple visual-motor reaction under interference; 2nd test - distribution of attention; 3rd test - audiomotor reaction.

Thus, the data of computer monitoring confirm psychophysiological studies [Popova, T.V. et al., 2016], the results of which indicate a pronounced inhibitory effect of relaxation exercises on autonomic functions and their stimulating effect on nervous processes.

Analysis of electroencephalograms showed that in the experimental group there was a significant predominance of α -activity in the frontal, central and temporal brain areas ($p < 0.01$). With eyes closed both groups showed an increase in α -activity in the frontal, central and occipital brain areas ($P < 0.05$). The experimental group showed a significant increase in the alpha power in the C4 central lead ($P < 0.05$).

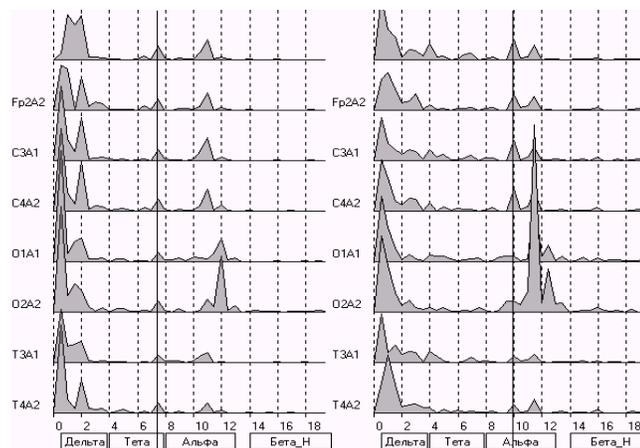
During immersive relaxation training (Fig. 2), statistically significant generalization and synchronization of α -activity was observed with an increase in the alpha power in most leads (average frequency - 10.5 Hz); the formation of a low-frequency area of the alpha power occurred (average frequency - 7.8 Hz). At

the second stage (visualization), there was a significant increase in the alpha power in the occipital brain area. Along with this, the low-frequency alpha power continued to increase in the central and occipital brain areas.



Background values

With eyes closed 10.5 Hz, M:2



Relaxation

Visualization

Fig. 2. EEG spectral analysis under relaxation exercises

In the final period of relaxation, a pronounced generalization of the alpha and theta power was observed in the low-frequency area (8 Hz) with a slight predominance of power in the right hemisphere. It should be noted that the subjects described this state as a state of euphoria. After relaxation, the subjects felt rested, full of strength and energy. According to the indicators of static endurance, the degree of fatigue in the subjects decreased. Indicators of personal anxiety decreased from 45.1 ± 3.2 to 36.4 ± 4.3 ($P < 0.05$) during these 3 months.

Discussion

The results of the study confirm the beneficial effect of relaxation exercises on the psychophysiological functions of university teachers. The improvement of psychophysiological capabilities is one of the conditions for enhancing professional activity and reducing occupational morbidity. A person should possess knowledge about the capabilities and reserves of the body so to stay confident in a variety of life situations.

Of particular importance for university teachers is the formation of resistance to difficult situations determined by their psychological readiness to work in difficult conditions. Such readiness develops as a result of life experience, knowledge, the nature of work, and special training sessions. The dynamics of stress is explained by two necessary attributes: tension (waste of energy, stress) and relaxation (accumulation of energy). Tension is an important factor in achieving success and cannot be harmful to a person if it is replaced by relaxation, which can restore energy balance in the shortest possible time. However, prolonged stress can lead to pathology. Regular relaxation exercises contribute to the harmonization of the functional state. A person who regularly performs relaxation exercises is distinguished by balance and self-control [Tandler, N. et al., 2019]. Emotional control is especially important for teachers, who very often face negative reactions. One of the means of preventing the so-called burnout is acquiring the skills of self-regulation [Amigo, I., 1997].

Self-regulation skills are of utmost importance as far as they are necessary for the mobilization and development of body reserves [Smolentseva, V.N., Masnyuk, N.E., 2021]. It is also confirmed [Rozhentsov, V.V., Polevshchikov M.M., 2003] that the performance of any complex physiological system, which is characterized by self-control, self-regulation and self-management, is determined by a relatively stable specific reaction associated with the nature of the stimulus and the properties of the system. Self-control contributes to individual improvement and allows facing a hostile social environment or one's own biological mechanisms, including obsessions and uncontrollable impulses. Self-improvement is aimed at the formation of a conscious, active and directed activity.

Conclusion

Socio-economic transformations in society are accompanied by a significant increase in psychoemotional stress. The most stressful activities are those associated with mental work and interpersonal communication. The teaching profession is characterized by a sharp increase in emotional and informational content, complicated relationships with students and colleagues. According to V. Volobaev [2008] and T. Krushinskaya [2008] prolonged exposure to neuro-emotional factors leads to excessive stress with the subsequent formation of unfavorable functional and psychological states. Our data allow us to conclude that the use of relaxation exercises helps to normalize the performance of the central nervous system. Therefore, the teaching profession requires acquiring relaxation exercises along with the general methods and technologies of self-regulation. Our relaxation program is based on a holistic approach, contributes to the restoration of physical and mental health, improves tolerance to various forms of adaptive behavior and helps to increase the productivity of professional activity.

No conflict of interest declared.

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