THE IMPACT OF NOISE ON THE CENTRAL NERVOUS SYSTEM AND COGNITIVE PRODUCTIVITY

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Abstract

The article examines the impact of noise on the central nervous system and human cognitive productivity. The main characteristics of noise, its types, and the features of its effects on the body are described. The influence of noise factors on the processes of excitation and inhibition in the nervous system, emotional state, attention, memory, and mental performance is analyzed. The physiological mechanisms of the development of cognitive disorders associated with stress reactions of the body are considered. The main methods for preventing the negative effects of noise and the importance of a favorable acoustic environment for maintaining human mental health are also presented.

Keywords: *noise, central nervous system, cognitive productivity, attention, memory, stress, cognitive disorders, prevention.*

Introduction

In the conditions of urbanization and technological progress, humans are constantly exposed to various environmental factors, among which noise occupies a special place. It accompanies everyday life — educational activities, work, transport, and the domestic environment — and becomes a constant component of the modern habitat. Despite the familiarity of this phenomenon, noise has a significant impact on the functional state of the body, primarily on the central nervous system and cognitive processes. [7], [9].

From a scientific point of view, noise is a combination of sound vibrations of various frequencies and intensities that do not carry useful information and are capable of causing unfavorable physiological and psycho-emotional reactions. In the hygienic aspect, noise is

considered a chronic stress factor capable of disrupting the processes of nervous regulation, causing emotional tension, and reducing the adaptive capabilities of the body. [2], [7].

The problem of noise exposure becomes especially relevant in relation to human cognitive activity. Studies show that even moderate levels of noise can impair attention, memory, speed of information processing, and overall mental productivity. Students, schoolchildren, and intellectual workers are the most sensitive to noise. [13].

The physiological mechanisms of noise exposure are associated with disruption of the balance between excitation and inhibition processes in the cerebral cortex, activation of the reticular formation, and the hypothalamic-pituitary-adrenal system. As a result, stress reactions develop, sleep quality deteriorates, the resistance of the nervous system to stress decreases, and cognitive impairments of varying severity arise. [1], [6], [8].

Thus, the problem of noise pollution has not only hygienic but also significant medical and social importance. Studying the influence of noise on the central nervous system and cognitive productivity is necessary for the development of effective preventive measures and the formation of a favorable acoustic environment. [3], [7].

Research Materials

The study used scientific publications on environmental hygiene, neurophysiology, psychophysiology, and cognitive psychology. The results of experimental and clinical-epidemiological studies devoted to the effects of noise on the central nervous system, psycho-emotional state, and human cognitive functions were analyzed. Data from the World Health Organization, sanitary and hygienic standards, and modern scientific reviews on this topic were also used.

Research Methods

The study applied analysis and generalization of scientific literature, a comparative-analytical method for comparing the results of various studies, as well as a systematic approach to studying noise as an external factor affecting the human body. A descriptive-interpretative method was used to reveal the mechanisms of noise influence on the central nervous system and cognitive processes. The obtained data were systematized and used to formulate scientifically grounded conclusions and practical recommendations.

Purpose of the Study

To assess the impact of noise of varying intensity on the functional state of the central nervous system and the cognitive productivity of students, as well as to identify the relationship between the level of noise exposure and changes in attention, memory, and psycho-emotional state.

1. The Concept of Noise and Its Characteristics

Noise is a combination of sounds of various frequencies and intensities perceived by the human auditory analyzer and producing an irritating or harmful effect on the body. From a physical point of view, noise is disordered mechanical vibrations of an elastic medium propagating in the form of sound waves. [3], [7].

The main characteristics of noise are:

- frequency (Hz);
- intensity and sound pressure;
- temporal structure;
- spectral composition.

Humans perceive sounds in the range of approximately 16 to 20,000 Hz. The greatest hearing sensitivity is observed in the region of about 1000 Hz. Noise level is measured in decibels (dB), most often on the dBA scale, which takes into account the peculiarities of human auditory perception.

Depending on its characteristics, noise is divided:

- by frequency — into low-, medium-, and high-frequency;
- by duration of exposure — into constant and intermittent;
- by origin — into mechanical, aerodynamic, hydrodynamic, and electromagnetic. [7], [2].

From the point of view of its effects on the body, noise is classified as disturbing, irritating, harmful, and traumatic. Prolonged exposure to intense noise may lead to the development of functional and morphological changes in the auditory analyzer and the central nervous system.

Modern studies consider noise as a stress factor causing the development of so-called acoustic stress. Prolonged exposure to noise above 85–90 dB is considered especially unfavorable and is accompanied by increased fatigue, decreased attention, headaches, and emotional disturbances. [2], [14].

