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**Case Study**

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# Long-Term Impact of Noise on the Health Status of the Population: A Case Study of the City of Samarkand

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**A B S T R A C T**

This study is devoted to a comprehensive assessment of the impact of the noise factor, formed under conditions of intensive urbanization processes in the city of Samarkand, on public health and the resulting socio-environmental problems. The study includes an analysis of the population dynamics of Samarkand for the period 2010-2025, as well as demographic indicators and the state of urban infrastructure. Within the period 2012-2024, statistical monitoring was carried out for diseases of the auditory organs, nervous system, and cardiovascular system associated with noise exposure. The results obtained showed that in areas with high noise load, morbidity rates-despite certain fluctuations-tend to increase in the long term. The conclusions of the study are of significant importance for the scientific substantiation of biological, environmental, and urban planning measures aimed at reducing noise levels.

## Introduction

In the context of increasingly complex environmental problems, noise is becoming one of the fastest-growing factors of anthropogenic impact, which for a long time was underestimated in terms of its effects on human health.

As a result of the rapid intensification of urbanization processes, the annual increase in traffic flows, and the growth in the number of industrial enterprises, the acoustic background in large cities is steadily rising. Despite the fact that for a significant portion of the population noise has already become an integral factor of everyday biological stress, its long-term cumulative impact is recognized by international health organizations as one of the significant risk factors (1-3).

## Literature Review and Methods

Within the framework of the study, the impact of the noise factor formed under conditions of urbanization on the human body and the environment was analyzed using a comprehensive approach. Official data from the State Committee of the Republic of Uzbekistan on Statistics and the Statistics Department of the Samarkand Region were used as reliable sources of information. During the research, population dynamics and morbidity indicators

were examined using statistical methods, while the acoustic condition of urban areas was assessed based on environmental monitoring. In addition, methods of audiometry and acumetry were applied to evaluate auditory function, which made it possible to identify pathologies associated with noise exposure. Furthermore, questionnaire surveys were conducted to determine public attitudes toward noise and to identify preventive needs. The obtained data enabled a comprehensive and systematic assessment of the biological and environmental impact of noise (4, 5).

## Results and Discussion

Within the framework of the conducted scientific study, a comprehensive analysis of the dynamics of demographic development of the city of Samarkand for the period 2010-2025 was carried out, including trends in population growth as well as the evolutionary state of urban infrastructure. In addition, the relationships between public health indicators and the state of the environmental environment were systematically examined, particularly pathological conditions that may arise under the influence of the noise factor (Fig. 1) (6, 7).

According to the results of the analysis, a steady and continuous trend of population growth was observed in the city of Samarkand during the period 2010–2025. Among the urban population, a systematic statistical monitoring of diseases potentially associated with noise exposure was conducted, including disorders of the auditory system, nervous system, mental health conditions, and the circulatory system. In particular, morbidity levels for the main classes of diseases associated with the noise factor were analyzed in detail for the period 2012–2024. The obtained results showed that long-term exposure to noise may lead to hearing loss, tinnitus, chronic fatigue, reduced concentration, and sleep disturbances. In this regard, in studying the problem of noise in the city of Samarkand, particular attention was given to the anatomical and physiological features of the auditory system, the mechanisms of acoustic impact on the human body, as well as the analysis of population groups living near transport highways and industrial zones and having increased sensitivity to noise. This approach expands the possibilities for scientifically based identification of environmental problems and the development of effective measures for their mitigation (8–10). The research results show that noise has a significant impact on the human body not only through the auditory system but also via the central nervous system. In this context, the complex influence of noise on the central nervous system of urban residents negatively affects the stability of the physiological state and manifests as one of the serious risk factors for the human body. The dynamic indicators of this process over a number of years make it possible to scientifically substantiate the long-term consequences of noise exposure (Fig. 2).

According to the results of the dynamic analysis, during the period 2012–2024 in the city of Samarkand, morbidity rates for diseases of the ear and mastoid process demonstrated an irregular and variable trend. In 2012, the morbidity level was 23.7 thousand cases, whereas by 2024 this indicator had decreased to 19.9 thousand cases. However, the trend line indicates a potential tendency toward a renewed increase in morbidity in the long term. Similarly, the dynamics of nervous system diseases, which occupy the next most significant position, are also characterized by instability. It has been established that in areas with a high level of noise exposure, an increase in psychoemotional stress and the development of sleep disturbances are observed (Fig. 3).

