

Hygienic Assessment of the Dynamics of Suspended Particulate Concentrations in the Ambient Air

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Abstract Objective: The aim of this study is to conduct a hygienic assessment of the dynamics of dust concentrations in the ambient air of Bukhara city based on state monitoring data. Materials and Methods: The study utilized official data from the Hydrometeorological Service Center for the years 2017–2021. Annual and monthly average concentrations of dust were compared with the hygienic standard – the maximum allowable annual average concentration (MAC = 0.075 mg/m³), established by SanPiN RUz №0053-23. Statistical analysis was carried out using methods of variance analysis with visual presentation of the results. Results and Discussion: A consistent exceedance of sanitary norms for suspended particulate matter in the ambient air was identified throughout the entire study period. The highest average concentrations were recorded during the spring and summer months, reaching 0.28 mg/m³ (in May and August), which is 3.7 times higher than the MAC. The analysis revealed distinct seasonal fluctuations, which, in our opinion, are associated with climatic conditions and other dust-generating processes. Conclusions: The obtained data indicate a stable and background level of dust pollution in the ambient air of Bukhara city, which necessitates strengthened hygienic control and preventive measures, especially during periods of high environmental stress.

Keywords Ambient air, Suspended particulate matter, Dust, Hygienic assessment

1. Introduction

Ambient air pollution is one of the most significant risk factors for public health and a major global environmental problem of the modern era. Numerous studies have shown that long-term exposure to polluted air contributes to an increased incidence of respiratory diseases, allergic reactions, immune system disorders, and oncological pathologies [4,6].

In recent years, particular attention has been paid to assessing the levels of suspended particulates and their impact on the health of vulnerable populations, including children. Studies have demonstrated that dust particles containing toxic and allergenic components exert immunomodulatory and damaging effects on the respiratory tract [6], and contribute to the development of acute allergic conditions in children [5].

The issue of air pollution and its link to childhood morbidity has been explored in a number of regional and international studies. For example, it was found that high concentrations of air pollutants correlate with increased rates of childhood illnesses [7]. Similar findings are reported in foreign studies examining the effects of dust pollutants and polycyclic aromatic hydrocarbons (PAHs) on children's health in urban settings and areas of electronic waste processing [8,9,10]. Occupational exposure to pollutants, particularly

in industrial environments, is also of great importance. Research on biomarkers of dust-induced lung diseases allows for an objective assessment of the risks associated with inhalation exposure to pollutants [3].

In the national context, the analysis of pollutant emissions into the atmosphere, their sources, and trends over the years provides a scientific basis for the development of sanitary and epidemiological measures [1,2].

Moreover, a crucial area of hygienic research is the comprehensive assessment of environmental burden on the population and the analysis of the temporal characteristics of pollutants, such as polycyclic aromatic hydrocarbons in street dust [9], or trace elements in areas with intensive electronic waste processing [10].

Thus, the existing evidence base highlights the necessity of regular atmospheric air monitoring and hygienic assessment of its quality. The present study is aimed at analyzing air pollution in the city of Bukhara based on government monitoring data to determine hygienic risks and identify priority pollutants.

Objective of the Study: The aim of the study was to conduct a hygienic assessment of the dynamics of suspended particulate concentrations in the ambient air of Bukhara city over a five-year observation period, based on data from state monitoring. The focus was on identifying seasonal and annual fluctuations, assessing compliance with sanitary standards, and determining potential health risks to the population.

2. Materials and Methods

This study utilized official data from the Center of Hydrometeorological Service for the period from 2017 to 2021. The hygienic assessment was carried out by comparing actual concentrations with the maximum allowable concentrations established in the Sanitary Rules and Norms of the Republic of Uzbekistan №0053-23 (SanPiN №0053-23). The analysis included the calculation of average, minimum, and maximum concentration values for each year of observation, as well as the determination of the extent to which the normative levels were exceeded. The temporal dynamics of pollution levels were evaluated, taking into account seasonal and annual variations.

Statistical analysis of the data was performed using methods of variational statistics. The obtained results were visualized in the form of tables and graphs reflecting long-term trends in atmospheric air pollution levels in the studied region.

3. Results and Discussion

In the context of anthropogenic environmental transformation, increasing urbanization, and changing climatic conditions, both average and extreme levels of suspended

particulate matter in the air have been rising. This trend enhances the hygienic and medico-social significance of the problem.

Figure 1 presents the dynamics of average, minimum, and maximum annual concentrations of suspended particulate matter in the ambient air of Bukhara city over the period from 2017 to 2021.

Analysis of the presented data indicates a consistent exceedance of sanitary standards for this indicator throughout the entire study period. The annual average concentrations of suspended particulate matter exceeded the established maximum allowable annual average level (MAC = 0.075 mg/m³) every year, indicating a stable pattern of atmospheric pollution. The highest average values were recorded in 2018 and 2019, showing pronounced peaks of maximum concentrations exceeding 0.30 mg/m³, which points to episodes of significant air pollution.

