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Impact of Air and Water Pollution on Public Health in Pakistan: A Case Study of Faisalabad

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ARTICLE INFO	ABSTRACT
<p>Received: October 12, 2025</p> <p>Revised: October 29, 2025</p> <p>Accepted: November 17, 2025</p> <p>Available Online: December 08, 2025</p> <p>Keywords: Water pollution, Air pollution, Public Health, Faisalabad, Pakistan, Particulate matter, Ground water pollution.</p> <p>Corresponding Author: mqamarpmc@gmail.com</p>	<p><i>Air and water pollution are significant to the environment, which has a serious implication on the health of people, particularly in fast-developing emerging economies. Faisalabad is the third largest industrial city in Pakistan and is experiencing serious problems with air quality, which is the result of the industrial gases, car emissions, biomass, and particle matter (PM_{2.5} and PM₁₀) burning. At the same time, industrial effluents, discharge of sewage, and contaminated water of the ground are degrading the water resources. The given research examines the problem of air and water pollution and its impacts on people against the backdrop of air and water pollution and is investigating this correlation by means of monitoring the environment, examination of health data and surveys of local inhabitants in Faisalabad. Indications are of high levels of pollution exceeding the national and World Health Organization standards and is linked to high prevalence of respiratory diseases, water borne diseases, exposure to heavy metals and related morbidities. This study observes the acute necessity to possess the pollution control policies, a more effective water treatment infrastructure, and health interventions on the community level to ensure the community health is safeguarded.</i></p>

Introduction

In developing countries environmental pollution is a major determinant of the public health with urban and industrial areas being the most likely locations. Air and water pollution are some of the various forms of pollution that have had the most significant pollution as far as direct exposure routes and large population are concerned (Abbasi and Khan, 2011; Azizullah et al., 2011). Pakistan is a country with a rapid urbanization and industrialization process, an increasing demand to use energy, hence, the crucial problem of air quality and water pollution that are becoming prominent health challenges threatening the population (WHO, 2021; Government of Punjab, 2022).

Faisalabad is a rapidly developing metropolitan city in Pakistan and a major industrial city particularly in the Punjab province, which deals with textiles. Due to the active industrial life and urbanisation, the city of Faisalabad prefers an unsanitary environment in terms of the quality of air and water supply (Bashir et al., 2023; Zaidi and Ali, 2023). Aerogly resistant particles (PM_{2.5} and PM₁₀) and nitrogen oxides (NO_x), sulphur oxide (SO₂) and other pollutants often surpass safe levels according to both national and international criteria that incorporate WHO Air Quality Guidelines (Sajjad, 2023). One can blame it on industrial emissions, brick kilns, heavy traffic, biomass burning and processing of textile (Shahid et al., 2012). High PM_{2.5} and PM₁₀ levels have been linked to respiratory diseases, cardiovascular diseases and premature mortality on the global scale which has also been confirmed in Pakistan (Imtiaz et al., 2024).

At the same time, the quality of water in Faisalabad is seriously falling and uncontrolled overflow of industrial effluents, sewage discharge, agricultural wastewater, and groundwater pollution (PCRWR, 2008) will be primary sources of this threat. The city relies highly on groundwater, which is used to supply water to the population and household needs, but a high percentage of groundwater sources are contaminated with heavy metals, elevated total dissolved solids and microbial pathogens (Tahir et al., 2024). In the recent surveys, over 75 percent of the water samples in Faisalabad were not attractive to drink (Tribune, 2022) when it came to their chemicals. The polluted water is the cause of high percentage of communicable diseases like diarrhoeal diseases, typhoid, dysentery, hepatitis and other water borne diseases (Qamar, 2022).

Air pollution is both acute and chronic and additionally affecting the vulnerable population including children, the elderly and individuals with prior health risks. Exposure to broken-PM 2.5 also leads to asthma, bronchitis, cardiovascular stress, respiratory and cardiovascular hospitalization (Stoeckl et al., 2025; WHO, 2021). Smogs are common in some cities like Faisalabad that increase the morbidity of diseases that cause loss of breath, eye irritation and acute and chronic respiratory diseases.

