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Assessment of Particulate Matter (PM) Exposure and its Associated Health Hazards Among the Selected Population of Bilaspur: A Survey-Based Study

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ABSTRACT

In today's modern world, due to industrial, automobile exhaust and other causes the Particulate Matter (PM) exposure is the topic of discussion among academicians and researchers which is significantly linked to various diseases that have been causing a decrease in life expectancy around the globe. Industries, power plants, coal mines, vehicular exhausts, road traffic emissions etc. are the major concerns to cause emissions. In the present study two sites (RTS colony & Mangla Chowk) were selected to measure PM concentration via monitoring air quality index with the help of a reliable mobile application, "AQI version 3.6". The objectives of the present survey-based study were to assess the PM concentration in some densely populated areas of Bilaspur and to determine the health issues related with manifestations caused due to PM2.5 and PM10 emissions. The findings of the study revealed that the concentrations of PM10 and PM2.5 were under the permissible exposure limit (PEL). AQI for the Mangla Chowk region was higher compared to the other areas. The effect on the nervous system was found to be the highest compared to the impact on other systems. Males were adversely affected as compared to females in significant aspects of clinical manifestations. This study is particularly based on Bilaspur city. Furthermore, these studies conducted in central India are significantly lower than other regions of India. Therefore, this study tried to bring out the health-related effects observed in the studied population of central India.

Keywords: *Particulate Matter, PM10, PM2.5, Air Pollution, Health Hazards.*

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Introduction

We are all aware with the importance of air, water, and land for the survival of living organisms. Air is necessary for respiration, and it is a mixture of various gases, pollutants, and biological molecules. The concentrations of these gases fluctuate due to natural and artificial means, leading to air pollution. Air pollution refers to the contamination of chemical, physical, and biological factors that alter the natural characteristics of our environment, which is a significant threat to our environment and human health [1]. Toxic chemicals from industries, agricultural waste, automobile emissions, and natural resources are notable sources of air pollution [2].

The concept of particulate matter (PM) or atmospheric particulate matter, which is a combination of liquid droplets and solid particles in the air, has also been discussed in several studies [3] [4] [5] [6]. These particles can come from natural sources such as dust storms, volcanic eruptions, and sea sprays, or human activities such as burning fossil fuels, agricultural waste, and emissions from industrial processes [7]. PM can cause health concerns as it can penetrate the lungs and bloodstream, leading to respiratory problems, allergies, and cardiovascular diseases.

The article also talks about other harmful gases, including sulfur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), and carbon monoxide (CO), which can lead to respiratory infections, lung diseases, and other health issues [8] [9].

The National Air Quality Index (NAQI) was established in 2014 in New Delhi as a part of the Swachh Bharat Abhiyan to measure air quality. It was developed by a technical group formed by the Central Pollution Control Board (CPCB) and IIT Kanpur. The AQI is a quantifiable tool that government agencies use to report air quality daily for public awareness about air pollution [10] [11]. The system converts the measured concentrations into a single number or set of numbers. Real-time data monitoring is available in five Indian cities: New Delhi, Mumbai, Pune, Ahmedabad, and Kolkata [12]. The NAQI has issued a set of 6 AQI categories for differentiating air quality. Research studies conducted across various regions in India, including metropolitan cities and states with heavy industries, have shown high levels of pollution, leading to significant health issues among the exposed population [13]. Industries such as steel plants, thermal power plants, and coal industries have been identified as major contributors to pollution [14]. Toxic particles in the air have been reported in higher concentrations

due to the presence of retail industries. The health issues traced within the population of these areas include gastrointestinal, nervous, cardiovascular, dermal, respiratory, urinary, and reproductive problems [15] [16].

Hence, keeping this in mind, the present study is being conducted to measure the PM Concentration around the densely populated areas of the Bilaspur district, to compare the noted PM Concentration with Permissible Exposure Limit and to correlate the observed PM concentration with health hazards in the studied population [17] [18].

Materials and Methods

The data was collected by "purposive sampling" and "A survey method." A survey method enables the researcher to conveniently collect a massive number of samples in a short duration. "A Mixed Method" was employed for both qualitative and quantitative studies.

Study area

This proposed study targets the industrial areas in and around Bilaspur (RTS Colony & Mangla Chowk), Chhattisgarh, India, which is the central part of the country. The city is preoccupied with diverse thermal and steel plants, rice mills, cement factories, paper mills, etc.

Environmental measurement

This study was conducted in and around the industrial sites of Bilaspur. PM concentration data were collected from a reliable digital application every 6 hours for a 24-hour clock cycle. Data on air quality from the selected four locations in the study area were recorded. The measured concentration was noted down. Data from digital boards installed by the government at the selected locations were also collected. The Average PM concentration (daily, weekly, and monthly) was calculated. A questionnaire-based survey was conducted on the study population to record the related health hazards.

