Міністерство освіти і науки України
Національний університет «Полтавська політехніка
імені Юрія Кондратюка»

ТЕХНОЛОГІЇ ЗДОРОВ'ЯЗБЕРЕЖЕННЯ: ТЕОРІЯ І ПРАКТИКА

Колективна монографія
за загальною редакцією проф. Л.М. Рибалко

TECHNOLOGIES HEALTH-SAVING

A collective monograph
according to the general editing by prof. L. Rybalko

11. Рибалко Л.М. Педагогічні умови формування здорового способу життя в студентської молоді. Вісник Чернігівського національного педагогічного університету імені Т.Г. Шевченка. Вип. 147. Т. ІІ / Чернігівський національний педагогічний університет імені Т.Г. Шевченка ; гол. ред. Носко М.О. Чернігів : ЧНПУ, 2017. С. 118-121. Серія: Педагогічні науки. Фізичне виховання та спорт).

12. Gozhenko A., Biryukov V., Gozhenko O., Zukow W. Health as a space-time continuum. *Journal of Education, Health and Sport*. 2018; 8(11). P. 763-777.

13. Ilhan N., BatmazM., AkhanL.Healthy Lifestyle Behaviors of University Students. *Nursing Science and Art*. Ilhan, 2010. Vol. 3 (3). p. 34-44.

21. Von Ah D., EbertS., NgamvitrojA., ParkN. Predictors of health behaviors in college students.*Adv Nurs DH. Kang*. 2004. 48 (5). p. 63-74.

22. Zaybak A., Fadiloglu C. Determining of the health promotion behaviors of university students and the factors affecting these behaviors. *Ege University Journal of Nursing*, 2004. Vol 20 (1). p. 77-95.

23. Golodiuk L.S. The productive methods of teaching mathematics on the basis of competence approach. *Science and Education a New Dimension. Pedagogy and Psychology*. IV (38). Issue: 77. 2016. Str. 17–21.

DIGITAL VISUAL FATIDUE: METHODS FOR DIAGNOSING< MONITORING, AND EFFECTIVELY PREVENTING DEVELOPMENT

Andrii Horoshko, Viktoriia Horoshko

The formation of modern society is characterized by the rapid development of information and communication technologies (ICT). They are an integral part of the overall social structure. The constancy of its existence begins to be largely determined by the functional stability of these technologies. The ICT activity plays an important role in modernization: the virtualization of social relations in the context of globalization. Thanks to the active use of information and communication technologies, the entire society is integrated into a single supersystem. In the modern world, due to the pandemic, the population's demand for pocket personal computers (PDAs or smartphones) has increased, which prompted developers to create a concept for the layout of mobile devices.

The number of mobile device users is growing rapidly, which requires high quality software. This is driving the rapid growth of mobile software development technologies. Although new technologies accompany people at all stages of human evolution, they have become the subject of special theoretical studies

relatively recently. From the standpoint of socio-philosophical discourse, the phenomenon of technology has become more conceptually considered since the middle of the 20th century. The constructive understanding of technology is provided by an active communication approach, focused on the interaction between people and technology. These approaches allow us to consider the emerging socio-technical systems in their entirety in order to accept the dominant beginning of the activity arising in the form of communication.

Based on the declared concept of technology and human interaction, human health sciences are actively developing with the dynamic development of scientific and technological progress. The health of all people depends on the influence of external and internal factors. The amount of incoming information is increasing and at this stage of social development, the problem of preserving and shaping the health of the population is important and relevant, since it is directly related to the issues of security and independence. The norm of health is a certain level of a functional state, a characteristic of its reserve capabilities and normative quality.

The relevance of the study is determined by the fact that its assessment is associated not only with a person's working capacity, but also with such physiological concepts as fatigue, overwork and recovery of the body, as well as professional burnout, which is increasingly occurring among specialists in technological industries, and the stress associated with it. The studies of many sociologists, psychologists, doctors and diagnosticians are devoted to the study of this topic. Many studies are known in the field of diagnostics of the functional state; there are a significant number of patents and copyright certificates of researchers who show great interest in this issue. The tasks of determining the functional state were carried out by scientists R.M. Baevsky, A.P. Berseneva, L. K. Garkavi, V.V. Parin, I.B. Ushakov, G.G. Ivanov, S.P. Morozov, I.I. Dedov, A.A. Kashitsyna, E.E. Godik, I.V. Gulyaev.

A number of methods for determining the functional state and fatigue of a person are discussed in the literature, but the process of adaptation to stress has not been fully studied taking into account the individual characteristics of a particular organism, there is no simple and obvious way to determine the onset of fatigue and overwork [1, c.73-77]. There is no method for the individual selection of diagnostic procedures for each subject, and the correction for learning during the experiment is also little taken into account. Analysis of the literature has shown that this method can be called the method of the critical flicker fusion frequency (CFFF). In connection with the choice to determine the functional state of the CFFF method, the development of computer technology devices for measuring the CFFF, providing the necessary accuracy and reliability of measurements, remains relevant [6, c.34-40].

