Педагогіка

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Sergeeva Lubov

Candidate of Medical Sciences, Associate Professor,

Associate Professor of the Department of Life Safety and Physical Education

State University of Telecommunications

Сергєєва Любов Анатоліївна

кандидат медичних наук, доцент,

доцент кафедри безпеки життєдіяльності та фізичного виховання

Державний університет телекомунікацій

Сергеева Любовь Анатольевна

кандидат медицинских наук, доцент,

доцент кафедры безопасности жизнедеяльности и физического воспитания

Государственный университет телекоммуникаций

ORCID: 0000-0003-2940-1433

Valchenko Oleksandr

Candidate of Military Sciences, Associate Professor,

Head of the Department of Life Safety and Physical Education

State University of Telecommunications

Вальченко Олександр Іванович

кандидат військових наук, доцент, завідувач кафедри

безпеки життєдіяльності та фізичного виховання

Державний університет телекомунікацій

Вальченко Александр Иванович

кандидат военных наук, доцент, заведующий кафедрой

безопасности жизнедеяльности и физического воспитания

Государственный университет телекоммуникаций

ORCID: 0000-0002-9635-9418

Sergeeva Viktoria
Family Doctor
Doctor's office N2, Irpen
Сергєєва Вікторія Сергєєвна
лікар загальної практики – сімейної медицини
КЗ ІМЦП МСД Ірпінської міської ради амбулаторія №2
Сергеева Виктория Сергеевна
врач общей практики – семейной медицины
Амбулатория №2 Общей практики семейной медицины, Ирпень
ORCID: 0000-0003-3517-8231

Hliebova Olena
Senior Lecturer of the Department of Life Safety and Physical Education
State University of Telecommunications
Глєбова Олена Іванівна
старший викладач кафедри
безпеки життєдіяльності та фізичного виховання
Державний університет телекомунікацій
Глебова Елена Ивановна
старший преподаватель кафедры
безопасности жизнедеяльности и физического воспитания
Государственный университет телекоммуникаций
ORCID: 0000-0001-9405-6440

SOME CHANGES IN THE PHYSICAL EDUCATION OF YOUNG PEOPLE TO PREVENT ADVERSE EFFECTS OF ELECTROMAGNETIC RADIATION OF THE RADIO FREQUENCY RANGE

ДЕЯКІ ЗМІНИ У ФІЗИЧНОМУ ВИХОВАННІ МОЛОДИХ ЛЮДЕЙ ДЛЯ ЗАПОБІГАННЯ НЕСПРИЯТЛИВИХ ЕФЕКТІВ ЕЛЕКТРОМАГНІТНОГО ВИПРОМІНЮВАННЯ РАДІОЧАСТОТНОГО ДІАПАЗОНУ

НЕКОТОРЫЕ ИЗМЕНЕНИЯ В ФИЗИЧЕСКОМ ВОСПИТАНИИ МОЛОДЫХ ЛЮДЕЙ ДЛЯ ПРЕДОТВРАЩЕНИЯ НЕБЛАГОПРИЯТНЫХ ЭФФЕКТОВ ЭЛЕКТРОМАГНИТНОГО ИЗЛУЧЕНИЯ РАДИОЧАСТОТНОГО ДИАПАЗОНА

Summary. *The article is devoted to some physical exercises and their validity when exposed to non-ionizing radiation of the radio frequency range (EMR-RF) on the body of a young person from different gadgets. As for the justification, the survey and medical examination of students showed the dependence of the autonomic regulation of the cardiovascular system on the time of exposure to EMR-RF range (in years).*

Our research was conducted to: determine the dependence of the functioning of organism systems on the exposure time of the EMR radio frequency range and justify improving the range of physical exercises for young people.

Materials and methods of research: in our research, we used a non-invasive technology to evaluate the state of human body regulatory systems - questionnaires and physiological studies. Depending on the time of the EMR-RF impact on students in the years, 3 groups were selected, which were analyzed: with minimum exposure time of EMR-RF, the average and maximum - from the performance of mobile phones, laptops and other gadgets. In the experiments, orthostatic tests were modeled to determine the violation of the barorreflexses control of arterial pressure. A comparative assessment of the functional status of volunteers was performed based on the parameters of heart rate, systolic and diastolic blood pressure, shock and minute volume of the heart, pulse pressure.

