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Congress Abstract

Association Between Atmospheric Chromium Concentration and Cancer Incidence in Almaty, Kazakhstan

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Background: The pollution of atmospheric air with heavy metals, including chromium, in major industrial centers has in recent years become one of the significant environmental problems threatening public health. For example, the highest value of the carcinogenic risk (ICR), calculated based on the concentration of chromium in the atmospheric air of Almaty from 2021 to 2025, was 0.044. According to the risk category, this level (10-2) is assessed as "high." Although chromium is recognized as a carcinogen for the human body, there is a lack of local, data-driven studies to assess its specific impact on cancer incidence among the city's residents. Analysis by specific types of cancer is particularly rare.

Objective: To assess the association between the average annual values of the average daily concentration of chromium in the atmospheric air of Almaty city and the incidence of cancer among the city's residents by organ. As well as determining the number of additional cases of disease associated with chromium.

Materials and Methods: The study was conducted as a retrospective analysis of ecological characteristics. Annual average values of the mean daily concentration of chromium in atmospheric air were used as a data source, taken from the informational bulletin of the Almaty City Branch of the "Kazhydromet" RSE. Official statistics on the incidence of malignant neoplasms of seven organ systems (the respiratory system, stomach, colon, rectum, pancreas, liver, and kidneys) for the Republic of Kazakhstan and the city of Almaty (per 100,000), along with the population data of Almaty for the period 2021–2023, were used in the study. To assess regional excess risk, the relative risk was calculated for each organ and each year as the ratio of morbidity in Almaty to the average level across the Republic of Kazakhstan. When the relative risk exceeded 1, the population-attributable fraction, the absolute excess risk, and the resulting annual excess number of cases were determined. The individual carcinogenic risk from inhalation exposure to chromium was calculated using the inhalation slope factor (42 μg/kg/day) recommended by the United States Environmental Protection Agency.

Results: During the three-year monitoring period, the individual carcinogenic risk from chromium in the atmosphere of Almaty was found to remain consistently high. Among the 7 organs, a consistent and clearly elevated relative risk was recorded for only 2 localizations: The relative risk for colorectal cancer ranged from 1.29 to 1.38 over all 3 years, while for kidney cancer it ranged from 1.15 to 1.24. These two localizations accounted for an average of 110 additional cases per year in the city, and approximately 330 additional cases over three years, the majority of which were colorectal cancers (approximately 66 cases per year) and kidney cancer (approximately 29 cases per year). On the contrary, morbidity from the respiratory system (17.1) and the stomach (12.3) was lower than the national average (respectively

20.1; 14.9) lower. The excess risk for the pancreas, rectum, and liver was unstable and modest.

Discussion: The obtained data are also consistent with the results of international studies. However, the identified association is not causal in nature and should be regarded as an ecological-level study. A meta-analysis of previous cohort studies has shown that workers exposed to chromium, especially men, have a significantly higher risk of dying from kidney cancer. And international data on colon cancer are more contradictory. For example, recent systematic reviews have found a weak association between chromium exposure and colon cancer, but an association that cannot be dismissed has been noted, while experimental models have demonstrated that orally ingested hexavalent chromium's oxidized oxygen compounds promote the development of colon cancer through accumulation and changes in the composition of the gut microbiota. These findings suggest that the predominance of colorectal and kidney cancers over respiratory cancers may indicate that chromium exposure occurs primarily through non-inhalation pathways, particularly via ingestion of contaminated drinking water, soil, or food, rather than through inhalation. However, this hypothesis needs to be confirmed with controlled studies that take individual exposure levels into account. Moreover, foreign data indicate that the latent period for the development of respiratory tract tumors exceeds twenty years. This may partly explain why no excess risk for this localization was detected during the three-year follow-up period in our study.

Conclusions: The results obtained, consistent with the study's objective, showed a statistical association between elevated levels of chromium in the atmospheric air and the incidence of certain cancer localizations among the city's residents. Based on these findings, the authors emphasize the need to strengthen the integrated environmental and hygienic monitoring of ambient air, drinking water, and soil in Almaty, in additional to implement screening programs for the early detection of colorectal and kidney cancers among populations residing in highly polluted areas.

Keywords: Chromium; Air Pollution; Neoplasms; Colonic Neoplasms; Kidney Neoplasms; Environmental Exposure