According to the results, during the considered period, morbidity indicators of the nervous system in the city demonstrated pronounced variability and an uneven dynamic pattern. In 2012, the morbidity level was 42.9 thousand cases, while in certain periods significant decreases in the indicators were also recorded. In addition, among the population living in areas with a high level of noise exposure, specialists confirmed psychophysiological disorders, including persistent tinnitus, increased irritability, and sleep disturbances. The emergence of psycho-emotional reactions, including episodes of euphoric states among young people, has also been observed.

At present, diseases of the circulatory system are recognized as one of the most widespread and pressing health problems among the population (Fig. 4).

As a result of the observations, it was established that morbidity indicators of circulatory system diseases among the urban population demonstrated an irregular and variable dynamic. In 2012, the morbidity level was 51.9 thousand cases, whereas during the period 2022–2024 a relative decrease was observed; however, the overall indicators remained at a high level (11).

In addition, changes in the indicators of mental and behavioral disorders associated with noise exposure were systematically analyzed by year (Fig. 5).

In the city of Samarkand, for the selected period, the results of a comprehensive and comparative analysis of the main disease indicators associated with noise exposure are presented, including diseases of the ear and mastoid process, mental and behavioral disorders, diseases of the nervous system, and circulatory system diseases (Fig. 6). According to the results of the study, during the period 2012–2024 in the city of Samarkand, an irregular and variable dynamic was observed in diseases associated with noise exposure. These pathologies include diseases of the ear and mastoid process, mental and behavioral disorders, diseases of the nervous system, and diseases of the circulatory system. It was established that in areas with a high level of noise exposure, the number of medical consultations among the population increased, and manifestations of sleep disturbances and irritability intensified, which had a significant impact on morbidity indicators. In addition, the negative impact of noise on working capacity and cognitive activity has been biologically and functionally confirmed, especially among individuals engaged in mental work, manifested by a reduced ability to concentrate and decreased creative thinking (12).

The impact of noise on the human body is mainly associated with the direct perception of sound and speech signals through the ear, their analysis, as well as the function of maintaining balance via the vestibular system. Such physiological and anatomical interrelationships are of great importance for identifying the mechanisms underlying the development of diseases of the laryngological (ENT) system and its organs. A significant contribution to the development of otorhinolaryngological science in Uzbekistan, within the framework of the Samarkand medical school, was made by the highly qualified physician and scientist T.Kh. Nasritdinov (13).

The study was of a broad applied nature: systematic monitoring was conducted across the city at more than 100 locations and over 50 precise coordinates using specially certified and calibrated noise measurement instruments. Based on measurements carried out in zones of highways and industrial enterprises located near residential areas, a comprehensive analysis of the environmental, hygienic, and epidemiological impact of noise was performed. The results of population surveys made it possible to identify the relationship between noise and environmental problems and served as a basis for the development of preventive measures. In addition, specialists developed practical recommendations for the identification of occupational diseases among industrial workers and their relationship with noise exposure. Thus, the study was conducted on the basis of a comprehensive, systematic, and interdisciplinary approach to assessing the impact of noise on human health. Although this issue had long been insufficiently studied, in the last 5–10 years it has emerged as an independent scientific field related to environmental safety, urbanization, and acoustic pollution. The auditory function of individuals working under conditions of elevated industrial noise was examined by specialists using the audiometric method. The study was conducted in a specially soundproof (quiet) room, where standardized speech signals were presented to each ear separately, and responses were recorded (Fig. 7) (14). Based on the results of the studies and surveys conducted with the participation of specialists, one of the most significant occupational diseases identified is sensorineural hearing loss or hearing impairment, which is predominantly recorded among workers who are continuously exposed to high levels of noise. In particular, a higher susceptibility to this pathology has been identified among industrial workers, miners, drillers, drivers, blacksmiths, seamstresses, agricultural machinery operators, and mill workers (15).

