Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 8
Open Access

Impact of Cement Factory emission on Air Quality and Human health around Khrew and Khanmoh villages, Kashmir

Syed Rizwana Qadri[a] , Mudasir Ahmad Dar[b], & Laiba Anwar[c]
[abc] Mittal School of Business, Lovely Professional University, Phagwara Punjab 144411, India

Cite this paper as: Syed Rizwana Qadri , Mudasir Ahmad Dar , Laiba Anwar (2024). Impact of Cement Factory emission on Air Quality and Human health around Khrew and Khanmoh villages, Kashmir. *Frontiers in Health Informatics*, *13 (8) 330-344*

Abstract:
The present study examines the yearly and seasonal patterns of air quality in the Khanmoh and Khrew regions of Kashmir between 2014 and 2023, with a particular emphasis on PM10 levels and AQI readings. The study finds complicated patterns impacted by local characteristics, commercial activity, and weather swings using data from the state pollution control board and AQI technique. Seasonal investigation shows divergent patterns, with Khanmoh showing better summer conditions and Khrew having worse winter air quality. The study emphasises the need for well-informed policy responses to address the region's air pollution concerns, notwithstanding its limitations, which include limited data and a narrow scope of pollutants. The study also shows a substantial correlation between particulate matter concentration and health outcomes by extending its analysis to include a correlation between PM10 levels and disease incidence in Khanmoh and Khrew. This emphasises how crucial it is to comprehend how air pollution affects public health and how important it is to have all-encompassing mitigation methods in place for its negative consequences.
Keywords: Ambient air pollution, Cement Industry, Particulate Matter, Bronchitis, Skin Infection, & Lung Function.

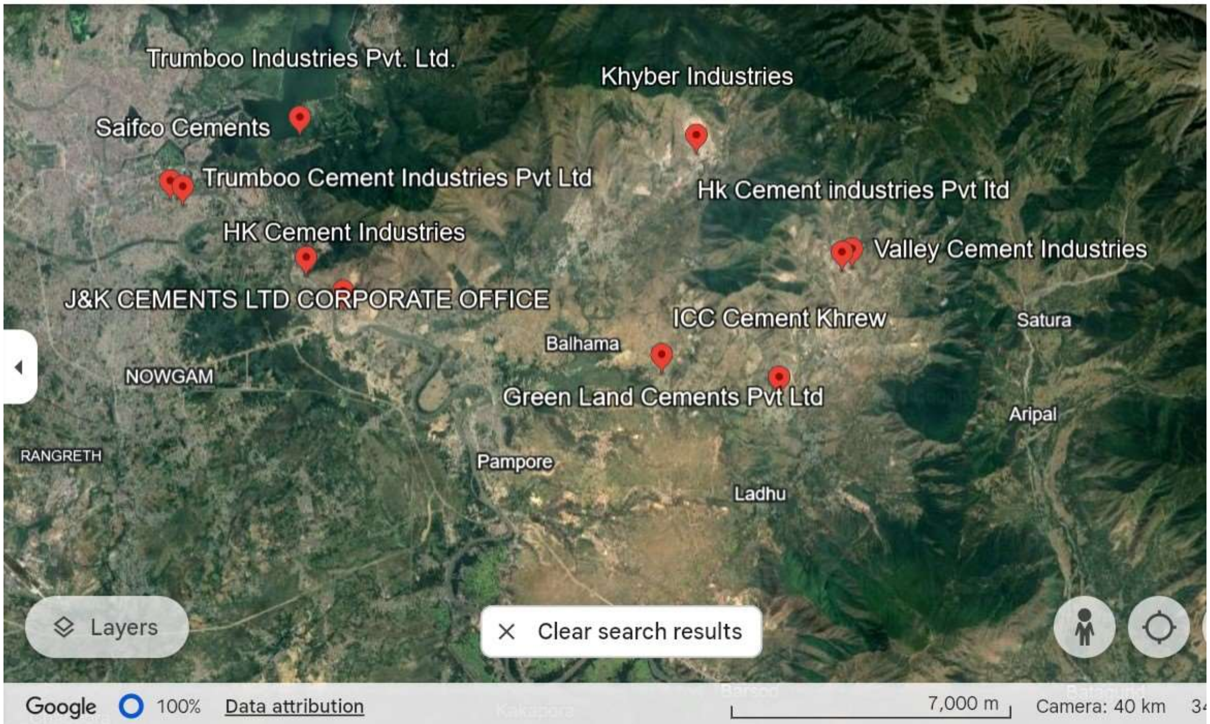
Introduction:

Cement manufacture is constantly in demand worldwide since it is a necessary component of concrete (Schneider et, al, 2011). Cement industries are forced to produce goods on a big scale in order to meet this rising demand, classifying them as heavy industries (Baurer & Hoenig, 2010). According to reports, global cement production exceeded the International Energy Agency (IEA) 2050 prediction and reached 4.4 billion in 2022 (An et, al 2019). Large-scale production, on the other hand, encourages massive energy consumption, industrial solid waste generation, flue gas emissions, and ultimately results in environmental instability (Summerbell et, al 2016). Due to the enormous consumption margin, it also generates over 5% of the world's greenhouse gas (GHG) emissions, placing it closely behind the steel industry in terms of global emissions (Ravindra, 2021). Asian cement industries are significant contributors to the volume of world output and environmental pollution, especially in nations like China and India (ICR2018).

India is the world's second-largest manufacturer of cement. More than 7% of the installed capacity in the world is made up of it (Bohm & Pierkes, 2009). The construction and infrastructure industries in India have the potential to grow, and this is expected to benefit the cement industry most. The desire for rural housing in India has also increased the usage of cement, which is one of the cheapest items to purchase in terms of rupees per kilogram (IBEF). In 1979–80, India produced the eighth-largest amount of cement in the world; today, it produces the second-largest amount. However, this rapid expansion in cement manufacturing has come at a significant cost in the form of high energy use. One of India's most energy-intensive industries is the cement business, consuming the second-highest percentage of fuel after the iron and steel sector (18.10%), primarily in the form of coal. Without a significant increase in energy intake, especially in the form of coal burning, it would not have been possible to expand (Sunkad, 2021). Due to some plants' toxicity from cement dust, air pollution has become a serious threat to their existence in industrial locations (Ighalo & Adeniyi, 2020).