The aim of the work is to analyze and develop, on the basis of the created software and hardware complex, the optimal mode of work and relieve fatigue, conduct a series of experiments to check the effectiveness of the proposed work and rest schedule.

1. Theoretical and methodological foundations for studying the effect of digital fatigue on human functional health. The digital economy, based on a qualitatively new type of ICT, changes and transforms all spheres of modern production and social life. The digital economy not only provides leadership in increasingly global forms of competition in the areas of efficiency, productivity and innovation, but also uses fundamentally new digital forms of communication between people and takes into account the individual principles of people's needs, as well as the opportunities offered by artificial intelligence [2, c.8225-8233]. The digital society based on a complex of technological, institutional and social radial innovations raises many important topics. The development of the digital economy will continue to grow rapidly, but since the positive aspects of this process fall into the perspective of research, we would like to focus on the negative impact of all ongoing processes on human health.

In particular, from the above material, it can be seen that the main working link will be the young generation, who are well versed in the skills of working in the IT-sphere. It is pleasant to raise the issue of maintaining health, avoiding visual fatigue and digital fatigue of the nervous system of young people during their education, as well as all stages of life. Since the central nervous system plays a dominant role in the regulatory processes occurring in the human body, it is preferable to take into account its state when assessing human health. As psychophysiological parameters characterizing the state of the human nervous system, psychophysiological parameters of the state of the visual analyzer are used, since the effectiveness of its functioning depends, first of all, on the level of functioning of the central nervous system.

In connection with the socio-psychological, socio-economic crises inevitable in the new conditions of development, the governments of many countries, assessing the prospects for development, are faced with the need to develop special national programs to strengthen and develop the health of the population. It is necessary to define a new strategy for maintaining health, based on the social value of individual health and the idea of a responsible attitude of each person for their health in front of society and society in front of a person [4, c. 21-29].

It is now known that the main factor that determines human health is a lifestyle (50-55%). The impact of environmental factors on health is estimated at 20-25% of all impacts, 20% are biological (hereditary) factors and 10% are related to health deficiencies and defects. At the same time, risk factors are not disclosed, and there are no available fatigue diagnostic devices. The intensification of the

educational process goes in different ways. Often a consequence of intensification is the appearance in a modern person of states of visual fatigue, overwork. The overwork creates the prerequisites for the development of acute and chronic health disorders, the development of nervous, psychosomatic and other diseases. From an acute state, fatigue can become chronic [7, c.54-60]. Of course, fatigue is not explained by any one factor - it is determined by a combination of various reasons, among which a significant place is occupied by mental and physical overload, inadequate to the body's capabilities, static body position during work, "monotony". So, in order for society and subsequent generations to be healthy, the causes of youth discomfort should be investigated and diagnosed in time using simple methods.

According to the Vision Council of America (VCA), digital visual fatigue is physical visual discomfort after a person has spent more than 2 hours in front of a digital monitor, mainly on devices such as desktops, laptops, tablets, and e-readers. This is due to the placement of the computer screen and smartphone at a short or medium distance from the visual analyzer. A combination of factors such as screen proximity, frequency and duration of use, and exposure to high-energy blue beams from video monitors contribute to faster and aggravate severe symptoms of digital visual fatigue. It is impossible to imagine the life of modern society without digital devices, but people should be aware of their negative impact on health. It should also be clear how to reduce the induced visual fatigue, how to take into account the level of fatigue after work [3, c. 22-28]. A person's labor activity should not only minimize pathological reactions in him but ensure the complete restoration of the spent body resources during the rest period between loads. For this reason, the psychophysiological response to stress should be within the range of physiological adaptations and should not exceed the compensation threshold.

The development of this problem is closely related to the achievements in the field of psychodiagnostics of functional states developing in the process of a person's labor activity or his studies. The functional state of the human body is a complex symptom system of various processes, functions and individual characteristics and, basically, determines the level of its activity and general characteristics of the behavior. When researching on diagnosing and predicting the effectiveness of an employee's or student's activity, different theoretical approaches to the problems of studying working capacity were used. There is an approach to predict health status by determining the sequence of phases of the health curve, the relationship with the functional state, or determining the phases of the adaptive process, involving the use of two types of indicators in the assessment process, including performance indicators, direct performance

indicators, as well as indirect indicators of functional status and psychophysiological assessment [5, c. 862-875].