During the study, acumetry and audiometry methods were comprehensively applied to assess auditory function. With the participation of specialists, groups of the population who had long-term occupational exposure to a noisy environment, as well as individuals from a control group, were examined. In total, 56 respondents of middle and older age and 144 individuals of young and mature age were included in the study. During the examination, both objective and subjective diagnostic methods were used, while movements, speech, and swallowing functions of patients were strictly limited during testing, and the investigations were carried out under standardized conditions. In total, more than 180 participants underwent acumetric and audiometric examinations (Fig. 8).

From an environmental perspective, the mapping of noise sources in urban and residential areas is of great importance, as well as the implementation of integrated measures aimed at protecting the population from acoustic pollution and reducing environmental problems.

**Figure.1** Dynamics of population growth in the city of Samarkand for the period 2010–2025.

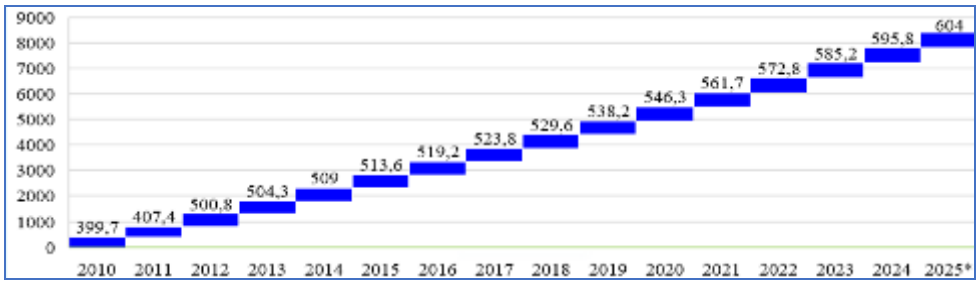


**Figure.2** Dynamics of diseases of the ear and mastoid process among the population of the city of Samarkand for the period 2012–2024 (per 1,000 population)**.**

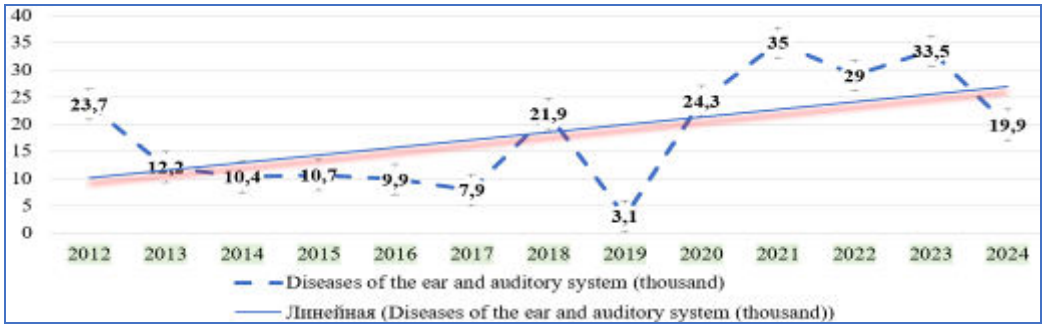


**Figure.3** Dynamics of nervous system diseases among the population of the city of Samarkand for the period 2012–2024 (per 1,000 population).

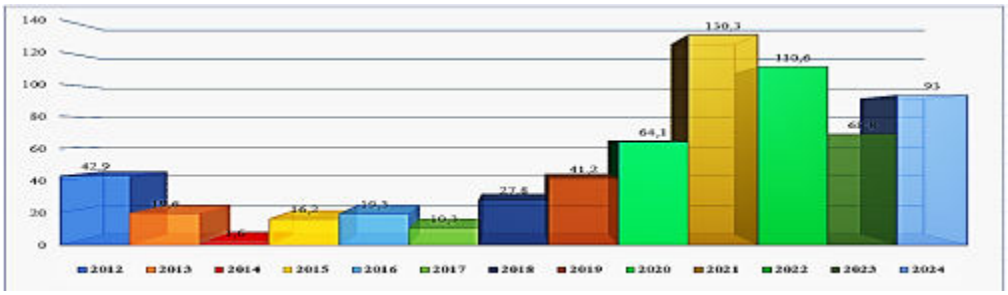


**Figure.4** Dynamics of changes in circulatory system disease indicators in the city of Samarkand for the period 2012–2024 (per 1,000 population).