Cement plant exhaust gases and dust particles emitted into the atmosphere reduce air quality and hence cause significant environmental pollution (Devi et, al. 2022).
With geographic coordinates of 33.7782 N and 76.5762 E, the Valley of Kashmir is located in the temperate zone, the Kashmir Valley is well-known for its wildlife and scenic surroundings all over the world. However, Kashmir's delicate ecosystems are currently dealing with a number of issues that demand quick attention. Cement factories in Kashmir and their placement are one of several problems. Nine cement facilities are now in operation in Kashmir, according to the Department of Promotion of Industry and Internal Trade (DPIIT). These cement factories are situated in the Pampore Pulwama neighbourhood of Srinagar's Khrew and Khanmoh regions.
Cement plants are well known for contributing to industrial expansion, boosting the global economy, and generating employment possibilities. The construction and operation of cement mills, however, have become a contentious subject in the context of Kashmir, igniting heated discussions among stakeholders. Supporters of these factories emphasize the advantages, claiming that they reduce unemployment and bring economic prosperity. Opponents, on the other hand, voice legitimate worries about the region's delicate ecological and environmental issues.
Although cement mills are essential to industrial operations, they also pose a threat to the environment. It is clear that the pollution produced by these enterprises harms the ecosystem and has a negative impact on the environment. They provide a complex web of adverse effects brought on by the release of dangerous gases, dust, and untreated wastewater. The air quality in the area may be harmed by pollutants emitted during cement manufacture that contribute to air pollution. These emissions frequently comprise particulate matter, such dust particles, which can have a negative impact on ecosystem health as well as human health. For those who live close to cement mills, inhaling these particles can cause lung problems and other health problems. Additionally, the accumulation of tiny particles on plants and crops might impede agricultural productivity by halting growth.
Another major issue is the untreated wastewater produced by cement manufacturing facilities. Such effluent can contaminate adjacent water sources, harming aquatic ecosystems and reducing access to clean water for drinking and agricultural use. One nearby water body that may be affected is Chatlam Wetland Reserve. A reduction in biodiversity and the destruction of aquatic habitats may result from this contamination, which has the potential to upset the delicate balance of aquatic life. Furthermore, the over-extraction of limestone, a crucial raw material used in the manufacture of cement, has the potential to have significant negative environmental effects. Given that limestone resources are frequently found in regions with dense vegetation, the unregulated mining processes could lead to deforestation. Ecosystems can be harmed, carbon sequestration capacity is decreased, and soil erosion is facilitated by the removal of trees and other plants. Furthermore, the ecological impact of habitat degradation brought on by excessive limestone extraction might intensify as different plant and animal species' survival is threatened. The location of these cement facilities is a significant additional influence. They are situated very next to Dachigam National Park's main area, which is the only habitat left for the severely endangered hangul species. A major mistake could soon be made by having such huge companies so close to a national park. These companies' emissions of smoke and dust immediately penetrate the main national park, harming the ecosystem. Similar to this, these factories are to blame for some of Kashmir's worst air quality in the Khrew, Wuyan, and Khonmoh districts. The houses and trees are both always shrouded in a layer of cement dust. Numerous respiratory conditions that these people have are hurting their health. People living in these locations have already been affected by the respiratory conditions brought on by the poor air quality.
An unfavourable alteration to the characteristics of an environment is called pollution. It poses a serious threat to the natural habitat and has a substantial effect on both human and other species' life (Adel et, al 2006). Carbon dioxide (CO_2), nitrogen oxide (NOx), and Sulphur oxide are the main elements of the dust that cement factories generate (Sox). Carbon monoxide (CO), nitrogen oxide (NOx), particulate matter (PM), and Sulphur oxide (SO_2) are among the harmful and exhaust gas components from the cars (Sox) (Chen & Kan 2008).
The objectives of this study are: to analyse the seasonal and annual trends of air quality in selected sites of Kashmir

valley; to study the impact of cement industry on air quality in Kashmir valley; to identify the possible impact that may affect the workers and community and to recommend some mitigating measures which could assist to run environment friendly Industry.



Source: Google Earth

Figure1: Google Maps of Cement Plants in Khrew and Khanmoh and the surrounding villages.

2. Methods and Instrumentation

2.1 Description of the study area

Two sites were chosen to evaluate the ambient air quality of the Kashmir Valley: The Khrew and Khanmoh areas.

Site 1: Khrew Area

In Jammu and Kashmir's Indian union territory, Khreu, also known as Khrew, is a town under municipal committee in the Pulwama district. It falls under the Union Territory of Jammu and Kashmir's Tehsil Pampore and District Pulwama. The distance between it and the city centre of Lal Chowk is twenty kilometres. Thousands of cement trucks are sent across the valley to this cement manufacturing hub, one of its many well-known features. Currently, there are five cement factories in the region, which contribute significantly to the local economy by providing jobs, but also cause a great deal of pollution. The first cement factory in the area was established by Kashmir Cement Project. TCI Max, HK Cement, Cemtac, ARCO, and ICC Cement are among the six cement plants. Additionally, hundreds of trucks transport manufactured cement bags and raw materials into and out of these plants daily. As per the World Health Organisation report, Khrew has a higher death rate than any other town in the district because of the release of toxic gases. Every day, factories emit 100,000 kg of harmful gases, toxic fumes, and potentially fatal elements into the atmosphere. The leading cause of deaths from fume exposure is lung disease, which is followed by heart disease and renal failure. As per the report, the cause of these conditions was determined to be the discharge of toxic gases. The report also recommended that pollution control step in and monitor the factories' pollution control devices on a monthly basis to ensure they are operating as intended. The majority of people in Khrew are either directly or indirectly affected by lung or another pulmonary disease.