It is impossible to provide one general information indicator for employees of all types and conditions of activity. This is due to the fact that the psychological structure of the activity and the psychophysiological functional system that implements this type of activity are determined. It should be noted that the stability of indicators in a given individual affects the determination of the functional state and performance (they are different for different individuals), which makes them as less situationally independent as possible. On the other hand, to assess the functional state, indicators are desirable, which, ideally, would be unambiguous for all individuals, and would be uniformly and linearly dependent on the intensity of external and internal influences. The abstract formulation of the problem of information parameters is incorrect. Because under various external influences the indicator parameters have different meanings and, therefore, different information content. At the same time, the general requirements for all selected parameters should be correlated with the effectiveness of the activity, but in various aspects the effectiveness of the activity depends not only on labor productivity, but also on the type of activity [17, c. 729-738]. For any specialist, the effectiveness of activity is not only labor productivity, but also the psychophysiological "price" of activity. Analysis of the published materials allows us to conclude that at present there is no consensus on the most appropriate system for monitoring and predicting performance, which was the reason for further research. Most researchers continue to pay attention to the development of physiological and psychophysiological methods for assessing the functional state, based on the principle of complexity. The principle of complexity, which is a feature of experimental research at the last stage, determines the number of complex diagnostic methods (the polygraph method is still widespread), which, in principle, leads to the development of various methods up to biochemistry. The diagnostic value of these complex methods is determined by the level of correlation with the performance, its qualitative and quantitative indicators [13, c. 131-137]. Methods or techniques for assessing and predicting fatigue are multivariate and can be described in a number of ways. So, for example, this approach can be complex and multi-level, multifunctional, specific for specific sequences and specialties, or vice versa, single-level, non-specific, objective, operational-dynamic, etc.

Currently, devices and methods for assessing conditions are under development and improvement. Fatigue is studied according to REG, EMG, heart rate, photoplethysmogram. The parameters of the accuracy, stability and reliability of these indicators, the sensors and methods of fixing the sensor to the object, the integrity of the transmitted information were improved, as well as the equipment

for recording these parameters. They are becoming more portable and easy to use, more communication systems are used, and the capabilities of microcontrollers are growing. Nevertheless, the determination of the functional state and the level of adaptation takes a rather long time, therefore the results come with a time lag, which can pose a danger to the health of both the person himself and the environment.

The development of a method for assessing and predicting fatigue using fewer monitoring parameters, as well as economic losses, can be effectively used and reduce medical and preventive costs, and will reduce the risk of man-made emergencies.

Physiological study of the functional state of the body is a number of experimental methods. EEG and "eye tracking" are widely used by modern specialists to determine psychophysiological characteristics. However, a more general method is based on recognizing the number of blinks per unit of the critical flicker fusion frequency (CFFF). Fatigue diagnostics should focus on identifying stressors and stressful situations, measuring stress levels, and identifying people with burnout.

After a preliminary analysis of modern scientific literature on the study of the functional state of the body during fatigue and under the influence of stress factors, we decided to study in detail the devices for measuring and diagnosing CFFF as the most effective indicator of all pathophysiological changes. As a result of constant stay in stressful situations and information load, the concentration of attention and the level of control, taken separately from one mechanical process in the younger generation, decreased, which naturally caused the appearance of new devices for the control of fatigue on the market of diagnostic devices [16, c. 321-323]. We used a smartphone and a proprietary device to determine the critical flicker fusion frequency. The use of computer technologies for the prevention of diseases includes the use of various mobile applications to maintain a healthy lifestyle, physical culture and sports through the control of individual physiological and anthropometric indicators. These programs vary in complexity and can be used by patients alone or in collaboration with a doctor [14, c. 709-718].

By the end of 2014, smartphone apps were announced in all European countries. Similar to Instagram, doctors can share clinical images and with medical students. At the same time, the information remains confidential - the patient's face is automatically dimmed, and access to the patient's medical or other personal information is not provided. The most promising direction is the development and implementation of various diagnostic devices that connect to smartphones [9, c. 123-129].

Mobile phones are becoming a kind of express laboratory and diagnostic equipment. According to forecasts, the main market share of mHealth products will

be occupied by devices (such as smart glasses, watches, bracelets, etc.) that register various health parameters and send them to a doctor wirelessly. A Taiwanese expert invention based on "smart" clothing, which includes many sensors and uses a smartphone as a central communication device to obtain important vital signs (body temperature, ECG, heart rate) is very promising. New programs and devices make disease prevention and early diagnosis more effective and improve health management systems. Devices become more functional and smaller. Each person has the opportunity to control their health individually. Electronic patient records can be combined with other applications such as appointment reminders or medication reminders. The future lies in the integration of mobile technologies with other types of medical informatization, which was the basis of the author's diagnostics and monitoring of fatigue of a modern person [12, c. 662].

