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HYGIENIC ASSESSMENT OF THE LONG-TERM IMPACT OF TRANSPORT NOISE ON URBAN POPULATION HEALTH

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Abstract: Transport noise is one of the most widespread environmental stressors in urban areas and poses a significant public health concern. Continuous exposure to elevated noise levels adversely affects both physical and mental health, contributing to the development of cardiovascular, neurological, and psychosomatic disorders. The present study aimed to conduct a hygienic assessment of long-term exposure to transport noise and its impact on the health status of urban residents. Noise levels were measured in residential areas with varying traffic intensity, and health indicators were evaluated using medical records and questionnaire surveys. The results demonstrated a direct association between chronic transport noise exposure and increased prevalence of hypertension, sleep disturbances, and stress-related conditions. The findings highlight the necessity of implementing effective hygienic and preventive measures to reduce transport noise and protect urban population health.

Keywords: Transport noise; Urban environment; Environmental hygiene; Public health; Noise exposure; Cardiovascular diseases

1. Introduction

Rapid urbanization and the continuous growth of road traffic have significantly increased environmental noise levels in modern cities. Transport noise, primarily generated by motor vehicles, railways, and aviation, is recognized as a major environmental pollutant affecting millions of urban residents worldwide. Unlike other environmental hazards, noise acts as a persistent stress factor that does not diminish over time but accumulates its adverse effects on human health. According to environmental hygiene principles, prolonged exposure to noise exceeding hygienic standards can disrupt physiological processes, particularly those related to the cardiovascular and nervous systems. Numerous epidemiological studies have demonstrated that chronic transport noise is associated with arterial hypertension, ischemic heart disease, sleep disorders, reduced cognitive performance, and decreased quality of life. Despite these findings, transport noise often remains underestimated in urban health risk assessments.

The aim of this study was to perform a hygienic evaluation of long-term transport noise exposure in urban residential areas and to assess its impact on the health status of the population.

2. Materials and Methods

2.1 Study Area and Population

The study was carried out in selected urban residential areas characterized by varying levels of transport activity and traffic density. The investigated zones were classified into high-, medium-, and low-traffic areas based on the average daily vehicle flow, proximity to major roads, and the presence of public transport routes. These areas predominantly consisted of multi-storey residential buildings and mixed-use urban infrastructure, typical of large metropolitan environments.

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A total of 300 adult residents aged between 25 and 65 years were recruited for participation in the study. Inclusion criteria required participants to have resided continuously in the selected areas for a minimum of five years, ensuring long-term exposure to environmental noise conditions. Individuals with occupational noise exposure, diagnosed hearing impairments, or severe chronic illnesses unrelated to environmental factors were excluded to minimize potential confounding effects. Participation was voluntary, and informed consent was obtained from all subjects prior to data collection.

2.2 Noise Measurement

Environmental noise levels were assessed using a calibrated sound level meter in compliance with national hygienic regulations and international standards for environmental noise monitoring. Measurements were conducted at fixed points located near residential buildings at a height of 1.5 meters above ground level and at a minimum distance of 2 meters from building facades to avoid sound reflection interference.

Noise monitoring was performed during both daytime (07:00–23:00) and nighttime (23:00–07:00) periods over multiple consecutive days to account for daily and weekly traffic fluctuations. The equivalent continuous sound level (Leq) was used as the primary indicator of noise exposure, as it reflects the average acoustic energy over the measurement period. Additional parameters, including maximum sound level (Lmax), were recorded to capture peak noise events associated with heavy traffic flow. The obtained values were compared with established hygienic permissible limits for residential areas.

2.3 Health Assessment

The health status of the study participants was evaluated using a comprehensive approach that combined objective medical data and subjective self-reported information. Outpatient medical records from local healthcare facilities were analyzed to identify the prevalence of chronic conditions, particularly cardiovascular diseases such as arterial hypertension and ischemic heart disease.

In addition, participants completed standardized questionnaires designed to assess sleep quality, perceived stress levels, emotional well-being, and general health status. These questionnaires included validated scales commonly used in environmental health research. Blood pressure measurements were performed under standardized conditions using certified sphygmomanometers. Measurements were taken twice after a short rest period, and the average values were recorded to improve measurement reliability. Individuals with consistently elevated blood pressure readings were classified according to established clinical criteria.

2.4 Statistical Analysis

Statistical processing of the collected data was performed using standard statistical software packages. Descriptive statistics were applied to summarize noise exposure levels and health indicators, including mean values, standard deviations, and frequency distributions. Comparative analyses were conducted to identify differences in health outcomes among residents living in areas with different traffic noise intensities. Correlation analysis was employed to determine the relationship between long-term transport noise exposure and selected health parameters, particularly blood pressure levels and sleep disturbances. Statistical significance was assessed using a p-value threshold of less than 0.05. The analytical approach allowed for the identification

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of meaningful associations between environmental noise exposure and adverse health effects, supporting the hygienic evaluation of transport noise as a risk factor for urban population health.

