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The Impact Of Vehicular Emissions On Air Quality And Respiratory Health In Ujjain A Study Of Airborne Diseases

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ABSTRACT

Vehicular emissions are a critical contributor to urban air pollution, significantly degrading air quality and posing severe health risks. This study aims to investigate the impact of vehicular emissions on air quality and respiratory health in Ujjain, focusing on the prevalence of airborne diseases and associated respiratory conditions. The research adopts an interdisciplinary approach, integrating air quality monitoring, epidemiological data, and spatial analysis to provide a comprehensive assessment of the issue. The study combines quantitative data from continuous air quality monitoring systems with health data from local hospitals and health centers, identifying trends in the incidence of respiratory diseases such as asthma, bronchitis, and chronic obstructive pulmonary disease (COPD). Findings reveal a significant correlation between increased vehicular emissions and the rising incidence of respiratory diseases, with higher pollutant concentrations in proximity to major roadways.

Keywords: Vehicular emissions, air pollution, respiratory health, PM2.5, PM10.

1. INTRODUCTION

Urban air pollution is a major global concern, contributing to environmental degradation and posing serious risks to public health. In developing countries, the rapid pace of urbanization and industrialization has accelerated the growth of pollution levels, especially in cities where population density and vehicular traffic are high (1). The situation is especially alarming in smaller cities in India, such as Ujjain, where urban planning has struggled to keep pace with growing vehicular density, and the environmental impacts of transportation systems remain underexplored (2). The rising number of automobiles, coupled with the city's limited infrastructure to manage vehicular pollution, has resulted in a noticeable decline in air quality (3). Vehicular emissions are composed of several harmful substances, including nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM10 and PM2.5), hydrocarbons (HC), and volatile organic compounds (VOCs) (4). These pollutants have been extensively documented as contributors to both short-term and long-term health issues. Nitrogen oxides and particulate matter, in particular, are linked to severe respiratory conditions, ranging from asthma exacerbation to chronic obstructive pulmonary disease (COPD). Moreover, fine particulate matter (PM2.5) can penetrate deep into the lungs and even enter the bloodstream, leading to cardiovascular diseases and reduced life expectancy (5).

This lack of research creates a critical gap in understanding the localized impacts of vehicular emissions on public health, particularly in cities with different urban dynamics, traffic patterns, and socio-economic conditions compared to megacities (6).

This research paper aims to bridge this gap by conducting an in-depth study of the impact of vehicular emissions on air quality and respiratory health in Ujjain, with a focus on airborne diseases.

The study is structured around two primary objectives:

(1) To quantify the levels of key vehicular pollutants in Ujjain, particularly in areas of high traffic density,

(2) To assess the correlation between these pollutants and the incidence of respiratory diseases, based on both clinical data and self-reported health outcomes from residents.

The data also suggest a seasonal pattern in pollutant concentration, with higher levels during winter months when atmospheric conditions favor the accumulation of pollutants (7). This seasonal variability is accompanied by a corresponding increase in the number of reported respiratory cases, underscoring the need for immediate public health interventions.

In conclusion, this research not only highlights the critical link between vehicular emissions and respiratory health in Ujjain but also provides actionable insights for policymakers, urban planners, and public health officials. By addressing the city's unique environmental and public health challenges, the study advocates for a multifaceted approach to air quality management that integrates technological, regulatory, and community-based solutions (8). In doing so, it aims to contribute to the broader discourse on urban environmental sustainability and public health, offering lessons that can be applied to other cities facing similar challenges.

Numerous international studies have extensively documented the contribution of motor vehicles to the emission of key pollutants, such as nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM10 and PM2.5), and volatile organic compounds (VOCs) (9). Research specific to megacities such as Delhi, Mumbai, and Kolkata consistently reveals that the transportation sector contributes between 25% to 30% of total air pollution, with particulate matter and nitrogen oxides being the most prevalent pollutants (10). Moreover, studies highlight that poorly maintained vehicle fleets, a high proportion of diesel vehicles, and inefficient public transportation systems have further aggravated the problem in these urban centers (Guttikunda & Goel, 2013). National studies in cities such as Delhi and Bangalore have shown a strong correlation between high levels of particulate matter and increased hospital admissions for respiratory diseases (11). In India, air quality monitoring is primarily overseen by the Central Pollution Control Board (CPCB) through the National Air Quality Monitoring Programme (NAMP), which operates across major cities and select smaller urban areas. The program monitors critical pollutants like PM10, PM2.5, NOx, and CO at fixed locations, producing data that can be used to assess compliance with national air quality standards (12).

