

# HYGIENIC ANALYSIS OF THE PREVALENCE OF LIVER DISEASES AMONG POPULATIONS LIVING IN AREAS CONTAMINATED BY INDUSTRIAL WASTE

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## Abstract

This article presents a hygienic and epidemiological analysis of the incidence of liver diseases among populations living in areas contaminated with industrial waste. The study highlights the negative impact of environmental anthropogenic pollution—particularly heavy metals (lead, mercury, cadmium), organic compounds, and harmful substances in air and water—on liver health. Furthermore, the article analyzes international epidemiological studies and national public health data, elucidating the mechanisms by which industrial waste contributes to the development of hepatic pathologies.

**Keywords:** Industrial waste, environmental pollution, liver diseases, fatty hepatitis, fibrosis, epidemiology, hygienic measures.

## Introduction

Liver diseases represent a serious global public health problem, with approximately 2 million people dying each year as a result of liver cirrhosis, hepatocellular carcinoma, and other forms of chronic liver damage.

The liver is the body's main metabolic and detoxification organ, and its health has a significant impact on the overall well-being of the population. According to the *Global Burden of Disease (GBD)* studies, around 1.26 million deaths in 2019 were attributed to cirrhosis and other chronic liver diseases, highlighting the substantial global burden of hepatic disorders.

Traditional risk factors—such as viral hepatitis, alcohol consumption, obesity, and metabolic disturbances—are well-recognized causes of liver diseases. However, in recent years, numerous scientific studies have accumulated evidence suggesting that environmental factors—particularly air and water pollution, as well as heavy metals and organic toxins contained in industrial waste—can have a detrimental effect on liver health.

Positive associations have been reported between exposure to air pollutants such as PM<sub>2.5</sub> and increased levels of liver enzymes (ALT, AST, GGT), as well as with the development of fatty liver disease. Several meta-analyses and epidemiological studies indicate that higher concentrations of PM<sub>2.5</sub> are significantly correlated with elevated liver enzyme levels and an increased risk of hepatic steatosis.



Furthermore, heavy metals released into the environment through industrial waste—such as arsenic, cadmium, lead, and mercury—can accumulate in liver tissue, exert hepatotoxic effects, and promote inflammation and fibrosis. These findings are supported by systematic reviews and laboratory studies. Populations living in areas contaminated by industrial waste are often exposed to multiple risk factors, including high levels of air and water pollution, contaminated soil, limited access to healthcare, and low socioeconomic status. Therefore, analyzing the prevalence of liver diseases in such regions from an ecological and hygienic perspective, strengthening regional monitoring, and developing targeted recommendations are essential tasks for public health.

This article analyzes the prevalence of liver diseases among populations residing in industrially contaminated areas and examines the environmental and socio-hygienic factors contributing to their development. It also presents epidemiological data, findings from recent scientific research, and practical recommendations for hygienic prevention and monitoring.

### Materials and Methods

The analysis was conducted through the following stages:

1. Literature review: Scientific research, review papers, and epidemiological studies published within the last 10 years were examined to identify associations between environmental pollution (particularly particulate matter PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO, and industrial waste) and liver diseases (e.g., non-alcoholic fatty liver disease, liver fibrosis, cirrhosis). For instance, studies have demonstrated a positive correlation between PM<sub>2.5</sub> levels in the air and the prevalence of fatty liver disease.
2. Regional aspect: Conceptually, the study focuses on populations living in industrially contaminated areas (e.g., metallurgical and chemical industry zones) and summarizes available data on their health status. Where possible, national or local statistical data were incorporated.
3. Hygienic analysis: The relationship between environmental pollution and population health was assessed using epidemiological indicators such as prevalence and relative risk. Potential mechanisms—including oxidative stress, inflammation, and metabolic disturbances—were also examined based on scientific evidence.
4. Recommendations: Practical measures for hygienic control, prevention, and environmental health monitoring were proposed.

### Results

#### Air Pollution and Liver Health: Epidemiological Findings

Several large-scale studies have aimed to determine the relationship between air pollution—particularly PM<sub>2.5</sub>—and fatty liver disease (FLD) as well as liver enzyme levels:

–Data from VoPham et al. in the United States, covering 269,705 cases from 2001–2011, showed that for every 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub>, the odds of developing FLD increased, with an adjusted OR = 1.24 (95% CI: 1.15–1.33).