There is an increasing need to prevent visual fatigue of personal computer users, which is associated with the widespread use of computer technology. To reduce the current medical support, reduce the need for special ophthalmological equipment and, ultimately, simplify the service of users of personal computers (PCs), the assessment and change of the functional state of visual acuity should be carried out directly at the workplace using reliable and affordable methods. Therefore, it is advisable to use non-invasive and non-pharmacological agents to prevent chronic visual fatigue and optimize visual function with increased stress on the visual system due to the ubiquity of PC.

2. Analysis of the data obtained during the experiment, assessment of objective symptoms to identify chronic visual fatigue. Studies of the processes occurring in the body of a person working at a computer have been carried out for a long time. The working group on the hygienic aspects of the use of computer technology of the World Health Organization (WHO) back in 1990, summarizing the materials of international scientific conferences (Canada 1984, Sweden 1986, etc.), as well as scientific research concerning the impact of computer technology on human health, established 5 possible risks in violation of the health status of workers: eye diseases and visual impairments; disorders of the musculoskeletal system; stress-related disorders; skin diseases; adverse pregnancy outcomes.

The detected disorders in the body were associated with the nature, intensity and mechanisms of the impact of environmental factors on the human body. Studies have shown that working at a computer is a model of mental work performed in a monotonous sitting posture, in conditions of limited general muscle activity with mobility of the hands, with significant eye strain against a background of high neuro-emotional stress under the influence of factors of various physical nature [8, c. 69].

Our research was carried out on the basis of a private enterprise "Workconsult". Several people over the age of 50 were selected as the target

group, several people were between the ages of 30 and 50, and the rest were between the ages of 20 and 30. The measurements were carried out according to the working schedule of the experimental group.

The research presents the results of a study of the degree of visual fatigue of a person working at a computer monitor during a standard 8-hour day, which requires concentration of visual and mental attention, such as working at a PC. The study took into account the number of people that were functionally available for the experiment. A decrease in CFFF at the end of the working day by 31.9 5.9% was noted as a symptom of fatigue (Table 1).

This study was carried out using a special diagnostic module controlled by a mobile phone. In this module, stimuli of red, blue and green colors were set. The device generated colored light pulses of various frequencies and wavelengths. The frequency range is from 3 to 70 Hz (frequency adjustment is smooth), and the duration of one optical pulse is 5 ms or more. LEDs, which are non-inertial light sources, are used to generate light stimuli. Stimulus generation measurements are displayed on the phone screen. Light stimulation is controlled by the diagnostic module.

Table 1. CFFF indicators for all employees of the team before the experiment at 9.00 (in the morning)

Age	Number of eyes	CFFF data (Hz)			$\lvert M_з - M_к \rvert$
		Green color	Red color	Blue colour	
m±M	n	m±$M_з$	m±$M_к$	$M_с \pm$ м	Δ
25,3±0,6(20-30)	20	62,0±0,7	61,1±0,6	58,8±0,6	0,9
35,5±0,5(30-35)	30	41,3±0,7	45,6±0,6	43,3±0,6	4,3
46,4±0,7(35-45)	12	42,0±0,6	46,0±0,4	44,8±0,5	4
59,2±5,0(45-55)	6	61,7±0,7	63,0±0,9	60,6±1,0	2
Average rate	68	62,2	54	51,8	2,8

Table 2. CFFF indicators for all employees of the team before the experiment at 18.00 (in the evening).

Age	Number of eyes	CFFF data (Hz)			$\lvert M_з - M_к \rvert$
		Green color	Red color	Blue color	
m±M	n	m±$M_з$	m±$M_к$	$M_с \pm м$	Δ
25,3±0,6(20-30)	20	32,55±0,7	21,8±0,6	47±0,6	10,704
35,5±0,5(30-35)	30	24,9±0,7	30±0,6	35±0,6	5,196
46,4±0,7(35-45)	12	31,5±0,6	30,36±0,4	35,84±0,5	1,14
59,2±5,0(45-55)	6	46,275±0,7	41,58±0,9	48,48±1,0	4,695
Average rate	68	33,80625	30,9705	41,5	2,84

Further studies were carried out in assessing CFFF, when only red stimuli were given with an increasing frequency, since the highest sensitivity to such stimuli was noted. Visual fatigue of the visual system was quantified according to the Visual Fatigue Index (VFI) criteria, which summarizes the frequency and severity of the following nine symptoms: 1) eye irritation, 2) itchy eyes, 3) gritty eyes, 4) hypersensitivity to light, 5) eye pain, 6) redness of the eyes, 7) excess secretion of the lacrimal glands, 8) dry eyes, 9) a feeling of blurred eyes on concentration.