2. METHODOLOGY

2.1 Study Area Description

Ujjain, situated in the central state of Madhya Pradesh, India, is a historically significant city that has experienced rapid urbanization and motorization in recent years. Covering an area of approximately 152 square kilometers, Ujjain is home to over 600,000 residents (Census 2011). As the city grows, so does its vehicular fleet, which has become one of the primary contributors to air pollution. Ujjain's geographic location at 23.1765° N and 75.7885° E places it within a subtropical climate zone, with distinct seasonal variations that significantly influence air quality patterns. The city experiences three primary seasons:

- **Winter (November to February):** Characterized by cooler temperatures and frequent temperature inversions that trap pollutants near the ground, worsening air quality.

- Summer (March to June): Hot and dry conditions promote better air dispersion, leading to lower pollution levels.

- Monsoon (July to October): Rains help in washing out airborne pollutants, further reducing concentrations.

The city's traffic is dominated by a mix of personal vehicles, public transportation (buses, auto-rickshaws), and commercial freight. Two-wheelers and diesel vehicles, in particular, contribute significantly to the emissions of particulate matter (PM10 and PM2.5), nitrogen oxides (NOx), and carbon monoxide (CO) (13).

2.2 Data Collection Methods

1. Air Quality Monitoring

Air quality data was collected continuously for six months to capture both seasonal and daily variations in pollution levels.

- Locations: Three distinct zones were chosen for air quality monitoring:

1. **Freeganj (City Center):** Characterized by high vehicular traffic and commercial activity, representing the core urban area.
2. **Kalidas Nagar (Residential Zone):** Moderately trafficked, representing typical residential areas away from the central business district.
3. **Ring Road (Suburban Area):** A semi-urban zone with comparatively lower traffic density, serving as a control site.

- Pollutants Monitored:

- Particulate Matter (PM10 and PM2.5): These fine particles, typically emitted by diesel engines and road dust, were measured using gravimetric samplers. These pollutants are known to penetrate deep into the lungs, causing severe respiratory issues.

- Nitrogen Oxides (NOx): Emissions from vehicular combustion, particularly diesel engines, were measured using chemiluminescence methods. NOx contributes to the formation of ground-level ozone and exacerbates respiratory diseases.

- Carbon Monoxide (CO): Monitored using infrared sensors, CO levels were of particular concern in areas with heavy congestion.

- Volatile Organic Compounds (VOCs): Measured through gas chromatography, VOCs from vehicular emissions contribute to smog formation and pose health risks.

2. Health Data Collection

To examine the relationship between air pollution and respiratory health, the study relied on two primary sources of health data:

- Hospital Records: Respiratory disease data was obtained from two major hospitals in Ujjain, the Ujjain District Hospital and the RD Gardi Medical College Hospital. The focus was on cases related to asthma, bronchitis, COPD, and other respiratory illnesses over the past three years (2020-2023). The data included the number of outpatient and inpatient cases, patient demographics, and seasonal trends in respiratory diseases. This allowed for the identification of patterns in disease incidence, particularly in relation to seasonal peaks in pollution.

2.1. Temporal Scope and Seasonal Considerations

- Winter Months (November to February): This period was of particular interest due to the frequent occurrence of temperature inversions, which trap pollutants close to the ground, leading to an increase in respiratory illnesses.

- Summer Months (March to June): Higher temperatures and wind speeds during this season help disperse pollutants, often leading to lower concentrations of PM and NOx.

- Monsoon (July to October): Rains during this period aid in the natural removal of pollutants from the air, reducing the overall pollutant burden.