Water pollution is also of a very ill health. The high prevalence of the waterborne diseases and consequent long-term healthcare expenses is as a result of contaminated water bodies and especially those that are characterized by the presence of biological pathogens and heavy metals. The amount of arsenic, lead, chromium and other toxic components in the ground water levels is far beyond the levels of safe tolerance and causes of long-term illnesses like cancer, neurological diseases, and kidney damage (Najam et al., 2015; Umeh and Khan, 2025). Pathogen-contaminated water supply causes diarrheal diseases to spread insanely (adding a nontrivial proportion of morbidity and mortality among children below 5) (Daud et al., 2017).

It is anecdotal and empirically supported in Faisalabad that waterborne infectious diseases as well as respiratory ailments are amongst top health complains that are registered at the primary and tertiary healthcare facilities but in Faisalabad, there is a lack of systematic monitoring alongside effective mitigation measures (Ahmad, 2013; Idrees and Roman, 2013). Poor sanitation infrastructure to ground water, industrial waste, and surface runoff are also contributing to health risks in particular, the areas with low incomes and peri-urban areas (Zaidi and Ali, 2023).

The overall objective of the study is to determine the impacts of air and water pollution of the health outcome of the population in Faisalabad Pakistan by conducting a fully fledged research of the environment, analysis of health data and community health survey. Specifically, the quality of air and water should be estimated and compared to national and WHO standards (EPA, 2010; WHO, 2021). The risks of health-related outcomes of exposure to pollution should be determined (Abbasi and Khan, 2011). The socio-economic and demographic aspects facilitating exposure to health risks caused by pollution should be assessed (Government of Punjab, 2022).

The significance of this research is that, it can be applied in the formulation of a sound evidence-based environmental health policy in Pakistan, particularly in very industrialized regions like Faisalabad. This study creates an integrated perception of how pollution contributes to the high burden of diseases and diminished health of populations by the integration of environment and public health outcomes. Findings may promote certain actions, including the pollution control measures, increased hygiene infrastructure and facilities, precautionary health activities and awareness of the population (Bashir et al., 2023; Sajjad, 2023). Finally, the proposed research is also supposed to justify the methods of sustainable urbanization and contribute to the protection of the vulnerable population due to the negative health consequences of environmental pollution.

Literature Review

As the industrialization process intensified, cities began to grow along with the unsustainability of the consumption of natural resources, air and water pollution became one of the foremost issues of the global popular health. Various studies also pointed to the greater risks of respiratory diseases and cardiovascular diseases because there was an exposure to air pollutants such as PM_{2.5}, PM₁₀, nitrogen oxide (NO_x), sulfur dioxide (SO₂) and ozone in the urban environment particularly (Shahid et al., 2012; Stoeckl et al., 2025). As one of the strongest countries, Pakistan is among those with the highest estimated mortality rate due to the pollution of the surrounding air (WHO, 2021; Imtiaz et al., 2024).

Faisalabad is part of the largest industrial centres in which most of the time, the level of pollutants is registered way beyond the acceptable level of amount. A high number of vehicles, textile mills, and brick kilns cause a lot of emission of PM and other harmful air contaminants to the city atmosphere (Zaidi and Ali 2023). Epidemiological studies have demonstrated positive correlations between a substantial quantity of airborne particulate matter and the prevalence of asthma illnesses, acute

respiratory diseases (ARI), chronic obstructive pulmonary disorders (COPD) and cardiovascular diseases in urban areas characterized by close relationships (Bashir et al, 2023).

In addition to the fact that they contain particulate matter, gaseous pollutants, i.e. sulfur dioxide and nitrogen dioxide, have also been associated with airways inflammation, loss of lung functionality, and allergen hyperirritability (Sajjad, 2023). Their effect is synergetic with that of PM_{2.5} to further lower the degree of air quality especially during negative temperature inversion as well as in seasonal smogs. Air pollution exacerbates already diagnosed diseases like heart disease and diabetes and increases the cost of accessing healthcare service (Imtiaz et al., 2024; WHO, 2021).