The total peripheral vascular resistance, the Robinson index, and the vegetative Kerdo index were calculated and estimated.

To implement pathogenetic prophylaxis of harmful manifestations of the influence of electromagnetic radiation of the radio frequency range on the human body, the following improvements are recommended: a set of physical exercises to enhance blood circulation in the central nervous system, psychological and muscle unloading techniques and physical exercises to balance the sympathetic and parasympathetic parts of the autonomic nervous system.

Based on the foregoing, it can be concluded that the pathogenetic prevention of the development of pathology under the influence of the EMR-RF range may consist of active physical exercise and autogenic training, as well as to combine active influence on the central and peripheral levels of the regulation of mental and neurovascular processes.

Key words: *physical education, body protection, the effect of electromagnetic radiation of radio waves.*

Анотація. *Стаття присвячена деяким фізичним вправам та їх обгрунтованості при впливі неіонізуючого випромінювання радіочастотного діапазону на організм молодої людини від різних гаджетів. Щодо обгрунтованості, при обстеженні студентської молоді була доказана залежність порушень вегетативної регуляції серцево-судинної системи від часу експозиції електромагнітного випромінювання радіочастотного діапазону (в роках) (від комп'ютерів, мобільних телефонів та інших гаджетів). Для здійснення патогенетичної профілактики шкідливих проявів впливу на організм людини електромагнітного випромінювання радіочастотного діапазону рекомендоване удосконалення комплексу фізичних вправ для підсилення кровообігу в центральної нервової системі, методик психологічно-*

м'язового розвантаження та фізичних вправ для врегулювання рівноваги між симпатичним та парасимпатичним відділами вегетативної нервової системи.

Ключові слова: *фізична культура, захист організму, дія радіохвильового електромагнітного випромінювання.*

Аннотация. *Статья посвящена некоторым физическим упражнениям и их обоснованности при воздействии неионизирующих излучений радиочастотного диапазона на организм. Относительно обоснованности, при обследовании студенческой молодежи была доказана зависимость нарушений вегетативной регуляции сердечно-сосудистой системы от времени экспозиции ЭМИ. Для осуществления патогенетической профилактики вредных проявлений влияния на организм человека ЭМИ радиочастотного диапазона рекомендуется усовершенствование комплекса физических упражнений для усиления кровообращения в ЦНС, методик психологическо-мышечной разгрузки и физических упражнений для урегулирования равновесия между симпатическим и парасимпатическим отделами вегетативной нервной системы.*

Ключевые слова: *физическая культура, защита организма, действие радиоволнового электромагнитного излучения.*

Introduction. The relationship between the environment and humans is very complex, and the effects of various environmental factors that can lead to various health disorders are varied. Increased fatigue, headache, memory and sleep disorders are a pending list of complaints of people exposed to radio waves [16, p. 42; 19, p. 300], the intensity of which, in some cases, significantly exceeds the permissible national norm [18], without taking the peculiarities of the developing organism [6, p. 190].

Analysis of relevant research. Currently, there is no doubt that the radio frequency EMRs of different ranges have a pronounced biological effect on the tissue vessels. At the same time, a number of papers indicate vasodilator effects of EMR-RF [17, p. 187], others report vasoconstrictor effects [13, p. 199] and, finally, the third ones conclude that the microcirculatory effects of EMR radio waves depend on the properties of the biological object and are determined by the initial state of the vascular tone, giving homeostatic action [11].

Aim of the Study. Our research was conducted to determine the dependence of the functioning of organism systems on the exposure time of the EMR radio frequency range and justify improving the range of physical exercises for young people.

Research Methods. In our research, we used a non-invasive technology to evaluate the state of human body regulatory systems - questionnaires and physiological studies. To determine the symptomatology of radio waves, students of the 1 and 4 year students of the State University of Telecommunications, future IT specialists, were examined (only those students who had I and II health groups). Depending on the time of the EMR-RF impact on students in the years, 3 groups were selected, which were analyzed: with minimum exposure time of EMR-RF, the average and maximum - from the performance of mobile phones, laptops and other gadgets.