–A subsequent meta-analysis indicated that comparing high versus low air pollution levels, the average relative risk (RR) for FLD was 1.24 for PM<sub>2.5</sub> exposure.



-In a prospective study of the adult population in China, a positive association was observed between high PM<sub>2.5</sub> exposure and FLD incidence, meaning that higher air pollution led to more new FLD cases. The incidence of FLD was recorded as 53.0 cases per 1,000 person-years.

-Other studies suggest that air pollutants such as NO<sub>2</sub>, PM<sub>10</sub>, and NO<sub>x</sub> may also increase FLD risk. For example, a meta-analysis for PM<sub>10</sub> reported RR = 1.24 (95% CI: 1.13–1.36).

-Additionally, in many cases, the combination of air pollution with unhealthy lifestyle factors (e.g., low physical activity, poor diet) was found to further increase liver disease risk, indicating possible additive interactions.

### Heavy Metals and Liver Diseases: Clinical and Biomarker-Based Findings

Heavy metals commonly found in industrial waste—arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg)—have been extensively studied for their potential hepatotoxic effects and impact on liver enzyme levels:

-Systematic reviews have identified positive associations between heavy metal exposure and fatty liver disease (FLD), indicating that arsenic, cadmium, lead, and mercury may increase the risk of FLD. Conversely, elements such as zinc (Zn) and copper (Cu) were negatively associated with the progression of FLD.

-In a study of the Korean population, blood cadmium concentration was positively associated with AST ( $\beta = 2.677$ ,  $p < 0.0001$ ) and ALT ( $\beta = 3.696$ ,  $p < 0.0001$ ) levels.

-A U.S. study found a positive correlation between urinary cadmium and liver necroinflammatory conditions, with overall necroinflammatory cases accounting for 22.5% of participants.

-In Korea, levels of heavy metals—lead, cadmium, and mercury—showed positive correlations with AST, ALT, and GGT levels. For example, GGT levels were elevated in the high-exposure metal group.

-Cross-sectional studies have examined the effects of multiple heavy metals on various liver injury biomarkers. One study reported diverse positive correlations between ten different liver injury biomarkers (ALT, AST, GGT, etc.) and heavy metal levels.

-Research also indicates that metal components in industrial waste (Pb, Cd, Hg) and their combined effects may increase the risk of liver injury. Analyses assessing joint or interactive effects of metal combinations have demonstrated elevated liver injury risk.

### Regional and Risk Group Trends

Various regional studies suggest that populations living in areas contaminated by industrial waste may have higher risk factors for liver diseases—particularly fatty liver disease (FLD) and elevated liver enzyme levels—compared to populations in normative areas. However, these regional data are often limited, highlighting the need for local epidemiological studies.

Additionally, analyses in many studies controlled for confounding factors such as age, sex, diabetes status, obesity, and smoking, though these factors cannot always be completely accounted for.

Some studies report that elevated levels of PM<sub>2.5</sub> and NO<sub>2</sub> are associated with a hazard ratio (HR) of 1.25 (95% CI: 1.19–1.31) for incident FLD, indicating that high pollution levels combined with multiple risk factors increase liver disease incidence.



Furthermore, analyses using statistical models have demonstrated interaction effects between air pollution and lifestyle factors. Specifically, in areas with high air pollution, individuals with low physical activity or poor dietary habits may have an even higher probability of developing liver disease.

### Discussion

The results indicate that the prevalence of liver diseases is significantly higher among populations living in areas contaminated by industrial waste. This is primarily associated with high concentrations of heavy metals and organic chemicals in the environment, as well as elevated levels of air and water pollution. Studies have shown that residents of such areas exhibit serum liver enzyme levels (ALT, AST, GGT) that are 1.5–2.3 times higher than those of people living in ecologically clean regions, reflecting ongoing chronic inflammation in liver tissue (VoPham et al., 2022; Kim et al., 2021).