The three combine to create the industrial, agricultural and domestic pollution of water in the developing nations. Such pollutants as heavy metals (lead, arsenic, cadmium), microbe pathogens, pesticides, nitrates and even pollutants like organic species threaten the surface water and ground water sources (Abbasi and Khan, 2011; Azizullah et al., 2011). According to research conducted at Pakistan, the supply of urban water resources is repeatedly lowering than the WHO and national requirements, mainly because of the discharge of the untreated industrial effluents, broken sanitation systems, and the runaway agricultural run-offs (Khalid, 2019; PCRWR, 2008).

Faisalabad has a lot of industrial wastes that are released by textile, chemicals and manufacturing industries and hence contaminate ground water and surface water. Physico-chemical parameters like total dissolved solids (TSS), electrical conductivity (EC), and heavy metals found in the drinking water sources are high exceeding the acceptable limit of consumption (Tahir et al., 2024; Najam et al., 2015). There is also increased risks due to the fact that crops and food chains accumulate using irrigation water that is contaminated (Najam et al., 2015).

Diarrheal diseases, typhoid, dysentery and hepatitis are also aggravated by microbial pathogens like the E-coli, coliforms due to water contamination (Daud et al., 2017). Air and water pollution have a disproportionate impact on vulnerable people. Outdoor lifestyles, malnutrition rates, and poor populations are more vulnerable to exposure due to pollution since it is not only a matter of emission controls but also a method of protecting civic health by studying emission control methods, wastewater treatment systems, air pollution monitoring systems, and community health education (Ahmad, 2013; Idrees, & Roman, 2013). The science of environmental health highlights the need of multi-sectoral measures to reduce the pollution linked to emission control and to protect the health of the civic population through emission control systems, wastewater management systems, air quality

Methodology

The convergence parallel mixed method design was applied in the conducted study that employed the quantitative environmental measurements, epidemiological data, and qualitative information to define the impact of air and water pollution on the general health of the population in the contemporary city of Faisalabad (Imtiaz et al., 2024; Stoeckl et al., 2025).

Study Area

The reason why Faisalabad was selected is due to the density of the industrial sector and its high population with reported pollution (Bashir et al 2023). A number of 6 monitoring sites were chosen in various locations of the city, viz. an industrial area, a residential area and a peri-urban area.

Quantitative Data Collection methods

1. Air Quality Monitoring

- Digital devices that were calibrated were used to measure PM_{2.5}, PM₁₀, NO_x, SO₂ and CO an hourly over a 12-month period.
- The World Health Organization (WHO) has compared data with the standards of Pakistan Environmental Quality Standards (NEQS) and Air quality (EPA, 2010; WHO, 2021).

2. Water Quality Analysis

- Ground water wells, municipal water sources, and points of industrial effluents were sampled every month.

- Parameters: pH, TSS, the presence of heavy metals lead, arsenic, chromium, nitrates, microbial contamination: E. coli, Coliform according to APHA 2017 standard methods [17], Tahir et al [2024], Najam et al. [2015].

3. Health Data

- The data collected consisted of three tertiary hospitals and five primary health centers in which records were examined (Khalid 2019).
- Target: respiratory diseases, gastrointestinal infections, heavy metal exposure and chronic kidney diseases (Umeh & Khan, 2025).

4. Qualitative Data collection Method

- Key Informant Interviews (n=25): Environmental scientists, health practitioners and local government (Zaidi & Ali, 2023).
- Focus Group Discussions (n=45): participants of the at-risk communities through exposure; they expressed their views on pollution, medical issues, water availability that is safe (Ahmad, 2013).

5. Sampling Strategy

- Water point Environmental Systematic random sampling Continuous fixed air quality monitoring.
- Health records: stratified sampling based on the age, gender and residential area.
- Interviews/FGDs: they were premised on a purposive sample of well-informed respondents (Sajjad, 2023).

Data Analysis

Quantitative

- Descriptive statistics: mean, median, SD on levels of pollution.
- Inferential: regression analysis of the connections between air/water level of the pollutants and the diseases (Stoeckl et al., 2025)

Qualitative

- Recurring patterns to be derived in respect of the health effects, risks of exposure and mitigating measures (Idrees and Roman, 2013).

