A dynamic increase in the impact of noise on the human body, in particular, on cardiovascular diseases

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Abstract. Some manufacturing processes are accompanied by significant noise and vibration. Sources of intense noise and vibration are machines and mechanisms with unbalanced rotating masses, as well as technological installations and apparatuses in which the movement of gases and liquids occurs at high speeds and has a pulsating character. The modern development of technology, equipping enterprises with powerful and fast-moving machines and mechanisms leads to the fact that people are constantly exposed to noise of increasing intensity. Increasing noise and vibration in the workplace has a harmful effect on the human body. As a result of prolonged exposure to noise, the normal activity of the cardiovascular and nervous systems, digestive and hematopoietic organs is disturbed, and professional hearing loss develops, the progression of which can lead to complete hearing loss. Among industrial hazards, noise and vibration occupy one of the leading places among production hazards. The harmful effects of increased noise levels on the human body are well known, therefore, the relevance of this problem is obvious.

1. Introduction
In production conditions, a variety of machines, apparatus and tools are sources of noise, vibration.
Noise and vibration are mechanical vibrations propagating in gaseous and solid media. Noise and vibration differ in frequency of oscillations.
Noise is an erratic combination of sounds of different strength and frequency; able to have an adverse effect on the body. The source of noise is any process that causes local pressure changes or mechanical vibrations in harsh, watery or gaseous media. Sources of noise can be engines, pumps, compressors, turbines, pneumatic and electric tools, hammers, threshers, machine tools, centrifuges, silos and other installations that have moving parts. In addition, in recent years, due to the significant development of urban transport, the noise intensity in everyday life has also increased, because he has acquired an enormous social significance as an unfavorable factor [1,3,5,7].
Vibration is small mechanical vibrations that occur in elastic bodies under the influence of variable forces.

2. Methods
Exposure to noise is believed to affect primarily the hearing aid and is attributed to:
- the direct traumatic effect of noise on the peripheral part of the auditory analyzer - the inner ear;
- traumatic effect on the brain;
- disorders in the blood supply system of the inner ear;
- the combined impact associated with all of the above factors.

In fact, the adverse effects of noise have a wider range of negative health effects. If hearing loss can be caused by noise with a sound level above 76 dBA, then disturbances in the functions of the cardiovascular, endocrine and nervous systems begin to manifest themselves with noise exposure with a sound level of 40 dB (A) and above. At sound pressure levels above 85 dB, neurovascular disorders occur six months earlier for each decibel of noise than at lower levels.

Changes in the cardiovascular system at the initial stages of noise exposure are of a functional nature: unpleasant sensations in the heart area in the form of tingling sensations, palpitations arising from neuro-emotional stress, pronounced instability of the pulse and blood pressure, especially during the period of being in noise conditions. On the electrocardiogram, sinus bradycardia, bradyarrhythmia, a tendency to slow down intracardiac conduction can be recorded. There is a tendency to spasm of the capillaries of the extremities and vessels of the fundus, as well as to an increase in peripheral resistance. Functional changes that occur in the circulatory system under the influence of intense noise, over time, can lead to persistent changes in vascular tone, contributing to the development of arterial hypertension. First of all, industrial noise, as well as the noise of a moving vehicle, has a hypertensive effect. This effect of noise is in direct proportion to its intensity, frequency and duration.

Recent studies have shown that noise is more harmful to the cardiovascular system than previously thought. Thus, W. Q. Gan et al, based on a study of the health status of 5223 workers aged 20-69 years, demonstrated the relationship of occupational bilateral hearing loss with the development of coronary heart disease. This association was particularly strong among workers under 50, noise workers, less educated workers and smokers.

Kersten N. and Backe E. found a significant dependence of the development of myocardial infarction in men working in industrial noise conditions with a sound pressure level of 95-124 dB (A).