Site 2: Khanmoh Area:

Khanmoh is a 14-kilometer radius from the main city of Srinagar, in the union territory of Jammu and Kashmir. It is well-known for its industrial estate because four cement plants—Khyber Cement, Saifco Cement, Khyber LMT, and TCI—operate there. There are 21787 people living in this area overall. There are 11451 males and 10336 females in the population. The region is roughly 7.5 square kilometres in size.

2.2: Ambient Air quality monitoring in Kashmir

The state pollution control board (SPCB **jkspcb.nic.in) for the past few years has been monitoring the ambient air quality at two locations—Khrew and Khanmoh—under its National Air Monitoring Programme (NAMP); both locations are classified as industrial areas.**

2.3: Air Quality Index (AQI):

The daily air quality is reported using the Air Quality Index (AQI). It informs us of the air's cleanliness or pollution level as well as any potential health risks. The AQI focuses on potential health effects that breathing contaminated air can have on us a few hours or days later. The range of the AQI is 0 to 500. The level of air pollution and the associated health risks increase with an increase in the AQI value. The national air quality standard for the pollutant, which is the threshold the EPA (Environment Protection Authority) has set to safeguard public health in India, is typically represented by an AQI value of 100. In general, AQI values under 100 are regarded as satisfactory. As shown in Table 1, air quality is deemed unhealthy when AQI values are above 100, initially for specific vulnerable populations and subsequently for all people.

Table 1: Air Quality Index (AQI) values indicate the degree of health risks associated with the air quality.

AQI	Air quality pollution level	Health Implication
0-50	Good	Air pollution poses no harm, and the quality of the air is deemed to be good.
51-100	Moderate	Persons with lung diseases, such as asthma, as well as people with heart diseases, children, and elderly adults, may experience breathing pain.
151-200	Poor	Long-term exposure may make people's breathing uncomfortable, and short-term exposure may make people with heart problems uncomfortable.
300+	Severe	May have major health implications on persons with lung/heart illnesses and even on healthy people who have respiratory effects. The negative effects on health might be seen even when engaging in light exercise.

$AQI_{pollutant} = pollutant\ data\ reading \div Standard \times 100$

Where $AQI_{pollutant}$ is the AQI value for PM10 emission, pollutant data reading is emission measured. The standard limit of PM_{10} for 24 hours=100µg/m^3 and for the year - 60µg/m^3.

It was obtained the yearly data from both study sites maintained by the state Pollution Control Board (SPCB). Using annual data, the Air Quality Index of both sites was calculated for the given period (2017 to 2023) of time. In order to examine the seasonal fluctuations in the AQI values, the 12-month breakdown was used. December, January, and February constituted the winter season; March, April, May, and June constituted the summer season; July, August, and

September constituted the monsoon season; and October and November constituted the post-monsoon season.

2.4: Clinical Data:

The Directorate of Health Services Kashmir provided the clinical data for this study, which was painstakingly collected between 2014 and 2023 by staff members stationed at the Khanmoh and Khrew health centres. This data collection focused on five major diseases linked to elevated particulate matter concentrations: skin infections, lung function impairments, irregular heartbeats, acute and chronic bronchitis, and infections of the skin. This extensive dataset provides an essential starting point for investigating the health consequences linked to high particulate matter levels. It provides information that is essential for comprehending and reducing the effects of environmental factors on public health in the Kashmir region.

2.5: Regression Analysis

We used a regression analysis to assess how particulate matter (PM10) affected the occurrence of these illnesses. The purpose of the analysis was to find any meaningful relationships between the annual PM10 concentration levels and the number of cases of each illness that were reported. This method makes it possible to evaluate the possible health concerns connected to the region's high PM10 concentrations.

3. Results and Discussion:

The study goes into great detail to analyse trends in the quality of the air, specifically focusing on particulate matter (PM10) in the Kashmir valley. In order to assess the effect of the cement industry on air quality, the study focuses on two different locations: Khanmoh and Khrew. The State Pollution Control Board provided the data used in this analysis, which covers the years 2014 through 2023. The Air Quality Index (AQI) formula was utilised to evaluate the particulate matter concentration, providing a reliable quantitative assessment. Using this methodology, the study seeks to identify yearly patterns in PM10 levels, offering important insights into the complex interactions that affect the quality of the air in the Kashmir valley due to industrial activity and environmental factors. This thorough investigation advances our knowledge of the dynamics of regional air quality and provides a solid basis for making well-informed policy decisions intended to lessen the negative environmental effects of the local cement industry.

3.1 Annual variations of AQI

3.1.1 Khrew Area

The table 2 shows the amount of particulate matter (PM10) present in Pulwama's Khrew area between 2014 and 2023. Figure 1 is clearly showing from 2014 to 2018, PM10 levels disclosed a noticeable trend of gradual decline, with the lowest level recorded in 2018 at 188 µg/m³. The following years, however, show a notable reversal and a steady rise in PM10 concentrations, which peak at 238 µg/m³ in 2023. This change raises the possibility that human activity or local environmental factors affecting air quality have changed. The information suggests that in order to address the rising particulate matter levels in the Khrew area, it is critical to conduct ongoing monitoring, comprehensive investigations into the sources of pollution, and implement targeted measures. It is interesting to note that only the years 2018 and 2019 are indicated in yellow on the Air Quality Index (AQI) as being in the "Moderate" category. This designation implies that, when comparing air quality standards to PM10 concentrations, 2018 and 2019 are relatively better years. When compared to other years in the dataset, the yellow categorization denotes a period with lower health concerns due to a moderate level of pollution (Table 3).