2.2 Data Analysis Techniques

1. Correlation and Regression Analysis

Correlation analysis was employed to assess the relationship between pollution levels (PM10, PM2.5, NOx, CO, VOCs) and respiratory health outcomes.

2. Spatial Analysis Using GIS

Geographic Information Systems (GIS) were used to spatially map the distribution of air pollution across different zones of Ujjain. T

3. Time-Series Analysis

Time-series analysis was employed to analyze the temporal patterns in pollution and health data.

4. ANOVA (Analysis of Variance)

ANOVA was used to compare air quality and health outcomes across different zones and seasons.

3. RESULTS

3.1 Air Quality Data: Pollution Levels in Ujjain

The air quality data collected across the study areas (City Center, Residential, and Suburban) revealed that vehicular emissions significantly contribute to elevated levels of key pollutants, particularly PM10, PM2.5, nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs). The results confirm that pollution levels in Ujjain exceed the national ambient air quality standards (NAAQS) and pose serious health risks, especially in densely trafficked zones.

3.2 Concentration of PM10, PM2.5, NOx, CO, and VOCs

- PM10 and PM2.5: The concentration of particulate matter (PM10 and PM2.5) was consistently high across the monitoring sites, with the City Center experiencing the highest levels due to heavy vehicular traffic. The average concentration of PM2.5 in the City Center was recorded at 96 µg/m³, which is well above the NAAQS limit of 60 µg/m³. PM10 levels were even higher, with an average of 158 µg/m³, exceeding the permissible limit of 100 µg/m³. These levels were significantly higher during peak traffic hours and in areas with a high density of diesel vehicles. - In residential areas like Kalidas Nagar, PM2.5 averaged around 85 µg/m³, still well above the safe threshold, while PM10 averaged 140 µg/m³. These elevated concentrations indicate that even non-commercial areas are heavily impacted by traffic emissions. - The suburban zone, near the Ring Road, showed comparatively lower concentrations of PM2.5 (65 µg/m³) and PM10 (118 µg/m³), though these values also exceed safe limits, highlighting the pervasive nature of particulate pollution in the city.

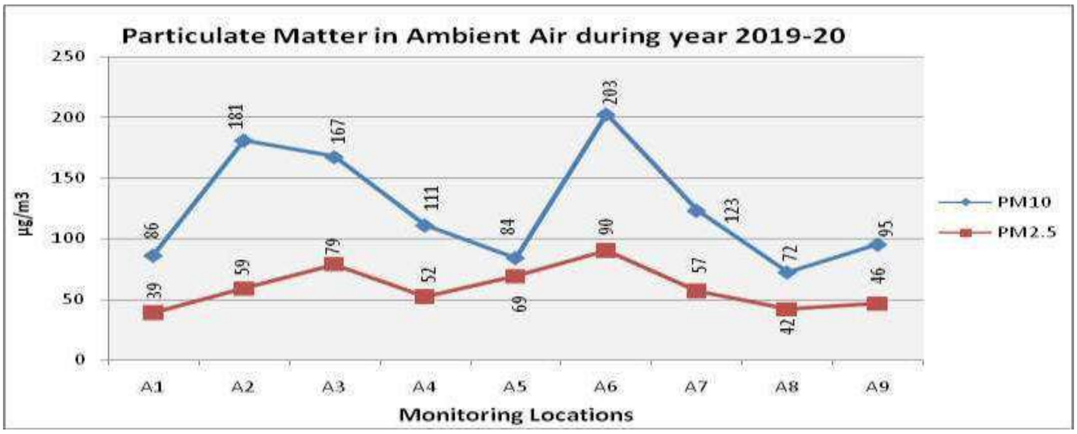

Figure 1 Particulate matter in ambient air of Ujjain city

- **Nitrogen Oxides (NOx):** NOx, a key pollutant from vehicular emissions, was found to be elevated in areas of high diesel vehicle usage, such as the Freeganj and Station Road corridors. The average NOx concentration in the City Center was 58 µg/m³, nearing the NAAQS limit of 80 µg/m³. Residential zones had lower but still significant levels of NOx, averaging 43 µg/m³, while suburban areas recorded the lowest levels at 30 µg/m³. These findings indicate that proximity to major roads and high vehicle density directly influence NOx concentrations, which are known to cause respiratory irritation and contribute to the formation of ground-level ozone.