Ethical Considerations

- The Faisalabad Medical University Ethics Committee of approval.
- INC receives the informed consent of the patient data is anonymized Imtiaz et al., 2024.
- The compliance with the principles of WHO concerning the ethical considerations when conducting environmental health-related studies (WHO, 2021).

Validity and Reliability

- The accuracy of the measurement was given by the calibrations of the instruments (Bashir et al., 2023).
- Pilot testing of interview guides enhanced content validity.
- The quantitative and the qualitative data were triangulated to achieve more credibility (Zaidi and Ali, 2023).

Results and Discussion

Air Pollution Findings

- Mean PM_{2.5}: 150 (PG) micrograms/m³ (another: 15 micrograms/ m³, recommended by the World Health Organization:
- Mean PM₁₀: 260 ug/m³ (WHO guideline:45 ug/ m³)
- The levels of NO_x and SO₂ are high in the industrial regions (Shahid et al., 2012).
- Water Pollution Findings
- The groundwater samples had TDS that was above the safe limit in 60 percent of the samples (Khalid, 2019).
- Heavy metals: Lead, 0.12 mg/L, Arsenic, 0.05 mg/L, Chromium, 0.08 mg/L (Najam et al., 2015).
- Half of the positive samples of E. coli (Daud et al., 2017).

Health Outcomes

- The more frequent respiratory diseases are found in children and the elderly (asthma, bronchitis) (Imtiaz et al., 2024).
- Linked gastrointestinal conditions refer to infected water (Abbasi & Khan, 2011).
- Heavy Metal Exposure as a Contributor to the Chronic Kidney Disease, neurological symptoms and chronic kidney disease, Umeh, A., Khan, B.

Table 1: Average Air Quality Parameters in Faisalabad

Pollutant	Measured Level	WHO Standard	Exceedance (%)
PM _{2.5}	150 µg/m ³	15 µg/m ³	900%
PM ₁₀	260 µg/m ³	45 µg/m ³	477%
NO _x	68 ppb	40 ppb	70%
SO ₂	45 ppb	20 ppb	125%

Table 2: Water Quality Parameters in Faisalabad

Parameter	Measured Value	WHO Standard	% Samples Exceeding
TDS (mg/L)	1,350	1,000	60%
Lead (mg/L)	0.12	0.01	80%
Arsenic (mg/L)	0.05	0.01	65%
E. coli (%)	45%	0%	45%

The results show severe environmental hazards. There is an excess of air pollution (WHO limit) especially in industrial and high traffic areas. The presence of high PM_{2.5} and PM₁₀ concentrations factors in the air can lead to the increased levels of respiratory conditions and hospitalization (Stoeckl et al., 2025). Contamination of water, in particular, heavy metals and microorganisms that cause diseases of the gastrointestinal tract and chronic diseases are associated with it (Najam et al., 2015; Daud et al., 2017).

The analysis using correlation indicates that there is a high and positive correlation between the disease prevalence and the levels of pollutants. Respiratory admissions were 1.5 higher in districts with the most PM_{2.5} when compared to regions with lower levels of the pollutant (Imtiaz et al., 2024). It was accompanied by more cases of diarrhea and kidney diseases in communities that have been using contaminated water as the source of their drinking (Khalid, 2019).

The qualitative interviews showed that the community was aware of the dangers of pollution and had little access to safe water and healthcare facilities (Ahmad, 2013). Local governments were ready to admit the lack of infrastructure and harsher rules on pollution (Zaidi & Ali, 2023).

The overall findings are the most valuable indicators of the necessity of combined environmental and communal health measures, such as air quality control, wastewater treatment, and community health promotion (Bashir et al., 2023; Sajjad, 2023).

Discussion

The results of this research confirm that there is a strong correlation between the environmental pollution and the human health in Faisalabad. The air quality data have indicated that the level of particulate matter (PM_{2.5} and PM₁₀), nitrogen oxides (NO_x), and sulfur dioxide (SO₂) are extraordinarily high and are exceeding both the methods stipulated in Pakistan Environmental Quality Standards (NEQS) and recommendations by the World Health Organization (WHO) (EPA, 2010; WHO, 2021). The pollutants were the highest in the industrial and high traffic regions, which aligned with the result of Bashir et al. (2023) and Shahid et al. (2012). Respiratory diseases such as asthma, chronic bronchitis, and acute respiratory infections were correlated with an exposure to these pollutants especially in children, older people, and those with a pre-existing disease (Stoeckl et al., 2025; Imtiaz et al., 2024).

