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RESEARCH ARTICLE

Hygienic Assessment of Dust Load and Modifying Risk Factors of Dust-Related Diseases in the Population

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Abstract: ***Background:*** Airborne dust pollution is a significant environmental health concern in arid and semi-arid regions. The city of Nukus is characterized by increased atmospheric dust load due to climatic and landscape-transformation factors. ***Objective:*** To evaluate the level of atmospheric particulate pollution and to assess the population's perception of environmental and behavioral risk factors contributing to dust-related morbidity. ***Methods:*** The study included a hygienic assessment of ambient air quality based on official 2023 monitoring data and a sociological survey of city residents using a structured questionnaire. Mean annual concentrations of priority pollutants were compared with established hygienic standards. Subjective risk perception was analyzed with weighting coefficients reflecting the contribution of each factor to dust-related health outcomes. ***Results:*** The mean annual concentration of suspended particles (0.20±0.008 mg/m³) exceeded the sanitary standard (0.075 mg/m³) by 2.67 times, indicating a stable and persistent dust load. Nitrogen oxides remained within permissible limits. Behavioral and lifestyle factors were identified as the leading contributors to perceived dust-related morbidity (86.3%; WC=25.9%), followed by ambient air pollution (82.5%; WC=24.8%) and indoor dust exposure (70.6%; WC=21.2%). Genetic predisposition demonstrated a comparatively lower impact (42.3%; WC=12.7%). ***Conclusion:*** Dust pollution of ambient air and associated indoor dust accumulation represent significant ecological and hygienic risk factors in Nukus. Lifestyle and behavioral patterns modify individual susceptibility to dust exposure and should be prioritized in preventive interventions.

Keywords: Dust pollution; Ambient air quality; Particulate matter exposure; Indoor dust environment; Environmental health risk; Lifestyle risk factors; Population perception; Arid region.

INTRODUCTION

The state of atmospheric air is a significant factor influencing the level of threats to public health. Intensive anthropogenic pressure leads to the destruction of the natural environment, disruption of the ecological balance in the biosphere and, as a consequence, to an increasing negative impact on the health and quality of life of the population. According to recommendations of the World Health Organization [12], priority air pollutants include suspended particles with a diameter of less than 10 μm and 2.5 μm (PM10 and PM2.5), nitrogen oxides (NOx), sulfur dioxide (SO2) and ground-level ozone (O3) [9].

The problem of dust pollution in air quality in regions with intensive anthropogenic landscape transformation is becoming increasingly important. Inhalation of dispersed particles can trigger the development of a wide range of pathological conditions affecting the respiratory, cardiovascular, endocrine, and reproductive systems, as well as contribute to the development of oncological processes [1, 2, 3, 4, 5, 8, 11]. In modern conditions, the nature and dynamics of general population morbidity are determined by the complex influence of numerous factors, among which lifestyle, demographic and socioeconomic parameters, and the state of the environment are the leading determinants [5, 7, 10].

One of the primary tasks of the modern sanitary and epidemiological service is the study and analysis of specific risk factors and health conditions at the pre-clinical level and the development of measures for the primary prevention of environmentally conditioned pre-clinical and pathological conditions of the human body [6].

Research conducted in the Republic of Karakalpakstan demonstrates a close link between air quality and public health [4, 5]. In particular, deteriorating air quality in the Aral Sea region is associated with the spread of allergic diseases, especially among children [6].

This study included a comprehensive hygienic assessment of the air quality in Nukus, taking into account dust pollution levels and the potential impact of these factors on public health. A sociological study was also conducted, using a standardized survey and interviews with city residents, aimed at identifying subjective perceptions of the sanitary and hygienic

conditions of their living environment and their potential relationship with well-being and frequency of medical care visits.

Objective: To evaluate the level of atmospheric particulate pollution and to assess the population's perception of environmental and behavioral risk factors contributing to dust-related morbidity.

MATERIAL AND METHODS

This study is based on an assessment of official air quality monitoring data in Nukus, including quantitative indicators of pollution dynamics and the composition of priority pollutants regulated by the state sanitary and hygienic control system. A hygienic assessment of air quality was conducted by comparing actual pollutant concentrations with maximum permissible concentrations (MPCs) established by current sanitary regulations. The priority pollutants monitored were those with the greatest impact on public health: suspended particles (dust), sulfur dioxide (SO_2), carbon monoxide (CO), nitric oxide (NO), and nitrogen dioxide (NO_2).

A social and hygienic analysis of Nukus residents' subjective assessments of environmental hygiene conditions and their impact on health was simultaneously conducted. Structured questionnaires designed to ensure comparability of responses and facilitate subsequent statistical interpretation were used to collect empirical data. A survey-interview method was chosen as optimal for studying the individual perceptions and behavioral characteristics of respondents. The anonymity of the procedure reduced the likelihood of systematic response bias.

Statistical processing of the data was performed using standard methods of variation statistics. Mean values and their errors were calculated, and the resulting indicators were compared, taking into account possible influencing factors. Results were visualized and analytical tables were generated in Microsoft Excel.

RESULTS AND OBSERVATIONS:

As a result of the analysis of the air quality monitoring data for the city of Nukus for 2023, the average annual concentrations of a number of priority pollutants were determined and compared with the established standard values of maximum permissible concentrations (MPC-year) in accordance with SanPiN RUz No. 0053-23 (Table 1).
Table 1.