3. Results

The results of environmental noise monitoring demonstrated substantial differences in transport noise exposure across the studied urban residential areas. In zones characterized by high traffic intensity, the equivalent continuous sound level (Leq) during daytime hours ranged from 68 to 78 dB, while nighttime levels varied between 60 and 70 dB. These values exceeded the hygienic permissible limits recommended for residential environments, particularly during nighttime periods, indicating a persistent exposure to excessive noise. In contrast, residential areas with low traffic density exhibited significantly lower noise levels, with daytime Leq values ranging from 52 to 58 dB and nighttime values between 45 and 50 dB, which generally complied with established hygienic standards.

Analysis of medical records and health assessment data revealed notable differences in health outcomes between residents exposed to varying noise levels. Individuals living in high-noise areas showed a higher prevalence of arterial hypertension, with 38% of participants presenting consistently elevated blood pressure levels compared to 21% in low-noise zones. Mean systolic and diastolic blood pressure values were significantly higher among residents exposed to long-term transport noise, suggesting a chronic physiological response to environmental stress.

Subjective health indicators further supported these findings. A substantial proportion of participants residing in high-traffic areas reported persistent sleep disturbances, including difficulty falling asleep and frequent nighttime awakenings. Sleep-related complaints were reported by 46% of respondents in high-noise zones, compared to 19% in quieter residential areas. Additionally, self-reported stress levels and symptoms of chronic fatigue were more prevalent among individuals exposed to elevated noise levels, indicating an adverse effect on psychological well-being and overall quality of life. Correlation analysis demonstrated a statistically significant positive relationship between transport noise intensity and key health indicators. Increased noise exposure was associated with higher systolic blood pressure values, poorer sleep quality scores, and elevated perceived stress levels ($p < 0.05$). The strength of these associations was more pronounced in participants with longer residential duration, highlighting the cumulative impact of prolonged noise exposure.

Overall, the results indicate that long-term exposure to transport noise in urban residential environments is associated with both objective and subjective indicators of deteriorating health. The observed exceedance of hygienic noise standards and the corresponding increase in adverse health outcomes emphasize the significance of transport noise as an environmental risk factor requiring targeted hygienic and preventive interventions.

4. Discussion

The findings of the present study confirm that long-term exposure to transport noise represents a significant hygienic risk factor for urban populations and exerts a measurable negative impact on both physical and mental health. Chronic exposure to elevated noise levels acts as a persistent environmental stressor, activating neuroendocrine stress-response mechanisms and leading to sustained stimulation of the sympathetic nervous system. This physiological response is accompanied by increased secretion of stress hormones, such as

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cortisol and catecholamines, which over time may contribute to endothelial dysfunction, increased vascular resistance, and the development of arterial hypertension.

The observed association between transport noise exposure and cardiovascular outcomes, particularly elevated blood pressure, is consistent with the pathophysiological mechanisms described in environmental hygiene and preventive medicine literature. Noise-induced sleep disturbances further exacerbate these effects by impairing nocturnal recovery processes and disrupting circadian rhythms. The high prevalence of sleep disorders and stress-related complaints among residents of high-traffic areas in this study supports the hypothesis that noise exposure negatively affects psychological well-being and overall quality of life.

The results of this research are in agreement with international epidemiological studies that identify environmental noise as an independent risk factor for non-communicable diseases, including cardiovascular and neuropsychological disorders. From a hygienic standpoint, the exceedance of permissible noise limits in residential zones reflects shortcomings in urban planning, traffic management, and environmental noise regulation. The accumulation of noise exposure over extended periods highlights the importance of considering long-term health risks rather than short-term acoustic discomfort alone.

In this context, transport noise should be regarded not only as an environmental nuisance but also as a public health issue requiring systematic preventive measures. The findings emphasize the necessity of integrating hygienic noise assessment into urban development policies. Preventive strategies such as optimizing traffic flow, limiting heavy vehicle movement in residential areas, expanding green buffer zones, installing noise barriers, and improving sound insulation of residential buildings may significantly reduce population exposure. Additionally, raising public awareness and strengthening regulatory enforcement can contribute to minimizing the adverse health effects of transport noise.

5. Conclusion

Transport noise represents a major environmental health hazard in modern urban settings. The hygienic assessment conducted in this study demonstrated a clear and statistically significant association between long-term exposure to transport-related noise and adverse health outcomes among urban residents. Elevated noise levels were linked to increased prevalence of arterial hypertension, sleep disturbances, and stress-related conditions, underscoring the cumulative and chronic nature of noise-induced health effects.

The results highlight the importance of recognizing transport noise as a modifiable risk factor within the framework of environmental hygiene and public health protection. Effective noise control policies, evidence-based urban planning, and targeted hygienic interventions are essential to reduce noise-related health risks. Implementing comprehensive preventive strategies may contribute to improving the quality of urban living and protecting population health in rapidly growing cities.

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