Minimum concentrations, despite seasonal fluctuations, also did not fall to safe levels, which may indicate background pollution caused by constant sources of dust emissions. The difference between minimum and maximum values within each year reflects marked intra-annual variability, likely associated with climatic conditions (dry and hot regional climate), seasonal activity of transport, construction, and agricultural operations.

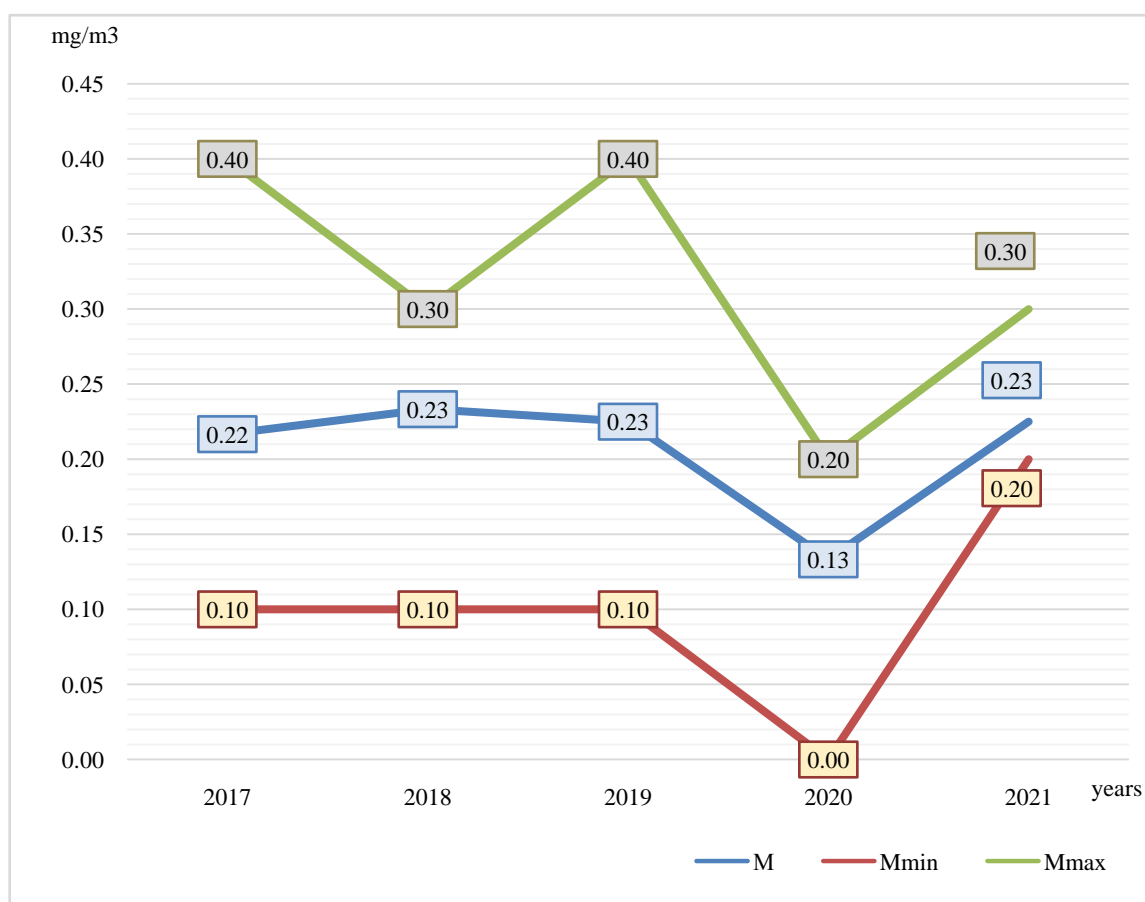


Figure 1. Dynamics of average, minimum, and maximum annual concentrations of suspended particulate matter in ambient air of Bukhara city for the period 2017–2021, mg/m³