In the experiments, orthostatic tests were modeled to determine the violation of the barorreflex control of arterial pressure (AP) [10, p. 112; 15; p. 5]. A comparative assessment of the functional status of volunteers was performed based on the parameters of heart rate (HR), systolic and diastolic blood pressure, which were determined by auscultation technique of N.S. Short, shock and minute volume of the heart - according to the formula Starr, pulse pressure - in accordance with the guidelines of MR 2.2.12.-0680-2000 [2]. The total peripheral vascular resistance (TPVR), the Robinson index, and the vegetative Kerdo index were calculated and estimated.

The statistical processing of the obtained results was carried out using the t-criterion of the Student, at the probability level $p < 0.05$, $p < 0.01$ and above, and according to the Wilcoxon-Mann-Whitney criterion, at $pU = 0.05$ [2; 7]. In the calculation of questionnaires, there were many data to compare the percentage distribution of signs of external influence on the person EMR, so we applied the criterion of compliance with the «chi-squared» (medod χ^2) [4; 7]. Determination of the existence of correlation relations between the term exposure and the pre-nosologic symptoms of adverse effect of EMR-RF on the human body were carried out by methods: by correlation of Spearman ranks; by pair correlation method; by calculating the coefficients of multiple correlation [8]. To determine the strength and validity of the effect of the EMR-RF, from different sources at the same time, carried out a dispersion analysis.

Results. Physiological examination was carried out on 126 students of the 1st year State University of Telecommunications (Kyiv, Ukraine). In the survey, individuals with increased or decreased weight, with bad habits (smoking), athletes were identified - and no such monitoring data was received before the analysis. Thus, 99 men were selected from the experimental data set.

Physiological examinations were carried out in the rooms (sitting), with short-term fast rise and after a long orthostatic test (standing at an angle of 70^o for 15 minutes). Thus, in the conditions of student admission to the audience, we simulated a short-term orthostatic test (SOT) and a long-term orthostatic test (LOT).

When performing metronization of arterial pressure (AP) and heart rate (HR) according to the Korotkov method, we were faced with the fact that part (2/3) of students had an elevated initial arterial pressure in comparison with standard ones. Therefore, students in a natural experiment were divided into three outgoing groups: 1) with minimal initial blood pressure data — those that meet the required physiological standards; 2) with average baseline blood pressure - those that exceed the normative standards of systolic arterial pressure

(SAP) by 13% (P <0.001); 3) with maximum baseline AP data - those that exceed the SAP regulatory standards by 28.8% (P <0.001) on average.

The data shows that when performing a short-term orthostatic test in the group with *minimal primary* AP, the systolic and diastolic arterial pressure (DAP) increased significantly by 5 and 9,8%, respectively (0,05>P>0,01). The long-term orthostatic test in the group with *minimal primary* AP data significantly increased systolic arterial pressure (SAP) by 10,13%, 14,4% - diastolic arterial pressure, and 11,9% - heart rate (P<0,01).

Short-term orthostatic test in the group with *mean primary* AP data changed the parameters of diastolic arterial pressure and heart rate: it increased significantly by 5,3% DAP and 10,56% of heart rate on average (0,05>P>0,01). Prolonged orthostatic test in the group with *mean primary* AP data, probably increased by 9,9% DAP and by 19,87% - heart rate (P<0,01).

Short-term orthostatic test in group with *maximum primary* AP data believed to increase by 6,57% DAP (0,05>P>0,01). A prolonged orthostatic test in the group with *maximum primary* AP data believed to increase DAP and heart rate by 10,55 and 15,68 percent, respectively (0,05>P>0,01).

It should be noted that an increase in the sympathetic component of the autonomic nervous system (VNS) was observed only in the group with minimal arterial pressure. *In all groups and subgroups in the experiment (SOT and LOT), the indices of total peripheral vascular resistance (TPWR) remained almost unchanged.*

The above results may indicate not only an increase in the physical activity of the cardiovascular system of the body in volunteers during the experiment. But they can also be evidence of the unadequacy of the sympatho-adrenal autonomic nervous system (SAS) in the baroreflexy hemodynamic regulation mechanisms (table 1).