Table 2: Concentration of particulate matter (PM_{10}) in Khrew area since 2014 to 2023

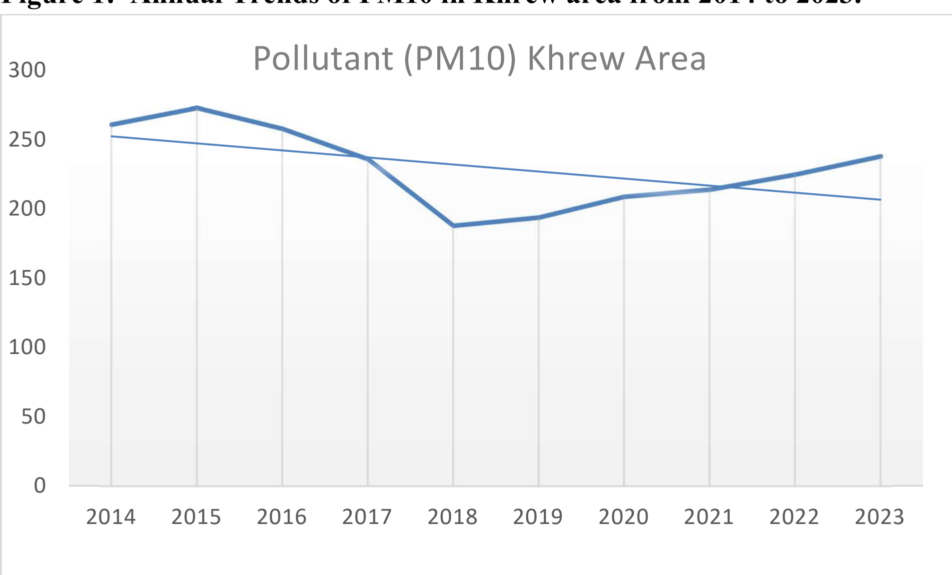
Year	PM_{10} (µg/m^3)	Mean Value (AQI)	Permissible Limit (NAAQs) (µg/m^3)
2014	156.78	261	60
2015	163.98	273	60

2016	154.76	258	60
2017	141.65	236	60
2018	112.55	188	60
2019	116.58	194	60
2020	125.85	209	60
2021	128.83	214	60
2022	135.10	225	60
2023	143.16	238	60

Table 3: Annual AQI color coding for the pollutant (PM10) of Khrew Area. (NAAQ)

Year	Particulate matter (PM_{10})	Calculated AQI	Overall category
2014	156.78	261	Poor
2015	163.98	273	Poor
2016	154.76	258	Poor
2017	141.65	235	Poor
2018	112.55	188	Moderate
2019	116.58	194	Moderate
2020	125.85	209	Poor
2021	128.83	214	Poor
2022	135.10	225	Poor
2023	143.16	238	Poor

Figure 1: Annual Trends of PM10 in Khrew area from 2014 to 2023.



3.1.2: Khanmoh area:

The table presents the results of an analysis of the particulate matter (PM10) concentration in the Khanmoh area of Pulwama from 2014 to 2023. It shows a pattern of fluctuations without a distinct linear trend. PM10 levels rose significantly in 2016, peaking at 298 µg/m³. In contrast, 2019 saw a significant decline, with the concentration reaching its lowest point at 198 µg/m³. Khanmoh does not show a consistent declining trend in the last few years, in contrast to the Khrew area. Significant variations may be attributed to local factors, industrial activities, or meteorological conditions, as evidenced by notable spikes in 2020 and the absence of a clear trend from 2021 to 2023. According to the data, 2019 is a better year than 2018 in terms of PM10 levels, which is consistent with the Khrew area's trend. Thorough research into particular sources causing variations is necessary for the Khanmoh region's pollution control policies to be well-informed.

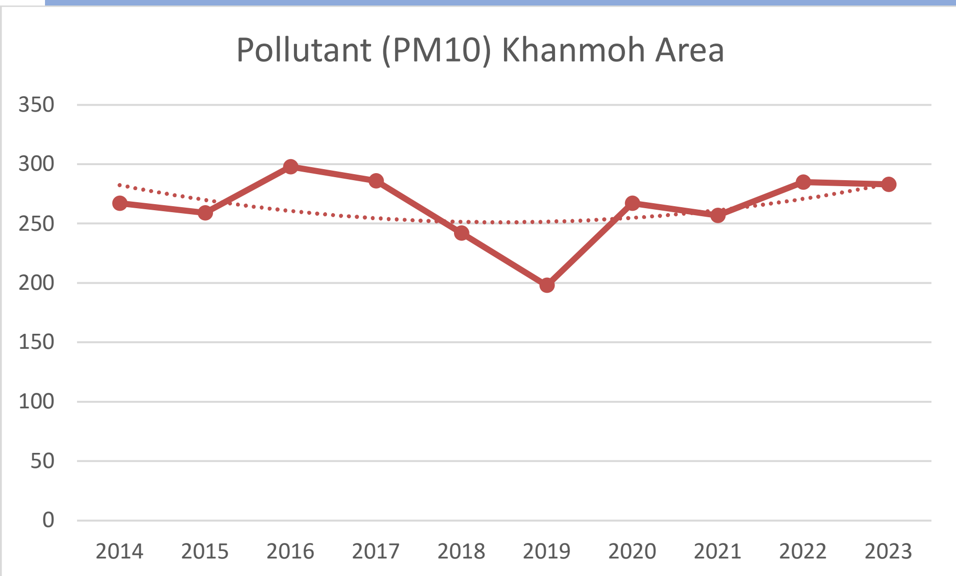
Table 4: Concentration of particulate matter (PM_{10}) in Khanmoh area since 2014 -2023

Year	PM_{10}(µg/m^3)	Mean Value (AQI)	Permissible limit(µg/m^3) (NAAQs)
2014	160.45	267	60
2015	155.89	259	60
2016	178.90	298	60
2017	171.87	286	60
2018	145.53	242	60
2019	119.8	198	60
2020	160.27	267	60
2021	154.72	257	60
2022	171.40	285	60
2023	170.31	283	60

Table 5: Annual AQI color coding for the pollutant (PM10) of Khanmoh Area. (NAAQ)