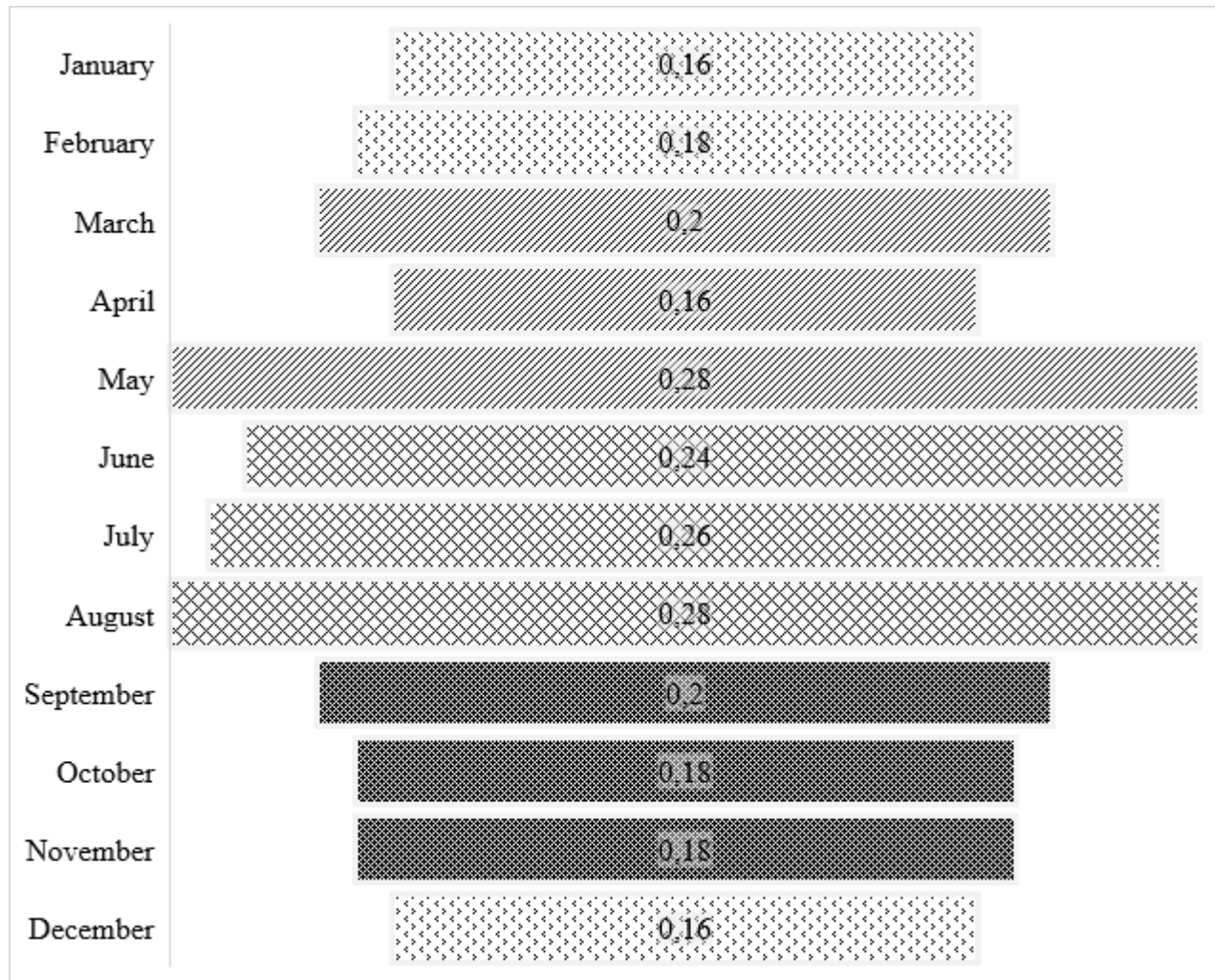


Figure 2. Average annual values of monthly mean concentrations of suspended particulate matter in the atmospheric air of Bukhara city during the period 2017–2021, mg/m³

Of particular concern is the identified trend of persistently elevated pollutant concentrations throughout the entire observation period. Prolonged inhalation exposure under such conditions can potentially have adverse effects on public health.

Ranking the levels of dust pollution in ambient air by month is a key component of the hygienic assessment of environmental impacts on population health. Such detail not only helps identify periods of maximum environmental burden but also allows for timely planning of preventive and sanitary-hygienic measures. Moreover, the seasonal approach is particularly relevant for regions with pronounced climatic and geographical features, such as the city of Bukhara, which is characterized by a prolonged warm period, low humidity, and increased wind activity in certain months of the year (see Figure 2).

For hygienic assessment, average monthly concentrations of suspended particulate matter in the atmospheric air for the period 2017–2021 were used. By averaging these indicators across the years, an integrated estimate of the background pollution level was obtained, reflecting the long-term dustiness of the atmosphere.

Considering the nature of the aggregated data and the duration of the observation period, the obtained values were compared with the maximum allowable annual average concentration (MAC), as established by sanitary regulations. This approach corresponds to current hygienic principles, according to which the MAC is used to assess the chronic effects of pollutants on the human body during long-term inhalation of contaminated air.

The analysis of the data presented in Figure 2 reflects the average annual values of the monthly mean concentrations of suspended particulate matter in the atmospheric air of Bukhara city over the period from 2017 to 2021. When comparing these values with the established maximum allowable annual average concentration (MAC = 0.075 mg/m³), a consistent exceedance of the hygienic standard is observed throughout the entire calendar year.

The highest average values are recorded in May and August (both at 0.28 mg/m³), which is approximately 3.7 times higher than the established hygienic norm. Elevated levels are also noted in July (0.26 mg/m³), June (0.24 mg/m³), and March (0.20 mg/m³). Even in the winter months (January, December) and in April, where concentrations are somewhat

lower (at 0.16 mg/m³), they remain more than twice the MAC.

Overall, the data indicate consistently elevated levels of dust pollution in the atmospheric air throughout the year, with a pronounced seasonal increase during the spring and summer months. This trend may be attributed to the region's climatic characteristics, increased construction activity, transportation loads, and other anthropogenic factors.

4. Conclusions

The observed dynamics highlight the importance of continuous hygienic monitoring of ambient air quality and the need for preventive measures aimed at reducing the impact of dust pollution, particularly during periods of its highest increase.

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