Table 1

Estimation of sympatone-adrenal VNS activity in orthostatic test

No.	Indicators	Groups of patients examined with *primary* AP:		
		1. *Minimal*	2. *Mean*	3. *Maximum*
1	HR, beats / min, in average	Increase by 15 – «satisfactorily»	Increase by 16 – «satisfactorily»	Increase by 13 - «satisfactorily»
2	SAP, mm Hg, on average	Increase by 3,4 – «good»	Do not change – «satisfactorily»	Do not change – «satisfactorily»
3	DAP, mm Hg, on average	Increase by 10 – «good»	Increase by 7,79 – «good»	Increase by 8,94 – «good»
4	PP- pulse pressure, mm Hg, on average - the direction of change	46,26 – 45,75 – 47,79 – «satisfactorily» - ↓↑	55,76 – 54,5 – 52,62 – «unsatisfactorily» - ↓-↓↓	67,72 – 60,18 – 57,75 – «unsatisfactorily» - ↓-↓↓

The data in table 1 indicate that the autonomic provision of cardiovascular reactions in experimental groups is inadequate, and works poorly **at almost 66.7%** (percentage of bad and very poor grades).

Changes in the rate of heart rate (HR) are considered normal on 3 - 10 beats / min, and on average, in group 3 - an increase in heart rate was noted at 5 - 13 beats / min. An excessive increase in heart rate in the group with a minimum initial blood pressure (in group 1) on 5 - 15 beats / min is noted, depending on the increase in the period of finding a person in the orthostatic test. That is, it is impossible to 100% associate experimental groups with adequate regulation of the cardiovascular system (CVS).

If to characterize the reactivity of the autonomic nervous system (VNS) to orthostasis, then DAP is the minimum pressure at diastole of the heart. It is due to the magnitude of the tone of peripheral arterial vessels. The increase in DAP (in the middle group the reliability was equal to $0.05 > P > 0.01$) and also the reduction in pulse pressure (PT) in the experiment depended on the functional tension of the organism in the orthostatic tests. Results of the tests indicate the formation of an adverse parasympathetic reaction of the organism to orthostatic stress.

In all groups, in orthostatic tests, the total peripheral vascular resistance (TPVR) is practically unchanged, and in healthy people, TPVR, on average, in orthostatic samples is reduced by 20-30%. The parasympathetic vegetative nervous system is responsible for the regulatory level of the formation of such inadequate TPVD reactions in orthostatic tests. But perhaps damage can be not only at the level of functions of the VNS, but also on the histological (damage of the walls of the vessels by pathological process).

Chronic modulation of the high parasympathetic activity of the VNS, stimulation of vagus nuclei can be caused by smoking or high body mass, or EMR-RF. We carefully excluded from research groups students who had causes of chronic stimulation of the vagus nuclei of the medulla oblongata (smokers or with high body mass). But, as studies have shown, EMR-RF remains among the possible factors that form the pathology. With these "weak players", as it was established, students communicate with almost from childhood: from 5 to 15 years is the exposure of EMR-RF from various gadgets and computers.

Consider the percentage distribution in the experimental groups - students with predominance of parasympathetic (vagus) regulation (V) of the cardiovascular system (CVS) in the short-term and long-term orthostatic test, sympathetic regulation (S) and normotonic (N), as well as, depending on the time exposure of EMR-RF at work by computer (t), in years (table 2).

From table 2 it turns out that a higher percentage of students with parasympathetic response to the autonomic nervous system to orthostasis is in the third experimental group (more than 40%). And in this group of studied students, the reliability of increasing the average exposure time of the EMR RF-range (in years, from gadgets from the answer to the questionnaire) - compared to other groups.

In analyzing the results of natural modeling of orthostatic test and student questionnaires in experimental groups, we found a probable correlation between the formation of a vasotonic type of autonomic response to the regulation of the

cardiovascular system and the time of exposure (work with a computer, in years).