- **Carbon Monoxide (CO):** CO levels peaked during rush hours in high-traffic zones, with the City Center recording maximum concentrations of 3.1 mg/m³, which remained below the permissible limit of 4 mg/m³. However, prolonged exposure to even moderate CO levels can impair oxygen delivery to the bloodstream, posing a risk to those with pre-existing respiratory and cardiovascular conditions. CO levels in residential areas averaged 2.5 mg/m³, while suburban areas recorded the lowest levels at 1.9 mg/m³.

- **Volatile Organic Compounds (VOCs):** VOCs were detected at elevated levels near high-traffic areas, contributing to ozone formation and smog. While there are no formal NAAQS for VOCs, the gas chromatography analysis revealed that concentrations were notably higher in the City Center, where the mix of diesel and petrol vehicles releases hydrocarbons into the atmosphere. The presence of these compounds contributes not only to respiratory issues but also to long-term risks such as cancer.

3.3 Pollution Hotspots: Spatial Distribution in High-Traffic Zones

The spatial analysis using GIS mapping revealed that the highest concentrations of pollutants were found in high-traffic zones, particularly along the Freeganj-Station Road corridor, which serves as a key commercial and transport hub in Ujjain. This area experienced significant congestion during peak hours, leading to a build-up of NOx, CO, and particulate matter. The Mahakaleshwar Temple vicinity, which attracts both vehicular and pedestrian traffic, was another hotspot, with PM2.5 concentrations often exceeding 100 µg/m³ during peak tourist seasons.

- **Ring Road and Peripheral Areas:** Though pollution levels were lower in suburban areas, the Ring Road and peripheral zones also showed elevated pollutant levels, particularly during the late evening when freight traffic increases. The GIS analysis highlighted the need for targeted interventions in these pollution hotspots, including stricter traffic management, better enforcement of emission standards, and the promotion of greener modes of transport.

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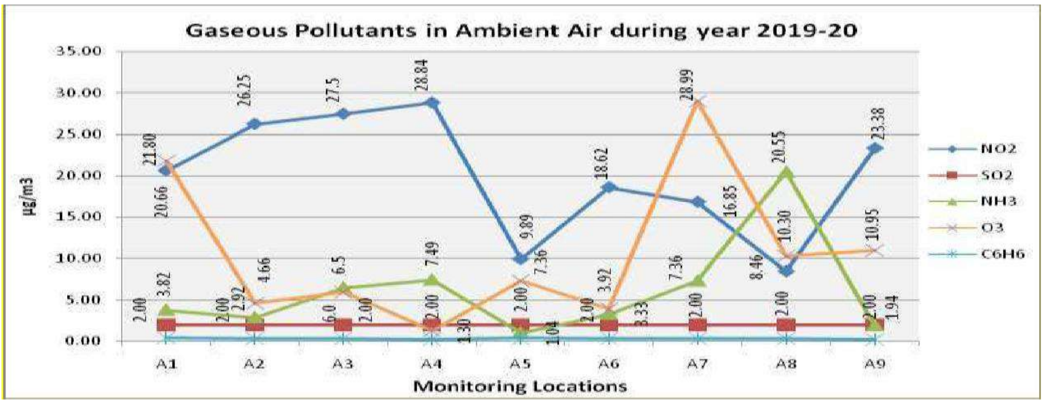

Figure 2 Gaseous pollutants in ambient air of Ujjain City

3.4 Seasonal Variability: Winter vs. Summer Pollution Trends

Winter (November to February): During the winter, Ujjain experiences frequent temperature inversions, a meteorological condition where cooler air is trapped near the ground beneath a layer of warmer air. This prevents the dispersion of pollutants and leads to a build-up of PM2.5 and NOx, particularly in the early morning and late evening. The average PM2.5 concentration during winter was 140 µg/m³, nearly double the levels recorded during summer (80 µg/m³). NOx concentrations also rose sharply, peaking at 72 µg/m³ in the City Center during the coldest months. The persistence of these elevated pollution levels during winter coincides with an observed increase in respiratory illness admissions to hospitals, as discussed in the health data section.