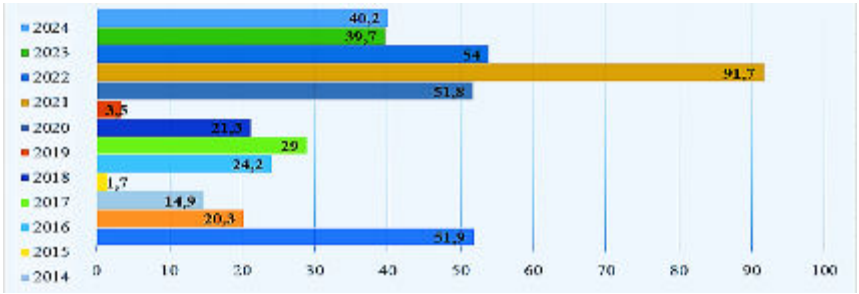

**Figure.5** Dynamics of mental and behavioral disorder indicators in the city of Samarkand for the period 2012–2024 (per 1,000 population).

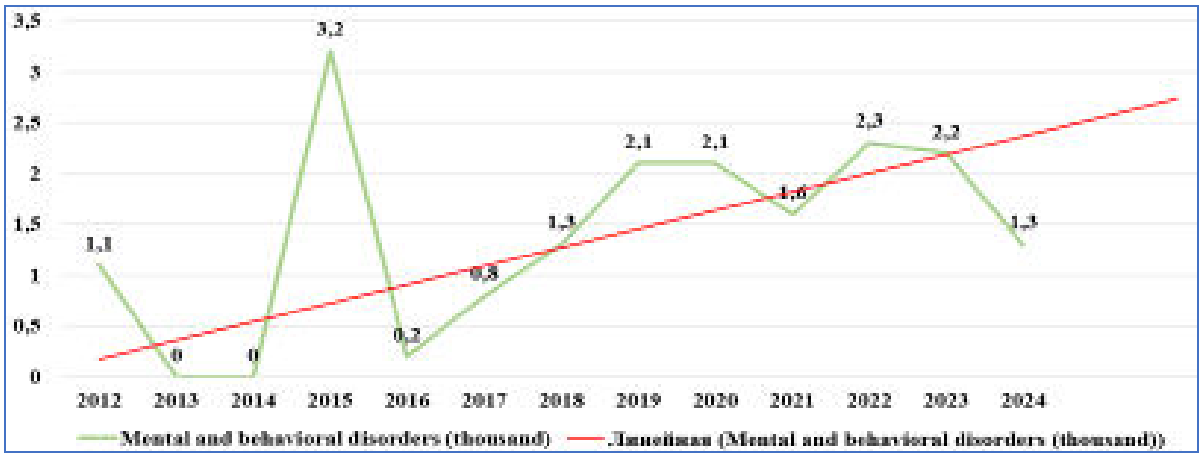


**Figure.6** Comparative dynamics of the main disease indicators associated with noise exposure in the city of Samarkand for the period 2012–2024.