Table 2

Distribution (%) of students in experimental groups according to the vegetative Kerdo index when performing short-term (SOT) and long-term orthostatic (LOT) tests and EMR-RF effects (t) in years

Groups of patients examined with *primary* AP:											
1. *Minimal*				2. *Mean*				3. *Maximum*			
SOT		LOT		SOT		LOT		SOT		LOT	
V,%	26,5	V	17,6	V,%	39,4 ↑	V,%	24,3 ↑	V,%	46,9 ↑↑	V,%	40,6 ↑↑
t(v) $M1_V$	9,0± 0,98	t(v) $M4_V$	8,8± 1,22	t(v) $M2_V$	8,3± 0,74 *	t(v) $M5_V$	8,1± 1,14	t(v) $M3_V$	9,6± 0,91 *, **	t(v) $M6_V$	9,6± 0,98 **, ****
N,%	26,5	N	26,5	N,%	15,2	N,%	27,3	N,%	25,0	N,%	25,0
t(n) $M1_N$	8,8± 1,13	t(n) $M4_N$	10± 1,35	t(n) $M2_N$	9,2± 1,35	t(n) $M5_N$	8,1± 0,99	t(n) $M3_N$	9,5± 1,62	t(n) $M6_N$	9,0± 1,15
S,%	47,0	S	55,9	S,%	45,4	S,%	48,4	S,%	28,1 ↓	S,%	34,4 ↓
t(s) $M1_S$	9,8± 0,86	t(s) $M4_S$	9,2± 0,7	t(s) $M2_S$	8,9± 0,78	t(s) $M5_S$	9,4± 0,62	t(s) $M3_S$	7,1± 1,01	t(s) $M6_S$	8,2± 1,28

Note: V-vagotonics, N-normotonics, S-sympathotonics. * - the reliability of the differences between M1 / M3 or M1 / M2 and ** - M2 / M3, at pU = 0.05 according to criterion U (Wilcoxon-Mann-Whitney); *** - the validity of the differences between M4 / M6 and **** - M5 / M6, at pU = 0,05 according to the criterion U (Wilcoxon-Mann-Whitney).

When calculating the correlation coefficient between the increase in the percentage of persons with a vagotonical direction (according to the Kerdo index), the operation of the VNS in orthostatic tests (x) and the time of the exposure of the EMR-RF from the computer (y) (as defined by the questionnaires) was found to have a strong direct correlation connection between the indices (r_{xy} = + 0,832, at P = 0,05).

When calculating the correlation coefficient (in series with minimum, average and maximum arterial pressure) between the increase in the percentage of persons with a vagotonics direction of the VNS in the long-term and short-term orthostatic tests (x) and the time of the exposure of the EMR-RF from the

mobile phone (y) (defined by the questionnaires) also found a strong direct correlation between the indices (r_{xy} = + 0.742, at P = 0.05).

In this regard, the pathogenetic prophylaxis of disorders in the central nervous system (CNS), VNS and CVS under the action of the EMR of the RF band can be supplemented by such a set of physical exercises:

1) physical exercises to increase blood circulation in the central nervous system [3, in our modification];

2) the method of psychological-muscular unloading [3; 14, in our modification];

3) the method of integrated regulation - physical exercises to balance the sympathetic and parasympathetic parts of the VNS [3, in our modification].

1. Physical exercises to increase blood circulation in the central nervous system (CNS). Exercises for improving cerebrovascular flow on the recommendations of the Ministry of Health [3], we supplemented exercises on spinal extensions [12], which increase blood circulation and have a complex effect on the reduction of fatigue from the psycho-physiological load.

The main load consists of inclination and turns of the head produce mechanical action on the walls of the neck blood vessels, increasing their elasticity. The training of the vestibular apparatus promotes the expansion of the blood vessels of the cerebellum, and respiratory exercises, especially breathing through the nose, increase their blood flow. All of this increases the cerebral circulation, thereby facilitating mental activity and preventing the emergence of pre-nosological symptomatology.

2. The method of psychological-muscular unloading. Thanks to this technique, we combines the types of relaxation of the organism, taking into account the adverse effects of stress and psychophysiological overload.

Neuromuscular relaxation is a system of special exercises for relaxing various muscle groups. The purpose of this training is to remove muscle tone, which is directly related to various forms of negative emotional arousal: fear,

anxiety, embarrassment. Nerve-muscle relaxation consists of a series of exercises for slow relaxation of the main muscle groups of the body. A characteristic feature of each exercise is the alternation of intense stress and the subsequent relaxation of the corresponding muscle group.