The groups were divided using the principle of the presence of complaints of vision diseases according to the indicators of visual discomfort. Group A concatenate persons with mild visual fatigue (n = 16). Group B concatenate persons with severe visual fatigue (n = 18). In these groups, not the age of the people was taken into account, but only the functional state of their vision. The groups were divided into subgroups to determine the most effective way to restore visual performance. The first subgroup rested every hour (10 minutes) during the work process to correct visual fatigue, the second subgroup worked as usual. Measurements were made during the working week.

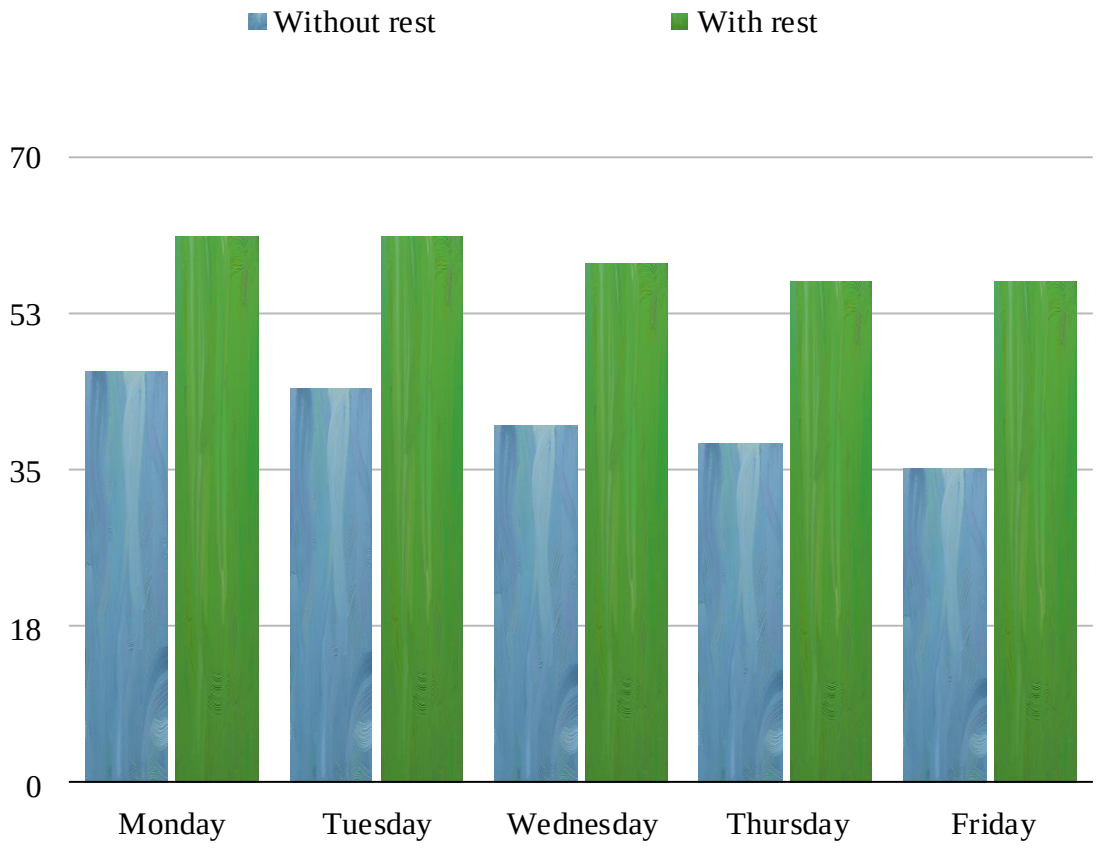
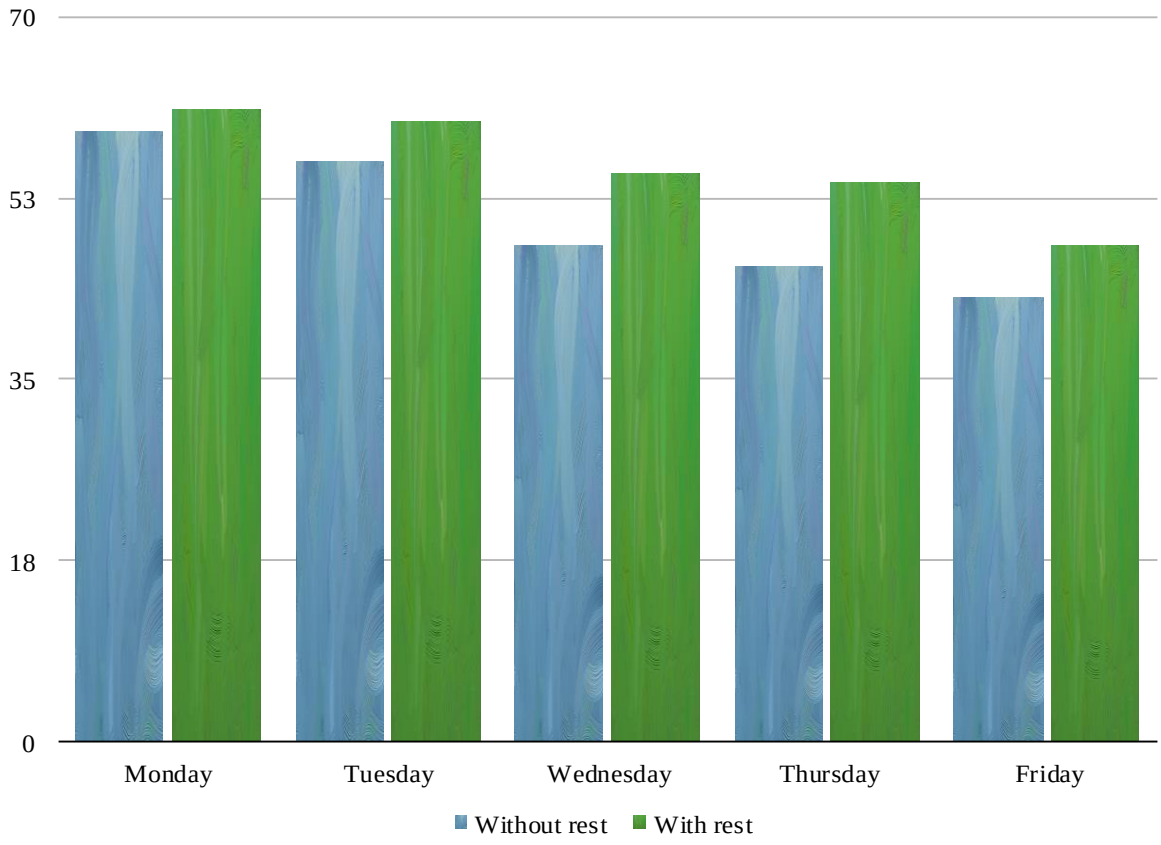