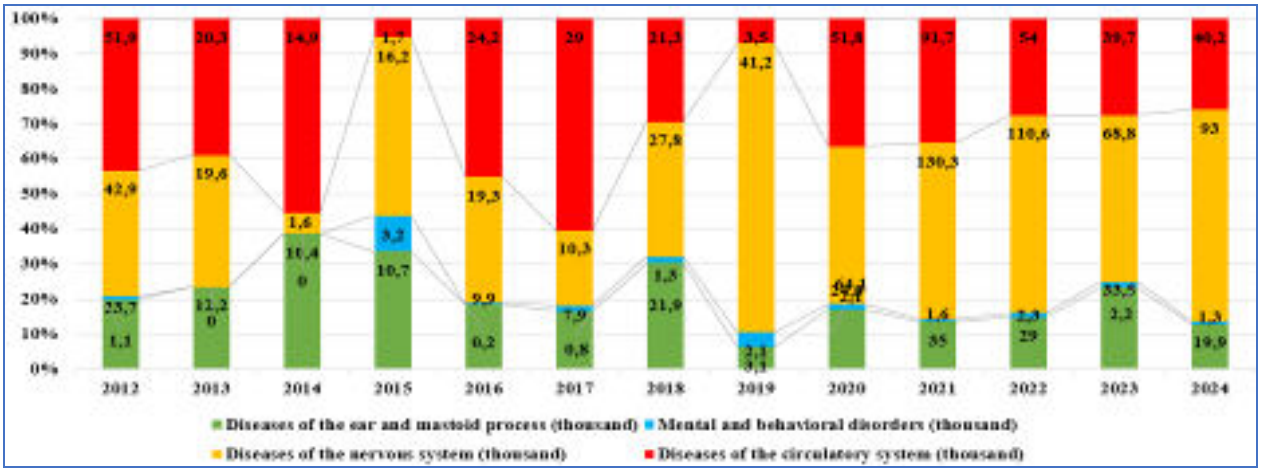


**Figure.7** Process of general examination of individuals affected by noise exposure.

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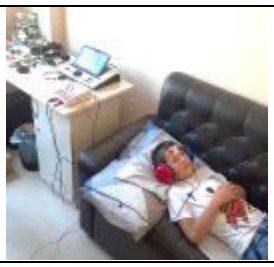
|  |  |  |  |
| Assessment of the functional state of individuals exposed to noise. | The process of studying noise-induced reactions in the human body. | Analysis of the impact of noise on the human body based on population surveys. | Process of observing the impact of environmental noise on the human body. |

**Figure.8** Experimental research process to determine the effect of noise frequencies on the human auditory system.

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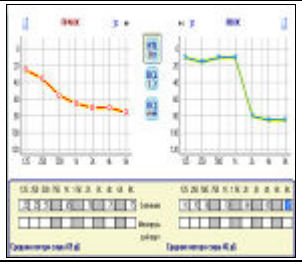
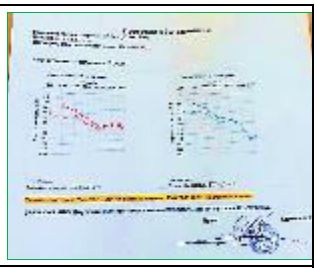
|---|---|---|---|
|  |  |  |  |
| Methods for identifying and investigating the impact of noise on the auditory system. | Results of the examination showing changes in hearing thresholds of the right and left ears in graphical form. | Device for hearing assessment using audiometric equipment (audiometer). | Presentation of experimental research results and expert conclusions. |

**Figure.9** Process of acoustic measurements under noisy conditions at an industrial enterprise and assessment of the working environment.

Analyses based on observational and experimental results show that, in order to protect the health of workers in industrial and transport sectors exposed to high noise levels, the use of personal protective equipment such as earplugs for the external ear is recommended. At industrial enterprises, special measurements are conducted in control panel zones to assess acoustic working conditions, determine noise levels, and perform analyses aimed at ensuring a safe working environment (Fig. 9).

Occupational hearing loss is generally a slowly progressive process characterized by a gradual increase with age and length of employment. If it is not possible to reduce noise levels in the workplace, the use of personal protective equipment is mandatory. Hearing protection devices include headphones (external and internal ear defenders), protective helmets, as well as special rubber and plastic earplugs. These devices can reduce noise levels by an average of 10-50 dB. According to the current regulatory document SanPiN No. 0008-20, the permissible noise level at night (from 23:00 to 07:00) is set at no more than 30 dB.

This study was aimed at a comprehensive analysis of the noise problem formed under urbanization processes in the city of Samarkand and its impact on public health and the environment. Indicators related to diseases of the auditory system, central nervous system, mental health, and the cardiovascular system were systematically examined for the period 2012-2024. The results of the study showed that noise has a significant negative impact on the human body not only through the auditory analyzer but also via the central and autonomic nervous systems. Long-term acoustic exposure leads to disturbances in the balance of excitation and inhibition processes in the nervous system, causing psychophysiological changes such as fatigue, sleep disturbances, reduced concentration, and impaired memory. The obtained data confirm the significance of noise as an environmental risk factor. In the practical part of the study, recommendations were developed

aimed at the use of personal protective equipment for individuals working in conditions of constant noise exposure, as well as the expansion of green areas and the creation of an environmentally sustainable environment.

## Author Contributions

Ashurmakhmatov Sarvar Isroil ugli: Investigation, formal analysis, writing—original draft.

## Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethical Approval** Not applicable.

**Consent to Participate** Not applicable.

**Consent to Publish** Not applicable.

**Conflict of Interest** The authors declare no competing interests.

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