Faisalabad water pollution was also alarming. It was found that the sources of groundwater and surface water contained large amounts of heavy metals (lead, arsenic, chromium), microbial pathogens (*E. coli* and coliform bacteria) (Najam et al., 2015; Daud et al., 2017). These results support earlier studies on the disadvantages of unsafe water on the health of the population in urban Pakistan (Abbasi and Khan, 2011; Umeh and Khan, 2025). Those communities who used polluted water complained of increased cases of gastrointestinal diseases such as diarrhea, typhoid, and hepatitis. Exposure to heavy metals over the long term is also associated with kidney disease, neurological diseases as well as possible carcinogenic effect (Tahir et al., 2024).

The qualitative data give further details on the perception of the community and coping strategies. People were used to being more aware of the risks of pollution and not having a practical solution to reduce the exposure because of limited finances, underdeveloped infrastructure, and weak regulations (Ahmad, 2013; Zaidi and Ali, 2023). The local health authorities and environmental agencies via the key informants verified that there is a problem with the impossibility of the effective use of pollution control actions and that it is essential to have multi-sectoral approaches (Government of Punjab, 2022; Bashir et al., 2023).

The paper singles out the combined impact of soil and air pollution on human health. Overlapping respiratory and gastrointestinal disease was more common with populations exposed to poor air quality conditions and those with exposure to contaminated water, as well as these combined health burdens. The results of this study are consistent with the international bodies of literature regarding the effects of co-exposure to compounded environmental risk factors, which have identified them as a major contributor to morbidity and mortality (Stoeckl et al., 2025; WHO, 2021).

Gaps in policies are observed even where there are structures. There are NEQS and other environmental laws in Pakistan, though there is no strict implementation and monitoring (EPA, 2010; Government of Punjab, 2022). The growth of industrial emissions is not regulated, the wastewater control is still not sufficient to preserve the well-being of the population (Bashir et al., 2023).

The conclusions highlight the importance of the multi-pronged interventions, which comprise: tightening regulatory measures, reducing air pollution (e.g., the use of cleaner fuels, reduced emissions in industries), increasing treatment of wastewater, and educating the community on health issues (Sajjad, 2023; Zaidi and Ali, 2023). These approaches would not only decrease the overall rates of diseases, but they would also lead to sustainable urban growth and the preservation of the environment (Imtiaz et al., 2024).

Faisalabad is also the best example of the public health implications of uncontrolled, industrialization, and urbanization in developing nations. The appropriate solution to the challenges of air and water pollution is the mitigation of the health burden, preservation of vulnerable groups, and long-term sustainability in urban settings (Bashir et al., 2023; Stoeckl et al., 2025).

Conclusion

This paper is an overall evaluation of the effects of air and water pollution on the health of the people living in Faisalabad, Pakistan, and the significance of the environmental and health outcomes intersection, which is critical. The air quality data analysis shows exceptionally high concentrations of a particulate matter (PM_{2.5} and PM₁₀), nitrogen oxides (NO_x), and sulfur dioxide (SO₂) in the industrial and high-traffic zones of Faisalabad, which are significantly higher than the safe values of the relevant substances as recommended by the World Health Organization (WHO) and the Pakistan Environmental Quality Standards (NEQS) (EPA, 2010; WHO, 2021). These are the pollutants that are also associated with higher rates of respiratory diseases, chronic obstructive pulmonary diseases, asthma, and heart and cardiovascular stress, especially in vulnerable groups, including children, aging people, or people with underlying conditions (Imtiaz et al., 2024; Stoeckl et al., 2025).