Average annual concentrations of pollutants in the atmospheric air of the city of Nukus for 2023 compared with maximum permissible concentrations, mg/m3

Pollutants	M±m	MPCg SanPiN No. 0053-23
Suspended solids	0.20±0.008	0.075
Sulfur dioxide (SO_2)	0.013±0.0003	-
Nitrogen dioxide (NO_2)	0.025±0.002	0.04
Nitric oxide (NO)	0.021±0.001	0.06

The average annual concentration of suspended particles was 0.20±0.008 mg/m³, which exceeds the hygienic standard (MPCg=0.075 mg/m³) by 2.7 times, indicating persistent dust pollution of the atmosphere. The concentrations of nitrogen dioxide (0.025±0.002 mg/m³) and nitrogen oxide (0.021±0.001 mg/m³) were within the established standards (MPCg=0.04 and 0.06 mg/m³, respectively), indicating the absence of an overload of nitrogen compounds. The concentration of sulfur dioxide was 0.013±0.0003 mg/m³; comparison with the standard was not performed due to the absence of a regulated MPCg value in SanPiN No. 0053-23.

Given the data obtained from instrumental air monitoring, it was necessary to assess the population's subjective perceptions of the impact of environmental factors on health and the behavioral responses that shape their individual risk profile. As part of the sociological component of the study, respondents' responses were analyzed, reflecting their perceptions of living and working conditions, air quality, and behavioral determinants of health.

A gradation of the population's subjective opinion regarding the significance of social and hygienic environmental factors, based on the weighting coefficient (WC) in the development of dust-related diseases, revealed that lifestyle factors play a leading role. This category was cited by 86.3% of respondents and is characterized by the highest weighting coefficient—25.9%—in the risk factor structure (Figure 1).

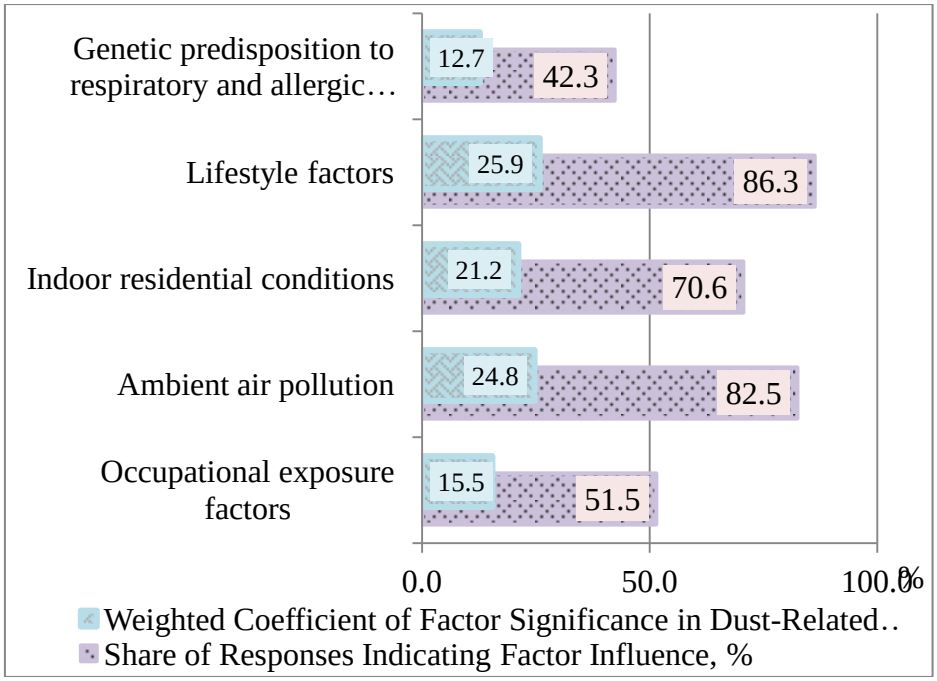

Figure 1. Gradation of subjective opinion of the population of Nukus (n=503) on social and hygienic factors of the environment that affect human health, taking into account the weighting coefficient of the factor in the development of diseases of dust etiology, %

The second most significant factor influencing human health according to the survey results was air pollution, accounting for 82.5% of the total, with a weighting factor (WF) of 24.8% for dust-related diseases. Residential living conditions, according to the respondents, were the next most significant factor influencing human health, accounting for 70.6%, with a weighting factor of 21.2%. The fifth most significant factor influencing disease development, according to the respondents, was hereditary predisposition, accounting for 42.3%, with a weighting factor of 12.7%. These indicators reflect the significance of each factor in the development of dust-related diseases. The higher the WF, the greater the impact of the corresponding factor on public health.

CONCLUSION

The conducted hygienic assessment of the state of atmospheric air in the city of Nukus showed that the leading factor of airborne pollution is the excess level of suspended particles, the average annual concentration of which (0.20±0.008 mg/m³) exceeded the MPCg standard by 2.67 times(0.075 mg/m³), indicating a constant and stable dust load on the air. Concentrations of nitrogen oxides and nitrogen dioxide were within regulatory limits, indicating that nitrogen-containing compounds do not contribute significantly to the overall pollution level.

A socio-hygienic analysis revealed a distinct structure in how the population perceives risk factors. Residents believe that behavioral and lifestyle factors play the greatest role in the development of dust-related diseases (86.3%; VK=25.9%), while air pollution ranks second in importance (82.5%; VK=24.8%). Intra-residential dustiness (70.6%; VK=21.2%) acts as a link between external and intra-environmental influences, reflecting the transfer of dust load from the atmosphere to the living space. Hereditary predisposition has a comparatively smaller specific contribution (42.3%; VK=12.7%).

Thus, dust pollution in the atmosphere and associated indoor factors should be considered a significant environmental and hygienic risk factor for the health of the population of Nukus. Moreover, behavioral attitudes and lifestyle of the population have a modifying effect, increasing or decreasing individual susceptibility to the effects of dust exposure.

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