Year	Particulate matter (PM_{10})	Calculated AQI	Overall category
2014	160.45	267	Poor
2015	155.89	259	Poor
2016	178.90	298	Poor
2017	171.87	286	Poor
2018	145.53	242	Poor
2019	119.8	198	Moderate
2020	160.27	267	Poor
2021	154.72	257	Poor
2022	171.40	285	Poor
2023	170.31	283	Poor

Figure 2: Annual Trends of PM10 in Khanmoh area from 2014 to 2023



The Khrew and Khanmoh areas of Pulwama have PM10 concentration trends from 2014 to 2023, but it is difficult to determine with certainty which area has the worst air quality. The levels of PM10 in both areas show year-to-year fluctuations and variations, with some years exhibiting higher or lower concentrations. In Khanmoh, the patterns are more erratic with spikes in 2016 and 2020, whereas in Khrew, there is a discernible increase in PM10 levels starting in 2018. The comparison shows that local factors, industrial activity, and meteorological conditions can all have an impact on air quality issues, which are complicated. To determine which area consistently has worse air quality during the designated years, more thorough analysis would be required. This analysis would include additional air quality parameters and information on pollution sources.

3.2 Seasonal variations of AQI:

In this paper, we investigate the seasonal fluctuations of particulate matter in Kashmir's cement industry, concentrating on two different locations: Khanmoh and Khrew. Expanding on earlier studies that examined yearly fluctuations, our research now focuses on the subtle variations throughout the four distinct seasons: summer (March, April, May, June), monsoon (July, August, September), and post-monsoon (October& November). The significance of seasonal variations in particulate matter levels cannot be overstated, as they not only enhance our comprehension of environmental dynamics within the area but also facilitate the development of focused approaches aimed at ameliorating possible detrimental consequences on air quality and public health. Our goal is to offer a thorough understanding of the seasonal dynamics of particulate matter in cement industries by investigating this temporal dimension. This will help to inform environmental management practices in Kashmir.

For the years 2014 and 2023, Table 6 displays the following AQI trends for the four seasons (summer, winter, monsoon, and post-monsoon):

3.2.1 Khrew Area

The Khrew area's AQI was significantly worse during the winter and better during the monsoon in 2014.The following sequence was shown by the AQI in decreasing order: winter > summer > monsoon > post-monsoon. The entire text suggests that the AQI is decreasing, meaning that the winter months have the worst air quality and the monsoon has the best. The Khrew area's AQI was significantly worse during the summer and better during the monsoon in 2023. In decreasing order, the AQI value went through the following sequence: monsoon > summer > post-monsoon > winter.

3.2.2 Khanmoh area

The Khanmoh area's AQI in 2014 was significantly worse during the summer and better during the monsoon. In decreasing order, the AQI value went through the following sequence: summer > winter > post monsoon>Monsoon. The Khanmoh area's AQI in 2023 was significantly worse during the summer and better during the monsoon. In decreasing order, the AQI value was as follows: summer > winter > post monsoon > monsoon.

Table 6: Seasonal variation of the AQI of the Two areas of Kashmir for the years 2014 and 2023.

Area	2014	2023	Remarks
Khrew	W>S>M>PM	M>S>PM>W	The quality of the air improved overall. In winter of 2014, the worst AQI shifted to summer of 2023.
Khanmoh	S>W>PM>M	S>W>PM>M	The quality of the air improved overall. For both years, the summer months have the worst AQI.

W winter, S summer, M monsoon, PM post monsoon.

3.3: Relation between Exposure to emission and Health outcome:

It is critical to comprehend how particulate matter (PM10) emissions affect public health, especially in places like the Khanmoh site, which is home to five active cement plants. From 2014 to 2023, regression analyses were performed to evaluate the association between different health outcomes and PM10 exposure. The findings showed a strong relationship between PM10 levels and a number of medical disorders. Significant amounts of the variance in these health outcomes were attributable to PM10 exposure, as evidenced by the remarkably high R-squared values (0.665, 0.509, and 0.409, respectively) for chronic bronchitis, lung function impairment, and irregular heartbeat. Furthermore, all of the health outcomes' standardised coefficients (Beta) were positive, indicating a correlation between elevated PM10 levels and worsening health conditions. Moreover, the robustness of these results is highlighted by the statistical significance, with p-values for lung function, irregular heartbeat, and chronic bronchitis below 0.05. (Table 7) These findings highlight the urgent need for efficient methods to track and reduce PM10 emissions, especially in industrial areas like Khanmoh, in order to protect the public's health and lessen the burden of respiratory and cardiovascular diseases on the general populace.

Variable	R	R- Square	Significance	Standardized Coefficient Beta
Particulate matter (IV) Acute Bronchitis (DV)	.480	0.230	0.04	0.480
Chronic Bronchitis (DV)	.816	0.665	0.00	.816
Skin Infection (DV)	.560	0.313	0.03	.560
Lung Function (DV)	.714	.509	0.01	.714
Irregular Heartbeat (DV)	.640	.409	0.00	.640

Table 7: Regression Analysis between PM10 and Health (Khanmoh)

Predictors: (Constant). Particulate Matter PM10 (µg/m3)
Dependent variable: Acute Bronchitis, Chronic Bronchitis, Skin Infection, Lung Function, Irregular Heartbeat.

Regression analysis on data from the Khrew area, home to four cement plants, sheds light on the connections between different health outcomes and particulate matter (PM10) exposure. Results show significant correlations between PM10 levels and a number of health conditions over the study period (2014–2023). With a remarkably high R-squared value of 0.503, chronic bronchitis indicates that PM10 exposure accounts for roughly 50.3% of the variance in chronic bronchitis. Likewise, lung function impairment has a strong R-squared value of 0.324, suggesting that a sizable amount of the variability in lung function is related to PM10 levels.
Higher PM10 exposure is associated with an increased incidence of chronic bronchitis and a lower function of the lungs, according to the standardised coefficients (Beta), which further support these findings with positive coefficients for both chronic bronchitis and lung function. The robustness of the observed connections is further highlighted by the statistical significance of these relationships, with p-values of 0.01 for lung function and 0.00 for chronic bronchitis. Nonetheless, this research suggests that the correlations between skin infection and irregular heartbeat and PM10 exposure are not as strong. The R-squared values for these results, which are 0.195 and 0.246, respectively, indicate that PM10 exposure accounts for a smaller percentage of the variance. Furthermore, in comparison to lung function and chronic bronchitis, the standardised coefficients and p-values for these health outcomes suggest weaker and less statistically significant relationships.