Figure 1. The number of industrial injuries as a percentage of the type of harmful factor (1-vapors and gases, 2-dust aerosol, 3-noise, 4-vibration, 5-illumination) Red graph - 2018, blue graph - 2019
It should be noted that work involving exposure to noise often requires a forced position of the body, increased attention, or neuro-emotional stress. In addition, work can be associated with the impact of other unfavorable factors, such as dust, vibration, toxic substances, an unfavorable microclimate - all these are aggravating factors that significantly affect the timing of the development of changes caused by exposure to noise.

In addition to industrial noise, human health is also affected by noise emanating from moving vehicles and urban infrastructure, the intensity of which has increased dramatically. For those living near airports, it is the constant sound of airplanes, in cities it is a passing train, the noise of traffic.

3. Results

In an increasingly urbanized world, noise is becoming a part of life. You can get used to it, not notice it, but the body, nevertheless, reacts to all noise effects. Chronic noise pollution can lead to neurological and endocrine disorders:

- headache, fatigue, increased irritability, speech impairment, depression, decreased concentration, rapid fatigue, decreased ability to work;
- negative impact on cognitive development in children;
- lower body weight of newborns, increased mortality among children under one year old;
- sleep disorders (daytime sleepiness, disturbed sleep at night);
- a significant decrease in testosterone levels;
- a feeling of heaviness and noise in the head that occurs at the end of the work shift or after work, dizziness when changing body position;
- increasing the level of catecholamines;
- increased sweating, especially with excitement;
- violation of pain sensitivity.

At the same time, the severity of changes largely depends on the parameters of noise (intensity and spectral composition), length of service in hazardous conditions, duration of exposure and individual sensitivity of the organism. The level of environmental noise is much lower in terms of the intensity of industrial noise, however, its effect extends mainly to the nervous, psycho-emotional and cardiovascular systems of the human body.

For the first time, the association of increased environmental noise levels with cardiovascular diseases (CVD) was announced by the WHO working group on the relationship of noise pollution to morbidity in 2007 at a conference on noise exposure. According to this group, environmental noise is responsible for severe sleep disorders in 2% of Europeans, neurotic conditions in 15%, and 3% of deaths due to coronary heart disease. Danish studies have shown that noise exposure from transport is associated with a higher risk of stroke among people over 64.5 years of age. Noise exposure at night increases the aortic calcification index by 8%, increases systolic pressure by an average of 6.2 mm Hg, diastolic pressure - by 7.4 mm Hg. Art. People exposed to high levels of noise pollution are more likely to suffer from coronary artery disease, heart failure, arrhythmia, and diabetes mellitus.

Further research showed that about 43,000 hospitalizations for coronary artery disease and stroke, 6,700 premature deaths due to coronary artery disease and about 3,300 premature deaths due to stroke are due to noise exposure each year. Of these approximately 10,000 premature deaths, traffic noise is responsible for 89%.

The risk of developing CVD depends on the level of noise and the duration of its exposure. An increase in the equivalent environmental noise level by 10 dB increases the risk of CVD by 7-17%. According to J. I. Halonen, a researcher at the London School of Hygiene and Tropical Medicine, the increase in the risk of death from CVD when exposed to noise is small (4%) compared to traditional risk factors such as low physical activity and hypertension. However, WHO estimates that in Western Europe 1 million healthy lives are lost annually due to noise exposure.
4. Discussion
An economic assessment of the effects of noise on the cardiovascular system, carried out by American scientists, showed that a 5 dB reduction in noise levels reduces the risk of hypertension by 1.4% and coronary heart disease by 1.8%, and leads to annual savings of 3.9 billion dollars for the USA. The European Commission has estimated the social cost of road and rail noise in the EU at 40 million euros per year.

The above studies allowed the European Society of Cardiology in 2015 to identify noise as a risk factor for CVD and to apply to the European Society with an online petition to reduce the negative health impact of environmental threats, develop social and technological approaches, in order to ultimately reduce the burden of CVD in Europe: “Protect our hearts. We have only one!” The fight against noise pollution, as one of the risk factors for CVD, is also relevant for the Republic of Belarus and, most likely, will be considered within the framework of large-scale prevention of non-communicable diseases and promotion of a healthy lifestyle in the Republic with the support of WHO.

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