2. The Impact of Noise on the Central Nervous System

The central nervous system is one of the body systems most sensitive to noise exposure. Functional disorders of the nervous system often occur earlier than pronounced hearing deterioration. [8], [1].

Under the influence of noise, constant irritation of the cerebral cortex occurs, the balance between excitation and inhibition processes is disrupted, and nervous system overstrain develops. Even moderate noise at the level of 50–60 dB can reduce concentration and cause psycho-emotional tension. [1], [6], [13].

At a noise level of 70–90 dB, pronounced changes in the functional state of the body are observed: irritability, anxiety, emotional instability, reduced stress resistance, and rapid

fatigue. Prolonged exposure to intense noise may lead to chronic stress and neurotic disorders. [5], [6].

Noise activates the hypothalamic-pituitary-adrenal system, which is accompanied by increased levels of adrenaline, noradrenaline, and cortisol. Chronic elevation of stress hormone concentrations causes vascular spasms, deterioration of metabolic processes, and overstrain of the nervous system. [1], [6].

One of the most common consequences of noise exposure is sleep disturbance. Even noise with an intensity of 35–40 dB can worsen sleep quality, while higher levels lead to frequent awakenings and chronic sleep deprivation. Sleep disturbance negatively affects emotional state, memory, and work capacity. [7], [9].

Prolonged exposure to noise is also associated with cardiovascular system disorders, increased blood pressure, and the development of hypertension. In addition, noise negatively affects the psycho-emotional sphere, causing feelings of anxiety, internal tension, and emotional discomfort.

Thus, noise has a pronounced nonspecific effect on the central nervous system, disrupting nervous regulation processes and reducing the adaptive capabilities of the body.

3. Noise and Cognitive Productivity

Noise has a significant impact on human cognitive functions, including attention, memory, thinking speed, and learning ability. Students, schoolchildren, and intellectual workers are especially sensitive to noise exposure. [6], [13].

Even moderate noise can distract attention and disrupt information processing. Under conditions of constant acoustic irritation, the brain is forced to simultaneously analyze useful and extraneous signals, which leads to overload of the nervous system and decreased concentration.

Studies show that at a noise level of about 65 dB, selective attention deteriorates, the number of errors increases, and mental productivity decreases. Under the influence of intense noise, a person becomes fatigued more quickly, performs intellectual tasks more slowly, and perceives new information worse. [13], [14].

Noise exposure is closely associated with the development of emotional tension and stress reactions. Irritability, anxiety, and internal discomfort impair learning ability and reduce the effectiveness of thought processes.

The negative impact of noise is especially pronounced in children and adolescents. Constant noise in educational environments worsens material assimilation, reduces attention stability, and interferes with полноценной mental activity.

Sleep disturbances caused by noise also negatively affect cognitive activity. Chronic sleep deprivation is accompanied by memory impairment, reduced thinking speed, and rapid fatigue.

It should be noted that sharp, unstable, and irregular noises have the most unfavorable effects. At the same time, natural sounds may have a calming effect and contribute to the restoration of emotional state.

Thus, noise is a significant factor in reducing cognitive productivity and worsening the effectiveness of educational and professional activities.

4. Physiological Mechanisms of Cognitive Disorders Under the Influence of Noise

The physiological mechanisms of noise exposure are associated with disruption of the central nervous system and the development of chronic stress reactions.

One of the main mechanisms is the alteration of excitation and inhibition processes in the cerebral cortex. Prolonged noise exposure reduces the mobility of nervous processes, increases the time of mental reactions, and worsens concentration. [1], [6], [8].

An important role is played by the activation of the reticular formation of the brainstem, which regulates the level of wakefulness and attention. Excessive stimulation of this structure leads to increased irritability, emotional lability, and rapid fatigue.

Noise also activates the hypothalamic-pituitary-adrenal system. Increased secretion of cortisol and catecholamines causes disruption of neuronal metabolism and negatively affects brain structures responsible for memory and thinking, primarily the hippocampus and prefrontal cortex. [1], [6].

The prefrontal cortex ensures the processes of attention, information analysis, and decision-making. Under chronic noise exposure, a decrease in the efficiency of its functioning is observed, which is accompanied by deterioration of executive functions and concentration.

The hippocampus, responsible for learning and memory processes, is especially sensitive to chronic stress. Excessive exposure to cortisol disrupts neuroplasticity processes and impairs the memorization of new information.

Sleep disturbance also has additional significance. Chronic sleep deprivation worsens the recovery of the nervous system, reduces cognitive activity, and increases the risk of anxiety and depressive conditions.