All things considered, these results highlight how critical it is to track and reduce PM10 emissions, especially in industrial locations like Khrew, in order to address the serious health hazards associated with air pollution. Reducing PM10 exposure has the potential to lessen the burden of lung function impairment and chronic bronchitis, improving community well-being and public health.

Table 8: Regression Analysis between PM10 and Health (Khrew)

Variable	**R**	**R- Square**	**Significance.**	**Standardized coefficients Beta**
Particulate matter (IV) Acute Bronchitis (DV)	0.533	0.284	0.02	.533
Chronic Bronchitis (DV)	.709	.503	0.00	.709
Skin Infection (DV)	.442	0.195	.144	.442
Lung Function (DV)	.570	.324	0.01	.570
Irregular Heartbeat (DV)	.496	.246	0.03	.496

Figure 3: Patients with different diseases from 2014 to 2023 years of the Khanmoh Health centre

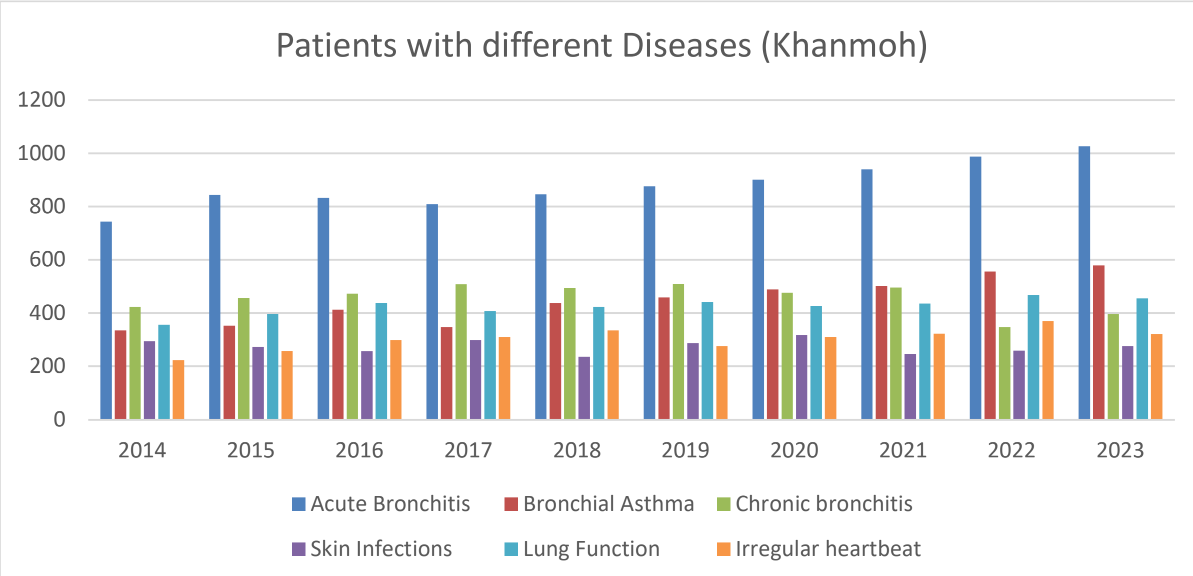
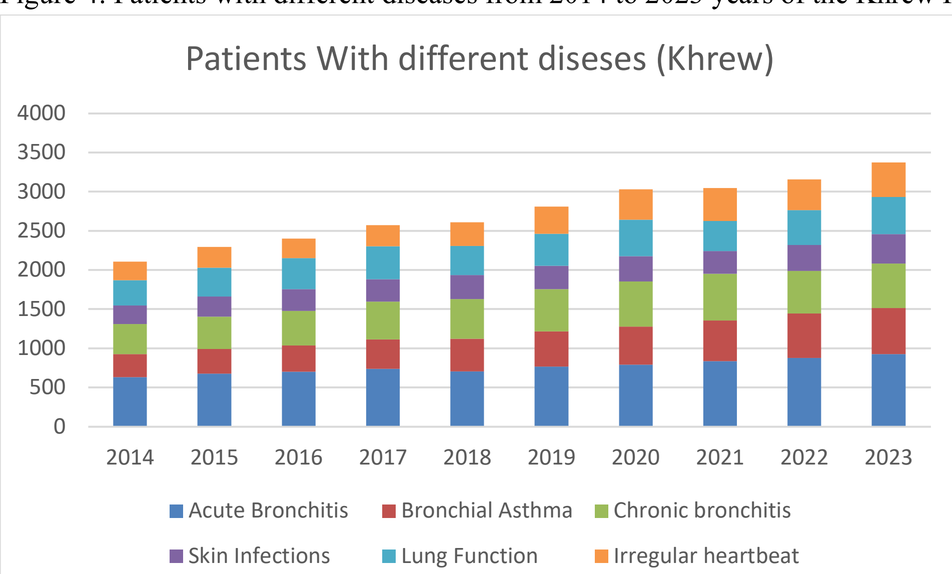


Figure 3 displays data from the Khanmoh area of Pulwama, which shows clear patterns in a range of health issues throughout time. From 2014 to 2023, the number of reported cases of acute bronchitis shows a continuous rising pattern. In a similar vein, bronchial asthma exhibits variability but generally experiences a rise, especially in the latter years. On the other hand, the prevalence of chronic bronchitis fluctuates initially before showing a falling trend starting in 2018, which may indicate an improvement in the condition's prevalence. While skin diseases can vary, they usually stay the same for the duration of the observation. On the other hand, data on lung function indicates a continuous decline over time, with yearly increments reported. Even while irregular heartbeats vary, they show a modest increase tendency, which is particularly apparent starting in 2019. These patterns shed important light on the Khanmoh area's health dynamics by drawing attention to problem areas like cardiovascular and respiratory health, which may call for more research and focused treatments.