Period of study

The proposed research study was conducted for three months (Pre-monsoon). It includes the monthly period from April to June, 2025.

Data collection

The PM concentration and AQI data were collected using a reliable mobile application "AQI version 3.6" and also the references of the digital boards installed by the government at various locations in the city were obtained. The answers to the framed survey questionnaire were collected from the people residing in different areas of Bilaspur through a survey-based method. Informed consent from all the participants was obtained for conducting the study. The participants were also briefed about the objectives and purpose of the study and their will to quit the study at any point of time. They were given assurance about the confidentiality of their personal information as well as the responses given by them.

Result and Discussion

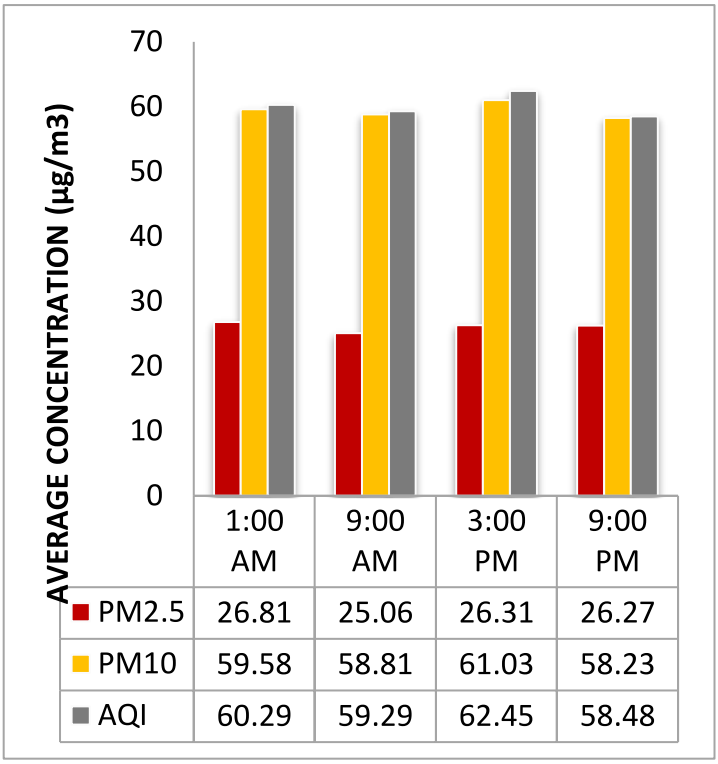

Fig. 1: Time to concentration graph of Mangla Chowk

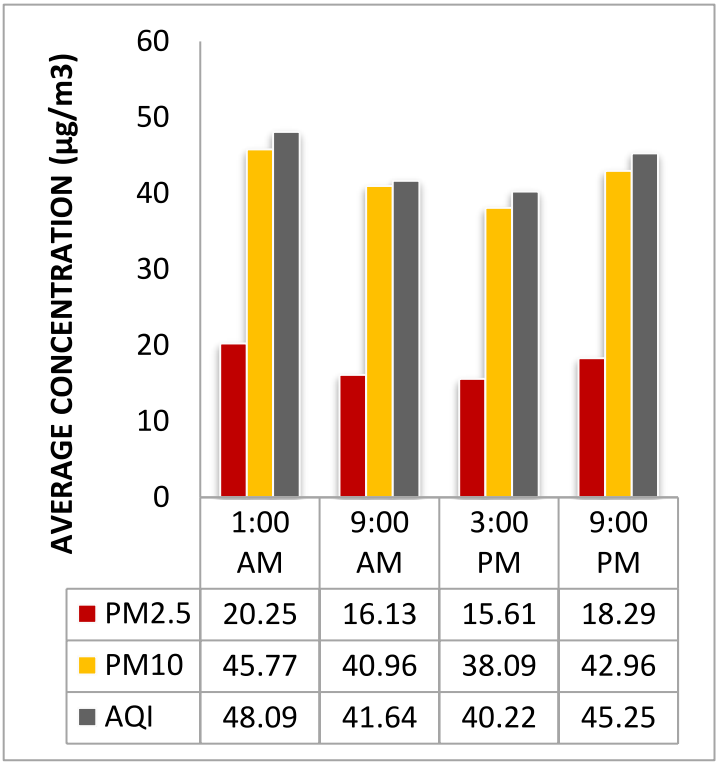

Fig. 2: Time to concentration graph of RTS Colony

Figure 1 implies that the average PM2.5 and PM10 concentrations over time are almost constant in different time intervals of the 24-hour cycle in the Mangala region. The highest average concentration of PM2.5 and PM10 is observed at 1:00 AM for both regions. This might be seen because the data collection was conducted in the rainy season. The moisture content at midnight is already high and more adds up when it rains. Due to this moisture content, the particles float in the atmosphere for longer, and their settling time slows down.