Fig. 1. CFFF indicators for all employees of the team, group A

In the group with less expressed complaints of visual fatigue, CFFF indicators had significant deviations from the generally accepted normal values - up to 21%, as well as in the group with severe complaints of visual discomfort - 50%. After 7 days of fixing the readings in group A, the following changes occurred: in the subgroup where short-term rest was used, this indicator changed to normal. In the subgroup where they worked in the regular mode, the CFFF indicators by the end of the working week decreased by 18.8%, these indicators are in the lower range of normal values, initially the CFFF indicators in this group were significantly lower than in group B. The results of CFFF diagnostics in the group with severe complaints of visual fatigue, as can be seen from the figure, were in the lower range of normal values before regular short-term rest.



Index of Visual Fatigue (IVF) indices at the beginning of the study corresponded to the values reflecting the presence of severe visual fatigue - 23.9 ±4.3 and 27.6 ±4.8 points in groups A and B, respectively.

At the end of the experiment, the average IVF value for subjects whose short-term rest was used as rehabilitation was observed to statistically decrease to 16.3 2.1 points, which indicates the absence of signs of visual fatigue at the workplace and can be direct evidence of work safety for the health of the company's employees.

To elucidate the mechanism of development of visual fatigue, the obtained data were analyzed correlatively. In the course of the analysis, it was found that before the start of rehabilitation measures (10 minutes rest after 1 hour of work), the IVF indices depend on the CFFF. It should be noted that after rehabilitation measures this connection disappeared, most likely due to a decrease in the number of complaints of visual discomfort and an increase in the CFFF index to the level of generally accepted criteria.

As already mentioned, in the group with severe complaints of visual fatigue, the CFFF indices were initially close to normal values corresponding to 37–65 Hz.

An increase in the CFFF index after a short rest may be associated with an improvement in blood flow in the choroidal blood flow system and an increase in

the energy and plastic metabolism of the central retinal artery basin, as well as the neuroreceptive system of the eyes.

Thus, it was found that a short visual rest led to an increase in the CFFF index, but since the experiment took a short period of time and an insufficient amount of human resources, the potential and direct dependence on the mental fatigue index from CFFF is not fully proven and is planned to be developed by the authors in subsequent research.

Establishing relationships between occupational, environmental and social stressors and the resulting consequences for humans - anthropoecological fatigue, stress diseases, accelerated biological aging, is necessary to determine an effective public health policy. The joint efforts of biologists, physicians, psychologists and sociologists are aimed at establishing the relationship between chronic stress reactions and chronic fatigue and biological aging and diseases [19, c. 13-15].