Figure 4: Patients with different diseases from 2014 to 2023 years of the Khrew Health centre.



Over a ten-year period, the data shown depicts the prevalence of different ailments in Pulwama's Khrew area. Important insights into the dynamics of the region's health can be gained by analysing the trends depicted in figure 4. Acute bronchitis prevalence shows a steady rising trend from 2014 to 2023, suggesting a gradual rise in cases that are reported. Analogously, bronchial asthma exhibits a consistent upward trend throughout time, indicating an increasing prevalence of respiratory problems among the populace. Contrarily, chronic bronchitis exhibits oscillations but often keeps a steady trend. There appears to be a minor increase in reported instances towards the later years, albeit considerable heterogeneity, which calls for more research into potential contributing factors. Skin infections show a variable pattern with no discernible trend, suggesting different prevalence levels over the course of the observation period. Access to healthcare services, cleanliness standards, and environmental factors may all have an impact on this variation (Table 8). Data on lung function shows a worrying downward trend over time, with steady increases observed. This highlights the necessity for focused efforts to address this condition and raises the possibility of a decline in respiratory health. Last but not least, irregular heartbeat varies but generally indicates an increased trend, especially after 2020. This emphasises how crucial it is to keep an eye on cardiovascular health and put plans in place to reduce the risk factors that lead to irregular heartbeats in the general population. In general, these patterns highlight the significance of continued monitoring and intervention initiatives to meet the community's changing health requirements in the Khrew area, especially in the areas of respiratory and cardiovascular health.

4. Conclusion:

The operational footprint of nine cement plants in the Khrew and Khanmoh areas of Kashmir from 2014 to 2023 shaped the comprehensive analysis of annual and seasonal air quality trends, which reveals a complex interplay of factors influencing air pollution dynamics. The PM10 levels in Khrew show a complex pattern with varying values and no obvious linear trend. The data is punctuated by notable peaks in 2020 and 2016, which suggest potential influences from meteorological variations, industrial activities, and local conditions. But the notable drop in PM10 concentration in 2019 over 2018 points to the potential influence of coordinated efforts or cyclical environmental circumstances.

However, the following years show no discernible patterns, indicating the need for in-depth research into particular sources of pollution in order to guide focused mitigation efforts. Khanmoh, on the other hand, exhibits a more erratic pattern with notable spikes in 2016 and 2020, highlighting the necessity of customised pollution control strategies based on thorough source apportionment studies. Seasonal differences in air quality also emphasise the complex connection between pollution levels and weather patterns. The data shows a pronounced seasonal difference in Khrew, where the monsoons provide relief during the winter months and the winters themselves represent the worst air quality, as seen in 2014 and 2023. On the other hand, Khanmoh has a distinct seasonal pattern; summers there are normally marked by elevated pollution levels, with the monsoon season offering respite (a pattern that is repeated in 2014 and 2023). These results highlight the need for targeted, regionally-specific interventions that take seasonal variations and local environmental conditions into account in addition to addressing industrial emissions. Through the implementation of a comprehensive strategy that incorporates targeted mitigation measures, comprehensive data analysis, and stakeholder collaboration, policymakers can effectively address the multifaceted issue of air pollution in the Kashmir region, thereby preserving environmental sustainability and public health for future generations.

The data from Pulwama's Khrew neighbourhood reveals noteworthy trends in a range of medical disorders during the previous ten years. A growing burden of respiratory disorders is shown by the steady rise in the prevalence of bronchial asthma and acute bronchitis in the general population. Although the tendency for chronic bronchitis remains mostly unchanged, there is a small rising trend in the later years. Skin infections show variable trends, indicating different prevalence levels. However, alarming patterns in the decline of lung function and irregular pulse are noted, highlighting the necessity of focused interventions to address the region's respiratory and cardiovascular health issues.

5. Limitations

With a focus on the effects of the cement industry from 2014 to 2023, the study on the annual and seasonal trends of air quality in the Khrew and Khanmoh areas of Kashmir provides insightful information. But it's important to recognise that the analysis has a number of inherent limitations. First off, because the state pollution control board is the only source of data used in this study, biases or inaccuracies may be introduced as a result of limitations in data coverage, quality, and consistency. Moreover, other pollutants and air quality parameters that could offer a more thorough understanding of pollution dynamics are largely ignored in favour of PM10 levels and AQI values in the analysis. Furthermore, the unique features of the research areas might limit how broadly the findings can be applied to other areas. Further research efforts, such as data validation, thorough pollutant monitoring, in-depth source attribution studies, integration of meteorological analysis, and consideration of regional variability, would be necessary to address these limitations. Notwithstanding these limitations, the study emphasises the significance of additional research to guide evidence-based policy interventions targeted at reducing air pollution and protecting public health in the Kashmir region and elsewhere.

Authors Contribution

Syed Rizwana Qadri: Conception, design, drafting-, data collection, and interpretation of the manuscript.

Mudasir Ahmad Dar: Conception and drafting of the manuscript.

The authors read and approved the final manuscript.

Laiba Anwar: Writing and interpretation

Acknowledgement

We deeply acknowledge and appreciate the invaluable contributions of the respondents who participated in this study.

Data Availability and statement.

We hereby declare that the author (Syed Rizwana Qadri) has access to the data supporting this work and that the data will be made available for research purposes upon reasonable request.

Disclosure Statement

There was no disclosed conflict of interest by the author(s).

Additional Information

Funding

No funding was received

Notes on contributors

Syed Rizwana Qadri, syedrizwana84@gmail.com,(ORCID:0009-0003-7787-4769) Research Scholar at Lovely Professional University India pursuing her PhD in Economics, with a good academic record.