Relaxation is one of the defining components of *psychological training* (autotraining). It is a volitional relaxation of the muscles. It, as a rule, has a double result: emotional tension decreases and a natural state of inhibition of the central nervous system (the body prepares for sleep) arises. Natural relaxation of the muscles is usually caused by positive emotions.

At the same time, the method initially causes the feeling of heaviness and heat in the body by self-induction and thus the state of muscle relaxation is achieved. Heat flowing throughout the body appears due to the expansion of the blood vessels, which causes the blood to flow to all parts of the body. The main elements of the technique are the training of muscle relaxation, self-hypnosis and self-education. With autogenous training you can get rid of many functional disorders of the central nervous system - obsessive fears, ideas, thoughts, overcome sleep disturbances.

3. Physical exercises to balance the sympathetic and parasympathetic departments of the VNS (Integrated regulation method). Chechetin D.A. [14] offers physical therapy for somatoform dysfunction of the autonomic nervous system (SFDVNS), the symptoms of which are mental disorders and somatic disorders.

The peculiarity of the method of therapeutic physical culture is its natural biological content, since in the therapeutic uses one of the basic functions inherent in each living organism is used - the function of motion, which is a biological stimulus that stimulates the processes of growth, development and formation of the human body. The curative effect of physical activity is based on the close relationship between the working muscles with the nervous system, the metabolism of substances, and internal organs. With movements, the regulation

of the body's activity improves, the metabolism improves, the delivery and use of oxygen by organs and tissues, blood supply to vital organs, and the final products of metabolism are extracted from the body.

According to the International Statistical Classification of Diseases and Health-Related Problems [9] (ICD 10), the SFDVNS refers to the same heading as Occupational Disease under Radiowave Irradiation.

Clinical picture of SFDVNS also (as well as occupational diseases under the influence of non-ionizing EMR RF-range) consists of cardiac and general neurotic manifestations.

Each of the symptoms of the SFDVNS, taken separately, has a low specificity, that is, it can be observed in a variety of pathologies, and only a combination symptoms or combination of these syndromes gives grounds for diagnosis. *Therefore, we have found it possible to take as the basis of the author's [14] recommendations for the prevention of manifestations of pre-nosological signs of occupational disease under the influence of non-ionizing radiofrequency EMR.*

Preventive physical culture develops adaptive processes, strengthens the protective mechanisms of the human body. Physical exercises neutralize the negative influence of the EMR of the RF band on vascular tone, blood circulation, external respiration, metabolic processes, external nervous activity and other vital processes, maintains the functional state and performance of the organism. Biological basis of physical exercises is muscular activity (movement) - a strong stimulator of vital functions.

Under the influence of physical exercises, the state of the basic nervous processes is normalized - excitability increases with the strengthening of braking processes, and inhibitory reactions develop at pathologically expressed increased excitability.

Physical exercises form a new dynamic stereotype, which contributes to the reduction or disappearance of pathological manifestations.

Physical exercises *of pathogenetic prophylaxis* are a specially selected complex of physical exercises, which is conducted in a well ventilated room, not earlier than 1 hour after eating. When selecting and applying physical exercises the principles of alternating loads on separate organs, systems and muscle groups, the graduality and sequence of its increase and decrease are observed. The intensity of the loads is 50 - 60% of the maximum, the density of the occupation is 75 - 80%, the duration of 25 - 30 minutes, the regularity 4 - 5 times a week. In the process of training 20% of physical exercises are updated, and 80% - are repeated to consolidate the results of treatment.

All means of physical culture require the use of musical accompaniment [1, p. 245].

Monitoring of health during conduction of gymnastics is carried out before, during and after physical exercise by measuring arterial pressure, heart rate and respiratory rate.

Conclusions. Based on the foregoing, it can be concluded that the pathogenetic prevention of the development of pathology under the influence of the EMR-RF range may consist of active physical exercise and autogenic training, as well as to combine active influence on the central and peripheral levels of the regulation of mental and neurovascular processes.

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