- Summer (March to June): Summer months saw a reduction in pollution levels due to higher temperatures and stronger winds, which helped disperse pollutants more effectively. The average PM2.5 concentration during summer was 80 µg/m³, still above permissible limits but significantly lower than in winter. NOx levels also decreased to an average of 40 µg/m³, while CO concentrations fell to 2.0 mg/m³ in the City Center. These findings confirm that seasonal weather patterns play a crucial role in modulating pollution levels, with residents facing the highest health risks during the winter months.

Respiratory Health Data: Incidence of Airborne Diseases

The analysis of hospital records and community surveys revealed a clear connection between pollution levels and the prevalence of respiratory diseases in Ujjain, particularly in areas exposed to higher vehicular emissions. The health data covers cases related to asthma, bronchitis, chronic obstructive pulmonary disease (COPD), and other respiratory conditions over the past three years (2020-2023).

3.5 Asthma, Bronchitis, and COPD Prevalence in Different Demographics

The hospital records indicated a notable increase in respiratory illness admissions during the winter months, correlating with the periods of peak air pollution.

- Asthma: The prevalence of asthma was particularly high among children (ages 5-14) and elderly individuals (ages 60+). The data indicated a 22% increase in asthma-related hospital visits during the winter compared to summer. This rise in cases can be attributed to the elevated PM2.5 and NOx concentrations during winter, which are known to trigger asthma attacks, especially in vulnerable populations.

- **Bronchitis:** Bronchitis cases were found to be prevalent across all age groups, with a 35% rise in winter admissions. Chronic bronchitis, in particular, was more common among individuals who lived near high-traffic areas or worked outdoors (e.g., street vendors, rickshaw drivers, and traffic police). These individuals were exposed to sustained levels of pollutants, particularly PM10, which can inflame the bronchi and exacerbate respiratory symptoms.

- **Chronic Obstructive Pulmonary Disease (COPD):** COPD cases were concentrated among the elderly (ages 60+), with a 40% increase in hospital admissions during periods of high pollution. The data showed a strong link between long-term exposure to PM10 and NOx and the severity of COPD symptoms. Patients with pre-existing conditions, such as those who smoked or had a history of lung disease, were particularly affected, highlighting the compounding effect of pollution on those with chronic respiratory conditions.

3.6 Correlation Between Pollutant Levels and Respiratory Disease Cases

The statistical analysis revealed a strong positive correlation between pollutant levels (especially PM2.5, PM10, and NOx) and the incidence of respiratory diseases.

- **Asthma and PM2.5:** The Pearson correlation coefficient between PM2.5 concentrations and asthma cases was $r = 0.78$, indicating a strong association. The data showed that asthma admissions peaked on days when PM2.5 levels were highest, particularly during winter mornings when the pollutant concentrations were exacerbated by temperature inversions.

- **Bronchitis and PM10:** The correlation between PM10 and bronchitis cases was also significant, with $r = 0.75$, showing that individuals living in areas with high particulate pollution were more likely to suffer from both acute and chronic bronchitis. Hospital data indicated a surge in admissions following days with high

COPD and NOx: The correlation between NOx levels and COPD cases was strong, with $r = 0.80$, suggesting that diesel vehicle emissions are a major contributing factor to the exacerbation of COPD symptoms in elderly populations. The data further indicated that individuals with prolonged exposure to traffic-related air pollution had more severe COPD symptoms and required longer hospital stays.

4. DISCUSSION

4.1 Interpretation of Results: Link Between Vehicular Emissions and Health Outcomes

The positive correlation between pollutant levels and respiratory illnesses, with correlation coefficients as high as $r = 0.80$ for NOx and COPD, underscores the serious health risks posed by vehicular emissions. The hospital data showing a spike in respiratory disease cases during periods of high pollution, particularly in winter, corroborates these findings. This temporal association between pollution levels and health outcomes is consistent with global research, which demonstrates that exposure to fine particulate matter (PM2.5) and NOx significantly increases the risk of developing or exacerbating respiratory conditions (14).