Mudasir Ahmad Dar, darmudasir74@gmail.com, (ORCID: 0000-0003-0719-4365) currently working as an Assistant Professor at Mittal School of Business and has more than three years of experience, with a doctorate in Economics.

Laiba Anwar, syedrizwana84@gmail.com, Research Scholar at Lovely Professional University India pursuing her PhD in Finance, with a good academic record.

6. References

1. Abdul-Wahab S (2006) Impact of fugitive dust emissions from cement plants on nearby communities. Ecol Modell 195:338–348
2. Agber T, Iorgirim S (2013) Assessment of air quality around Dangote Cement Company, TseKucha, Gboko, Benue State, Nigeria. Paper presented at the Proceedings of the 13th International Conference

of Environmental Science and Technology. Athens, Greece 5th–7th September.

3. Akpan O, Amodu E, (2011) An assessment of the major elemental composition and concentration in limestones samples from Yandev and Odukpani areas of Nigeria using nuclear techniques. J Environ Sci Technol 4:332–339
4. Aigbedion, I.N, 2005, Environmental pollution in the Niger Delta, Nigeria. Inter-disciplinary Journal Enugu – Nigeria, 3(4), 205–210.
5. Aydin, S., Aydin, S., Croteau, G. A., Sahin, I., & Citil, C. (2010). Ghrelin, nitrite and paraoxonase/arylesterase concentrations in cement plant workers. *Journal of medical Biochemistry*, *29*(2), 78-83.
6. Benedetti, M, (2017). Assessing and improving compressed air system's energy efficiency in production and use: Findings from an explorative study in large and energy-intensive industrial firms. Energy Procedia, 105, 3112-3117.
7. Beketie, K. T., Angessa, A. T., Zeleke, T. T., & Ayal, D. Y. (2022). Impact of cement factory emission on air quality and human health around Mugher and the surrounding villages, Central Ethiopia. Air Quality, Atmosphere & Health, 15(2), 347-361.
8. Chen, C., Habert, G., Bouzidi, Y., &Jullien, A. (2010). Environmental impact of cement production: detail of the different processes and cement plant variability evaluation. Journal of Cleaner Production, 18(5), 478-485.
9. Chaurasia S, Ahmad I, Gupta A, Kumar S (2014) Assessment of air pollution emission from cement industries in Nimbahera, Rajasthan. Int J Curr Microbiol App Sci 3:133–139
10. Devi, K. S., Lakshmi, V. V., & Alakanandana, A. (2017).Impacts of cement industry on environment-an overview. Asia Pac. J. Res, 1, 156-161.
11. Dawoudian, J., Bahamin, S., &Tantoh, H. B. (2021). Environmental impact assessment of cement industries using mathematical matrix method: the case of Ghayen cement, South Khorasan, Iran. Environmental Science and Pollution Research, 28(18), 22348-22358.
12. Fayaz, S., Rather, G. M., Naqshbandi, Z. K., & Bhat, M. S. (2017). INDOOR AIR QUALITY AND ITS IMPACT ON THE HEALTH OF GUJJARS OF NORTH KASHMIR HIMALAYAS. JOURNAL OF INDIAN RESEARCH, 5(2), 50-61.
13. Ghorani-A R-Z, Balali-Mood M (2016) Effects of air pollution on human health and practical measures for prevention in Iran. J Res Med Sci 21:65
14. Huntzinger, D. N., & Eatmon, T. D. (2009). A life-cycle assessment of Portland cement manufacturing: comparing the traditional process with alternative technologies. Journal of cleaner production, 17(7), 668-675.
15. Ighalo, J. O., & Adeniyi, A. G. (2020).A perspective on environmental sustainability in the cement industry. Waste Disposal & Sustainable Energy, 2(3), 161-164.
16. Jehangir, A., Dar, N. A., Yousuf, A. R., & Sofi, A. H. (2011).Air quality at Sonamarg-a tourist hill station in Kashmir valley, India. Journal of Experimental Sciences, 2(6).
17. Mukhtar, A., & Mukhtar, F. (2020). Air Pollution a Major Threat to the People of Khrew (J&K).
18. Mishra, U. C., Sarsaiya, S., & Gupta, A. (2022). A systematic review of the impact of cement industries on the natural environment. Environmental Science and Pollution Research, 1-12.
19. Mohamad, N., Muthusamy, K., Embong, R., Kusbiantoro, A., &Hashim, M. H. (2021). Environmental impact of cement production and Solutions: A review. Materials Today: Proceedings
20. Mehraj, S. S., Bhat, G. A., Balkhi, H. M., &Gul, T. (2013). Health risks for the population living in the neighborhood of a cement factory. African Journal of Environmental Science and Technology, 7(12),

1044-1052.

21. Patnaik, R. (2018, March). Impact of industrialization on the environment and sustainable solutions– reflections from a south Indian region. In IOP Conference Series: Earth and Environmental Science (Vol. 120, No. 1, p. 012016).
22. Poudyal, L., & Adhikari, K. (2021). Environmental sustainability in cement industry: An integrated approach for green and economical cement production. Resources, Environment and Sustainability, 4, 100024.
23. Ravindra L (2021). CEMENT INDUSTRY IN INDIA: PRODUCTION & CONSUMPTION A global journal of social science, 2(1), 2581-5830.
24. Sheikh, M., & Najar, I. A. (2018). Preliminary study on air quality of Srinagar,(J&K), India. Journal of Environmental Science Studies, 1(1), 45.
25. Summerbell, D.L, (2016). Potential reduction of carbon emissions by performance improvement: A cement industry case study. *Journal of Cleaner Production*, *135*, 1327-1339.
26. Sunkad, S. G. (2021). The Role of Industries in the Development of the Nation. *European Journal of Research Development and Sustainability*, *2*(4), 55-58.
27. Zeleke Z, Moen B, Bratveit M (2010) Cement dust exposure and acute lung function: a cross shift study. British Medic Council Publ 10(1):19
28. Zeyede Z (2011) Respiratory health among cement workers in Ethiopia. Dissertation, the University of Bergen.