Thus, the publication describes the mechanisms common to fatigue and aging. The genetically programmed rate of biological wear (aging and resistance to stress) is fundamentally variable and modulated by environmental factors. When studying the ratio of the role of endogenous, genetic and exogenous factors on these processes, it was found that the latter determine about one third of age-related changes in physical and half of the age-related decrement of mental performance, hypertension and hyperlipidemia. In the same work, it was shown that the dynamics of the population risk of functional limitations is significantly influenced by working conditions and visual fatigue. The lack of rest arising from physiologically inadequate modes of action of professional and non-professional stressors serves as a target diagnostic sign of a state of chronic fatigue, which is the root cause, initial stage and an accompanying component of almost all occupationally-related chronic diseases of workers.

Upon further research, it was found that 31% of workers were more likely to fatigue at work on weekends, and only on vacation - 16% of workers; moderate fatigue, respectively, in 18 and 2% of employees; slight fatigue - 2% of employees on weekends, among them there are no people with the accumulation of fatigue for vacations. Among workers who do not notice professionally conditioned fatigue on working days, only 5% note a slight deterioration in health in the previous year. Among the "slightly tired", 32% of employees reported a slight deterioration in health, 1% - a significant deterioration. 35% of “moderately tired” health worsened slightly over the year, and 8% - significantly. For "very tired" these values were 42 and 30% [18, c. 524-530].

The established regularity of the relationship between acute and chronic fatigue is based on the duration of the recovery period, which increases with an increase in the degree of daily fatigue. As shown in severe fatigue during an 8-hour day, the duration of being in a state of fatigue is 14.8 hours / day, 1/3 of these

hours of fatigue is observed during working hours, 2/3 - outside working hours. Severely tired workers with an 8-hour working day and a 40-hour week, 70-75 hours a week are in a state of fatigue, a daily and monthly lack of rest occurs, which leads to the development of a state of chronic fatigue, which affects the nature of the annual change in the employee's health. The risk of worsening health over the year, according to the testimony of workers, increases with an increase in the degree of their usual fatigue at work, with great fatigue it is 62 ±6%, which statistically coincides with this value in people with CFS - 63 ±5%.

Analysis of the problems that determine human digital visual fatigue has shown the existence of many methods. Most of them can only work with a certain time delay. As the physical form develops, the parameters that determine fatigue lose sensitivity and the amount of information, and data processing is primarily focused on the characteristics of its dynamics, comparing individual indicators with the average. Analysis of the involved processes, the nature of adaptation to stress, determination of the moment of onset of fatigue and overwork are not always immediately recorded by modern devices. The use of microcontroller technology with a wireless interface greatly simplifies the component base of the developed composite electronic components and expands the capabilities of human fatigue diagnostics [10, c. 4-14].

The mobilization of intelligent tools facilitates the implementation of remote control methods and smooth control of the main parameters of the diagnostic process. In comparison with the previous author's model, the measurement accuracy is improved by 67%. The proposed software makes this procedure simple and accessible to most diagnostic operators. But this model does not take into account the moment of training, which can distort the indicators, and the software does not provide the ability to save the indicators obtained during the study and build graphs for each color load. The research methodology did not take into account the distinctive criteria of fatigue, overwork and professional burnout. With further research and modernization, it became necessary for additional qualitative analyzes of the surveyed questionnaires, the preparation of additional test items and the development of a new survey methodology [11, c. 183-189].

The lack of rest, arising under the modes of exposure to environmental, ergonomic and psychosocial factors that are inadequate to the regenerative capacity of the human body, is a target diagnostic sign of a state of chronic fatigue and fatigue. Chronic fatigue modulates the aging process and the growth of chronic human diseases. To assess these processes, the values of age population trends in health indicators are required, observed in a favorable environment, without the harmful effects of professional and non-professional factors. With a high and very high level of physiological labor intensity, the annual increase in the risk of CFS increases by 2 and 4 times. Programs for improving working

conditions should include a section on minimizing the risks of a permanent lack of rest among workers, including regulation of the physiological intensity of work and options for "time protection" from harmful environmental factors.

Sociological surveys show that according to the population, the main causes of all diseases are work and stress. The share of the population employed in occupations in which psychogenic factors are the most frequent cause of stress and a source of health risk for workers is constantly increasing. When studying the impact of psychosocial factors on the health of the working population, the most commonly used models are “demand-control-support” (DCS) and “effort-reword-imbalance” (ERI). The main goal of the ERI model is to identify the relationship between employee health and the imbalance between his efforts at work and remuneration. In the last decade, more and more studies of organizational and psychosocial health factors of workers using DCS and ERI models are being integrated into a more general work-life balance system, in which the root cause of chronic health disorders is the need for recovery from work, arising with occupational stress and workload inadequate to the recovery capabilities of the human body. To assess the degree of harm of effort-reward imbalance, the chronobiological criterion “annual increase in risk” should be used, using modern diagnostic methods.

The authors plan to work on the relationship between digital visual fatigue and burnout, chronic fatigue in the future.