Constant noise exposure causes sensory overload: the brain is forced to continuously analyze a large number of sound signals, which requires significant energy expenditure and reduces the volume of cognitive resources. [13].

Thus, noise has a complex effect on the neurophysiological mechanisms of memory, attention, emotional regulation, and body adaptation.

5. Prevention of the Negative Effects of Noise

Prevention of noise exposure includes a complex of individual, sanitary-hygienic, and technical measures.

One of the most accessible methods of prevention is controlling the volume of audio devices. When using headphones, it is recommended to set the volume no higher than 60% of the maximum level. Earplugs and special noise-canceling headphones are effective means of protection.

Limiting the time spent in noisy environments is of great importance. When it is necessary to work under conditions of increased noise, regular breaks and periods of silence for recovery of the nervous system are recommended.

State regulation of noise levels also plays a significant role. In residential areas and industrial facilities, sanitary standards establish permissible levels of noise exposure.

Effective technical protection methods include sound insulation and the use of sound-absorbing materials. Modern premises use acoustic panels, insulating structures, and special noise reduction systems. [7], [3].

The rational organization of the work and educational environment is of great importance. Creating a calm acoustic environment contributes to improved attention, reduced stress levels, and increased cognitive productivity.

Compliance with rest schedules and adequate sleep is also an important preventive condition. Periods of silence contribute to the restoration of central nervous system activity and normalization of emotional state.

Thus, reducing noise pollution and creating a favorable acoustic environment are important conditions for maintaining health and high mental performance. [13], [9].

Conclusion

The conducted analysis shows that noise is an important medical and hygienic factor that has a complex effect on the human body. Its influence affects not only the auditory analyzer but also the central nervous system, emotional state, and cognitive functions.

Even moderate noise levels can reduce concentration, impair memory, and decrease mental productivity. Prolonged exposure to intense noise leads to the development of chronic stress, sleep disturbances, emotional instability, and reduced adaptive capabilities of the body.

A special role in the development of cognitive disorders is played by neurophysiological mechanisms associated with the activation of the body’s stress systems, disruption of excitation and inhibition processes in the cerebral cortex, and deterioration in the functioning of structures responsible for memory and attention.

Under conditions of increasing noise pollution, the development of effective preventive measures, including sanitary-hygienic standards, technical protection methods, and the formation of a culture of sound hygiene, becomes especially important.

Thus, creating a favorable acoustic environment is an important condition for preserving mental health, cognitive productivity, and a high quality of life under modern conditions.

References:

1. Данилова, Н. Н. Физиология высшей нервной деятельности : учебник / Н. Н. Данилова, А. Л. Крылова. — Ростов н/Д : Феникс, 2005. — 478 с. — ISBN 5-222-06746-7.
2. Пинчук, Н. В. Психоакустика и воздействие шума : учебное пособие / Н. В. Пинчук. — Санкт-Петербург : Речь, 2007. — 128 с. — ISBN 5-9268-0557-0.
3. Иванов, Н. И. Инженерная акустика. Теория и практика борьбы с шумом : учебник / Н. И. Иванов. — Москва : Логос, 2017. — 424 с.
4. Самойлов, В. О. Физиология человека для технических специальностей: центральная нервная и сенсорная системы : учебное пособие / В. О. Самойлов, Е. В. Бигдай. — 2-е изд., испр. и доп. — Москва : Юрайт, 2022. — 433 с. — ISBN 978-5-534-12796-6.
5. Веренич, С. В. Нервная система в норме и патологии : учебно-методическое пособие / С. В. Веренич. — Минск : БГПУ, 2005. — 76 с.
6. Данилова, Н. Н. Психофизиология : учебник / Н. Н. Данилова. — Москва : Аспект Пресс, 2012. — 368 с.
7. Гигиена : учебник / под ред. Ю. П. Пивоварова. — Москва : Академия, 2010. — 528 с.
8. Общая физиология центральной нервной системы : учебное пособие / под ред. А. Д. Ноздрачёва. — Санкт-Петербург : Лань, 2014. — 288 с.
9. ttps://xn--90aifdm6al.xn--p1ai/blog/vliyanie-shuma-na-cheloveka
10. https://studfile.net/preview/4426759/
11. https://studfile.net/preview/2470770/page:2/
12. https://natural-sciences.ru/article/view?id=14048
13. https://cyberleninka.ru/article/n/vliyanie-shumovoy-nagruzki-na-psihofiziologicheskie-parametry-studentov
14. https://vfokuse.mail.ru/articles/69610186-uchenyie-rasskazali-o-vliyanii-postoyannogo-shuma-sovremennoj-zhizni-na-mozg/