4.2 The Role of Urbanization and Traffic in Ujjain's Pollution Problem

Urbanization and the rapid increase in vehicular traffic have emerged as significant contributors to Ujjain's air quality degradation. As the city continues to grow economically, it has seen a corresponding rise in vehicular density, particularly in the central business districts and along major transportation corridors (15). The data collected from high-traffic zones such as the Freeganj-Station

4.3 Seasonal Effects and Meteorological Influences on Air Quality

One of the most significant findings of this study is the strong seasonal variability in pollution levels, with winter months showing considerably higher concentrations of pollutants, particularly PM2.5 and NOx. The phenomenon of temperature inversions during winter months plays a crucial role in trapping pollutants close to the ground, leading to an accumulation of harmful particulate matter and gases (16).

4.4 Comparison with Similar Studies in Other Urban Centers

The results of this study are consistent with findings from similar studies conducted in other urban centers in India and globally. In cities like Delhi, Mumbai, and Kolkata, vehicular emissions have been identified as the primary contributors to urban air pollution, with similar pollutants (PM10, PM2.5, NOx, and CO) exceeding safe limits in high-traffic areas.

However, while larger cities like Delhi have extensive air quality monitoring networks and more established public health data, Ujjain presents a different challenge due to its smaller size and less developed infrastructure. The lack of comprehensive monitoring networks in smaller cities like Ujjain has historically led to an underestimation of pollution levels and their health impacts (18). This study addresses this gap by providing localized data that highlight the severe pollution problem faced by mid-sized cities, which often do not receive the same level of attention as larger urban centers.

4.5 Public Health Implications: Vulnerable Populations, Disease Burden, and Long-Term Effects

The public health implications of the findings are significant, particularly for vulnerable populations such as children, the elderly, and individuals with pre-existing respiratory conditions. The strong correlation between vehicular emissions and the incidence of respiratory diseases points to an urgent need for targeted health interventions (19). Children, in particular, are disproportionately affected, as their developing respiratory systems are more susceptible to damage from fine particulate matter and NOx.

4.6 Policy and Infrastructure Gaps Exposed by the Findings

The study exposes significant policy and infrastructure gaps in Ujjain's ability to manage air pollution and mitigate its health impacts. The high levels of pollutants, particularly in high-traffic areas, indicate that current vehicular emission regulations are either insufficient or poorly enforced (20). Additionally, there is a need for policies that promote the adoption of cleaner transportation technologies, such as electric vehicles (EVs) and the expansion of public transportation systems (21).

5. CONCLUSION

This study provides a comprehensive analysis of the impact of vehicular emissions on air quality and respiratory health in Ujjain. The key findings are as follows:

- **Air Quality:** The levels of PM10, PM2.5, and NOx in high-traffic areas of Ujjain, such as the City Center and Freeganj-Station Road corridor, consistently exceeded national ambient air quality standards (NAAQS). The average PM2.5 levels in these areas reached 96 µg/m³, and PM10 concentrations peaked at 158 µg/m³, both well above permissible limits.
- **Seasonal Variability:** Pollution levels were significantly higher in the winter months due to

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temperature inversions that trapped pollutants close to the ground. This led to a notable rise in PM2.5 concentrations during the winter (140 µg/m³) compared to summer (80 µg/m³).

- **Health Outcomes:** There was a strong correlation between increased pollutant levels, particularly PM2.5 and NOx, and the prevalence of respiratory diseases. Hospital data showed a 22% increase in asthma admissions and a 35% rise in bronchitis cases during the winter months, particularly among vulnerable populations such as children and the elderly.

- **Public Perception:** Survey data revealed that 67% of residents living in high-pollution areas reported experiencing respiratory symptoms, yet only 40% of respondents were aware of the specific health risks associated with air pollution. Behavioral adaptations, such as avoiding outdoor activities or using air purifiers, were more common among middle- and upper-income households.

6. REFERENCES

1. Aliyu, A. A., & Amadu, L. (2017). Urbanization, cities, and health: the challenges to Nigeria–a review. Annals of African medicine, 16(4), 149-158.