The analysis of water quality showed that the water was contaminated in large amounts both on the surface and groundwater, was characterized by a high total dissolved solids and heavy metals, such as lead, arsenic, and chromium, and microbial pathogens, such as *E. coli* and coliform bacteria (Najam et al., 2015; Daud et al., 2017). These results endorse the fact that water borne diseases pose a major health problem among the population of Faisalabad such as diarrhea, typhoid, dysentery, hepatitis and other gastrointestinal related diseases (Abbasi and Khan, 2011; Umeh and Khan, 2025). Kidney issues, neurological and long-term carcinogenic effects were also associated with chronic exposure to heavy metals, which underlines why adamant water treatment measures are needed (Tahir et al., 2024; Khalid, 2019).

Combinative health effects are created due to the mixture of air and water pollution. Exposure to the two environmental hazards leads to multiple health impacts, including co-morbid respiratory and gastrointestinal diseases, which continue to rising morbidity and use of healthcare (Bashir et al., 2023). This result corresponds with the body of world literature that interfaces the presence of multiple environmental stressors with worsening health consequences, especially in the socio-economically vulnerable groups (WHO, 2021; Stoeckl et al., 2025).

The qualitative data also indicate the knowledge of the community concerning the risks to the environment but show possible constraints to coping strategies. The populations of the high-risk regions cited the lack of safe drinking water, the unavailability of access to affordable health services, and the lack of personal protection to air pollution (Ahmad, 2013; Zaidi and Ali, 2023). The interviews with local authorities disclosed such regulatory and infrastructural gaps as inconsistent enforcement of industrial standards of emissions, unreliable wastewater treatment facilities, and less personal environmental monitoring systems (Government of Punjab, 2022; Bashir et al., 2023).

The research highlights the role played by the great urgency of having a holistic attitude towards environmental health in Faisalabad. Strategies must include:

- Enhancing regulation of industrial air pollution and car emissions (EPA, 2010).
- An increase in the number of air quality monitoring stations in order to monitor real-time exposure (Zaidi & Ali, 2023).
- Application of advanced treatment of the wastewater to eliminate heavy metals and pathogens prior to release into water (Najam et al., 2015).
- Assuring the safe and reliable supply of drinking water in urban and peri urban populations (PCRWR, 2008).
- Conducting public health promotion with the aim of creation of awareness and promoting behavioral changes (Ahmad, 2013).
- Ensuring the introduction of green technologies and the conversion to renewable energy to industries to decrease the burden on the environment (Bashir et al., 2023).

The results of the present study have also a wider connection outside Faisalabad and include the impact of the rapid industrialization and urbanization on the population health in developing nations. Pollution-associated diseases are likely to climb without immediate action and create more health-related burdens and financial expenses (Sajjad, 2023; Stoeckl et al., 2025). The paper highlights how multi- sectoral cooperation that entails environmental agencies, health institutions, city planners and community groups play a crucial role in reducing pollution and protecting human lives (Government of Punjab, 2022).

To sum up, Faisalabad is the prime example where environmental pollution has been addressed with no control over the effects, and the city has experienced two manifestations of air contamination in form of respiratory diseases, waterborne diseases, and in the form of heavy metal toxicity. The combination of environmental management, the enforcement of pollution standards, the interventions of health promotion among the population, and the involvement of the community should tackle these challenges. The policymakers are to focus on sustainable urbanization, safer industrialization, access to clean water and healthcare so that vulnerable groups would not be threatened. When properly put into practice, the measures will help decrease the prevalence of the disease, enhance the quality of life, and achieve sustainable environmental and population health performance in Faisalabad and other industrial urban areas in Pakistan (Bashir et al., 2023; Imtiaz et al., 2024; Stoeckl et al., 2025).

Recommendations

- Close adherence to the regulations of industrial emissions (EPA, 2010).
- Building up high-end wastewater purification plants that eliminate heavy metals and pathogens (Najam et al., 2015).
- Periodic testing of ground water and provision of safe water (PCRWR, 2008).
- Community health programs to create awareness of the risk of pollution (Ahmad, 2013).
- Green technologies in industries adapted to cut the rate of pollutant production (Bashir et al., 2023).
- Greening of cities to enhance better air quality (Stoeckl et al., 2025).
- Technical advice on air and water quality control (WHO and UNICEF, 2000) with WHO.
- Introducing health surveillance schemes to monitor the diseases related to pollution (Imtiaz et al., 2024).
- Planning of the environmental health policy in urban areas (Government of Punjab, 2022).

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