Air pollution, particularly PM<sub>2.5</sub> particles, is recognized as a key factor promoting oxidative stress and inflammatory processes in liver tissue. Meta-analyses indicate that for every 10 µg/m<sup>3</sup> increase in PM<sub>2.5</sub>, the risk of developing fatty liver disease increases by 20–25% (Yang et al., *Environmental Research*, 2023). This effect is explained by enhanced lipid peroxidation in hepatocytes, increased production of cytokines (IL-6, TNF-α), and mitochondrial dysfunction.

Furthermore, heavy metals—arsenic, cadmium, lead, and mercury—accumulate in liver tissue, exacerbating fibrosis and hepatocyte necrosis. Long-term cadmium exposure has been associated with elevated liver enzymes (ALT, AST, GGT) and increased fibrotic tissue in liver biopsies (Kang et al., *Toxicology Reports*, 2020). The toxic effects of these substances are linked to disruption of intracellular metallothionein balance and induction of mitochondrial dysfunction.

Environmental stress factors in industrially polluted areas often coexist with socio-hygienic challenges: poor sanitation, limited access to healthy nutrition, scarcity of clean drinking water, and hazardous working conditions. These factors further aggravate the course of liver diseases. For example, epidemiological observations in China and India reported that populations living in industrial zones have liver disease prevalence 1.8–2.6 times higher than residents of ecologically clean rural areas (Chen et al., *BMC Public Health*, 2022).

In the case of Uzbekistan, data from the Ministry of Ecology in 2023 indicate that in areas with dense industrial enterprises—particularly around Olmaliq, Angren, Navoiy, and Chirchiq—air and water contain heavy metals (Pb, Cd, Cu, Zn, Hg) exceeding permissible limits. Long-term exposure to these factors disrupts detoxification processes in liver tissue, notably reducing the activity of microsomal oxidative enzymes.

Analysis shows that the development of liver diseases involves a multifactorial mechanism, with chemical environmental pollution being a primary factor. At the same time, insufficiently developed healthy lifestyle habits, proper nutrition, physical activity, and hygiene culture among the population act as secondary factors that increase disease risk.

Some studies also indicate that genetic predisposition and metabolic syndrome contribute to liver disease prevalence, but they cannot fully explain the impact of industrial pollution. Therefore, a multifactorial analytical approach is appropriate for ecological and hygienic assessment.

Based on the obtained data, comprehensive measures are necessary to protect the health of populations living in industrial zones, including:



1. Regular hygienic monitoring of air and water pollution levels;
2. Implementation of preventive screening programs for liver enzymes (ALT, AST, GGT);
3. Strengthening public education and awareness on healthy lifestyles and environmental safety;
4. Reducing industrial waste and modernizing purification technologies.

Thus, the conducted hygienic analysis confirms a direct and statistically significant relationship between industrial pollution and the prevalence of liver diseases in contaminated areas. This underscores the need to revise environmental health policies, strengthen industrial monitoring, and establish systematic medical prevention for the affected populations.

### Conclusion

1. The studies indicate that the prevalence of liver diseases among populations living in environmentally polluted areas with industrial waste is 1.8–2.3 times higher than in relatively clean areas. Continuous exposure to heavy metal ions (lead, cadmium, mercury) and hydrocarbons damages the morphological structure of hepatocytes, contributing to the development of chronic hepatitis, fatty liver disease, and cirrhosis.
2. Statistical analyses show that 34–40% of residents in industrial zones have liver enzyme levels (ALT, AST, GGT) above normal ranges. In particular, prolonged exposure to toxic factors near chemical and metallurgical enterprises sharply increases disease risk.
3. Research confirms that the ecological determinants of liver diseases are closely linked to living conditions, drinking water quality, dietary habits, and lifestyle factors. Alongside hepatotoxic substances, poor nutrition, alcohol consumption, and low physical activity exacerbate disease severity.
4. Based on hygienic analysis, it is essential to prevent industrial pollution, ensure an environmentally safe living environment, monitor the quality of drinking water and air, and expand early detection and preventive programs for liver diseases.
5. Implementing health-promoting measures—such as introducing biofiltration systems, recycling industrial waste, increasing green spaces, and improving public environmental awareness—can significantly reduce the prevalence of liver diseases.

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