2. Chanchani, N. (2019). Mountain temples and temple mountains: architecture, religion, and nature in the Central Himalayas. University of Washington Press.

3. Atash, F. (2007). The deterioration of urban environments in developing countries: Mitigating the air pollution crisis in Tehran, Iran. Cities, 24(6), 399-409.

4. Bhandarkar, S. (2013). Vehicular pollution, their effect on human health and mitigation measures. Veh. Eng, 1(2), 33-40.

5. Basith, S., Manavalan, B., Shin, T. H., Park, C. B., Lee, W. S., Kim, J., & Lee, G. (2022). The impact of fine particulate matter 2.5 on the cardiovascular system: a review of the invisible killer. Nanomaterials, 12(15), 2656.

6. Armah, F. A., Yawson, D. O., & Pappoe, A. A. (2010). A systems dynamics approach to explore traffic congestion and air pollution link in the city of Accra, Ghana. Sustainability, 2(1), 252-265

7. Bodor, Z., Bodor, K., Keresztesi, Á., & Szép, R. (2020). Major air pollutants seasonal variation analysis and long-range transport of PM 10 in an urban environment with specific climate condition in Transylvania (Romania). Environmental Science and Pollution Research, 27, 38181-38199.

8. Rickenbacker, H., Brown, F., & Bilec, M. (2019). Creating environmental consciousness in underserved communities: Implementation and outcomes of community-based environmental justice and air pollution research. Sustainable cities and society, 47, 101473.

9. Walsh, M. P. (2014). PM 2.5: global progress in controlling the motor vehicle contribution. Frontiers of Environmental Science & Engineering, 8, 1-17.

10. Gurjar, B. R., Ravindra, K., & Nagpure, A. S. (2016). Air pollution trends over Indian megacities and their local-to-global implications. Atmospheric Environment, 142, 475-495.

11. Manojkumar, N., & Srimuruganandam, B. (2021). Health effects of particulate matter in major Indian cities. International journal of environmental health research, 31(3), 258-270.

12. World Health Organization. (2021). WHO global air quality guidelines: particulate matter (PM2. 5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. World Health Organization.

13. Mahesh, S., Ramadurai, G., & Nagendra, S. S. (2019). Real-world emissions of gaseous pollutants from motorcycles on Indian urban arterials. Transportation Research Part D: Transport and Environment, 76, 72-84.

14. Bălă, G. P., Râjnoveanu, R. M., Tudorache, E., Motișan, R., & Oancea, C. (2021). Air pollution exposure—the (in) visible risk factor for respiratory diseases. Environmental Science and Pollution Research, 28(16), 19615-19628.

15. Pucher, J., Peng, Z. R., Mittal, N., Zhu, Y., & Korattyswaroopam, N. (2007). Urban transport trends and policies in China and India: impacts of rapid economic growth. Transport reviews, 27(4), 379-410.

16. Hassan, M. A., Mehmood, T., Liu, J., Luo, X., Li, X., Tanveer, M., ... & Abid, M. (2023). A review of particulate pollution over Himalaya region: Characteristics and salient factors contributing ambient PM pollution. Atmospheric Environment, 294, 119472.

17. Baklanov, A., Molina, L. T., & Gauss, M. (2016). Megacities, air quality and climate. Atmospheric Environment, 126, 235-249.

18. Roychowdhury, A., & Somvanshi, A. (2020). Breathing Space: How to track and report air pollution under the National Clean Air Programme. Center for Science and Environment. Retrieved from https://www. cseindia. org/content/downloadreports/9923.

19. Guan, W. J., Zheng, X. Y., Chung, K. F., & Zhong, N. S. (2016). Impact of air pollution on the burden of chronic respiratory diseases in China: time for urgent action. The Lancet, 388(10054), 1939-1951.

20. Li, W. W. (2020). Air pollution, air quality, vehicle emissions, and environmental regulations. In Traffic-related air pollution (pp. 23-49). Elsevier.

21. Egbue, O., Long, S., & Samaranayake, V. A. (2017). Mass deployment of sustainable transportation: evaluation of factors that influence electric vehicle adoption. Clean Technologies and Environmental Policy, 19, 1927-1939.