Conclusions. The use of microcontroller technology with a wireless interface greatly simplifies the component base of the developed composite electronic components and expands the capabilities of human fatigue diagnostics. The attractiveness of mobile intelligent tools contributes to the introduction of remote control methods and smooth adjustment of the main parameters of the diagnostic process. The offered software makes this procedure accessible and easy for most diagnostic operators in the world. The mode of work and rest, proposed in the work, is effective even for a short period of use and can be recommended for mass use.

The practical significance of the work. The study can be used in the field of human life safety, industrial sanitation, in particular, in the system for determining the level of fatigue of programmers, personal computer operators, dispensary observations of the state of vision of schoolchildren and students.

References

1. Abbasi-Kesbi R., Memarzadeh-Tehran H., Deen M. J. Technique to estimate human reaction time based on visual perception //Healthcare technology letters. – 2017. – Т. 4. – №. 2. – С. 73-77.

2. Baesmat A. S., Lakshmi V. Progress of medical undergraduates to an era of computer vision syndrome and insomnia as an aftermath of increased digitalization during covid-19 pandemic //European Journal of Molecular & Clinical Medicine. – 2021. – Т. 7. – №. 11. – С. 8225-8233.

3. Enoka R. M., Duchateau J. Translating fatigue to human performance //Medicine and science in sports and exercise. – 2016. – Т. 48. – №. 11. – С. 2228.

4. Godik E. E., Gulyaev Y. V. Functional imaging of the human body //IEEE Engineering in Medicine and Biology Magazine. – 1991. – Т. 10. – №. 4. – С. 21-29.

5. Ji Q., Lan P., Looney C. A probabilistic framework for modeling and real-time monitoring human fatigue //IEEE Transactions on systems, man, and cybernetics-Part A: Systems and humans. – 2006. – Т. 36. – №. 5. – С. 862-875.

6. Karvekar S. B. Smartphone-based human fatigue detection in an industrial environment using gait analysis. – 2019.

7. Korunovska J., Spiekermann S. The effects of digitalization on human energy and fatigue: a review //arXiv preprint arXiv:1910.01970. – 2019.

8. Kuznetsova V., Azhmukhamedov I. Advantages and Risks of Using the Digital Educational Environment //ARPHA Proceedings. – 2020. – Т. 3. – С. 1369.

9. Larkin D., Martin C. R. The interface between chronic fatigue syndrome and depression: A psychobiological and neurophysiological conundrum //Neurophysiologie Clinique/Clinical Neurophysiology. – 2017. – Т. 47. – №. 2. – С. 123-129.

10. Mallis M. M. et al. Summary of the key features of seven biomathematical models of human fatigue and performance //Aviation, space, and environmental medicine. – 2004. – Т. 75. – №. 3. – С. A4-A14.

11. Park S. et al. Effects of display curvature, display zone, and task duration on legibility and visual fatigue during visual search task //Applied ergonomics. – 2017. – Т. 60. – С. 183-193.

12. Penner I. K., Paul F. Fatigue as a symptom or comorbidity of neurological diseases //Nature Reviews Neurology. – 2017. – Т. 13. – №. 11. – С. 662.

13. Smahel D., Wright M. F., Cernikova M. The impact of digital media on health: children's perspectives //International journal of public health. – 2015. – Т. 60. – №. 2. – С. 131-137.

14. Tramontano M. et al. Vestibular rehabilitation has positive effects on balance, fatigue and activities of daily living in highly disabled multiple sclerosis people: A preliminary randomized controlled trial //Restorative neurology and neuroscience. – 2018. – Т. 36. – №. 6. – С. 709-718.

15. Tu Y. et al. 17.2: Invited Paper: Influence of Blue Light from Smartphone on Visual Fatigue //SID Symposium Digest of Technical Papers. – 2021. – Т. 52. – С. 108-111.

16. Voronina A. A., Kolyagina A. V. Assessment of students 'binocular functions with refractive disorders //Молодежный инновационный вестник. – 2020. – Т. 9. – №. 2S. – С. 321-323.

17. Wang Y. et al. A model for evaluating visual fatigue under led light sources based on long-term visual display terminal work //Lighting Research & Technology. – 2018. – Т. 50. – №. 5. – С. 729-738.

18. Yu Q. et al. A Novel Method for Detecting the Degree of Fatigue Using Mobile Camera //International Conference on Geo-Spatial Knowledge and Intelligence. – Springer, Singapore, 2017. – С. 524-530.

19. Zhang Y. et al. 2.3: Invited Paper: Visual Fatigue and Comfort Evaluation of the Different Proportions of Blue Light on the Same Display by Visual Research Task //SID Symposium Digest of Technical Papers. – 2021. – Т. 52. – С. 13-15.