The comparison of figure 1 and figure 2 might be conclusive that RTS Colony is less polluted as compared to Mangala Chowk. Since RTS Colony has enough trees and plantations, therefore, contributes to healthy air quality. Mangala region, on the other hand, is located on the outskirts of Bilaspur city with inadequate tree plantations, which is somewhat responsible for poor air quality.

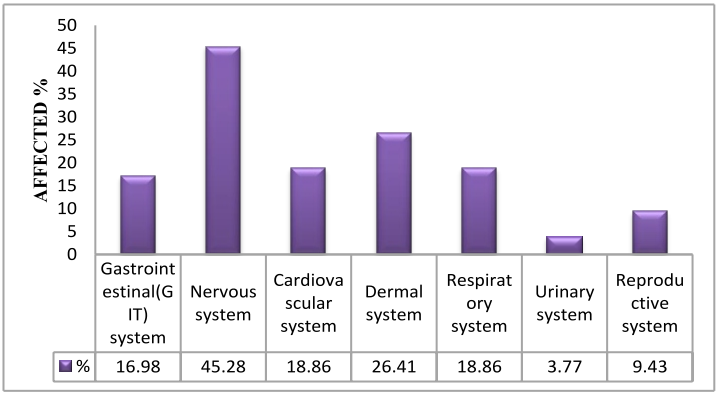

Fig. 3: Graph showing percentage of organs affected due to the exposure of PM 10 & PM 2.5

Figure:3 indicates that the population's highest affected percentage was on the Nervous system, with 45.28% followed by 26.41% suffering from dermal system effects. The cardiovascular and respiratory system effects had an equivalent percentage effect of 18.86%, following 16.98% in the gastrointestinal (GIT) system. Further, a minor contribution to the impact, with 09.43% in the reproductive system, is observed. Only 03.77% contribution to the urinary system was seen from the participating population. The high effect percentage in the nervous system and, to some extent, in the dermal system is not mainly due to PM 2.5 and PM 10 exposures but might be due to other air-related factors. The symptoms of fatigue, irritation, anxiety, depression, headache, insomnia, tremors, motor neuropathy, and peripheral neuropathy were considered in the sample collection survey questionnaire. These symptoms are commonly seen in the population due to other sources of air pollutants [19].

The crucial effects of PM 2.5 and PM 10 exposures in the population are usually detected in the respiratory system. These fine and coarse particles can penetrate the alveolus of the lung and further reach up to the blood vessels, as found in recent research studies [19] [20]. The affected population percentage in the studied subject population is only 18.86%, and it is suggestive that the exposure to PM particles in the studied area does not heavily affect the health and body of the studied population.

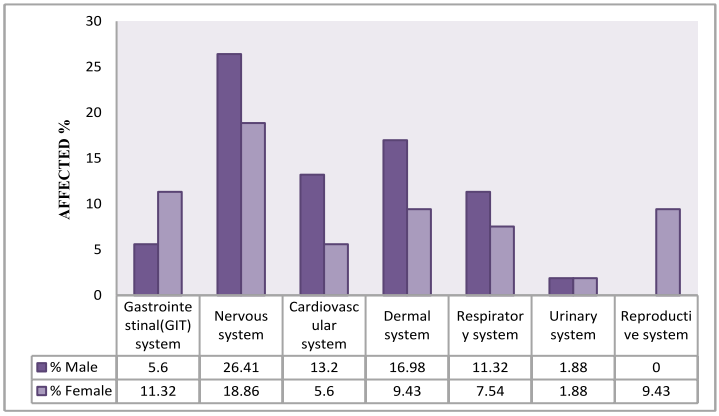

Fig. 4: Graph Showing gender wise percentage of affected organs due to the exposure of Particulate Matter

Figure 4: demonstrates the gender-wise clinical effects on the studied population. The outsized impacts, which might be due to the exposure of PM 2.5 and PM 10 emissions, are mainly seen in the nervous system in males (26.41%) compared to females (18.86%). The effects on various systems followed by dermal system > the cardiovascular system > respiratory system > the gastrointestinal system > urinary system > reproductive system in the same fashion as that observed in the graph above.

These effects, mainly seen in males, might be due to their elevated mobility in the environment. Males are, to some extent, still the dominant factor in society. Since the males are in large numbers in the community, the necessity for them to come out and take up businesses or services for survival is necessary as compared to that of the females. The exposure to the polluted air in maximum time intervals, where the concentration of PM2.5 and PM 10 is high, can be detected. Thus, it is seen heavily in males, and so are the effects on their health and body.

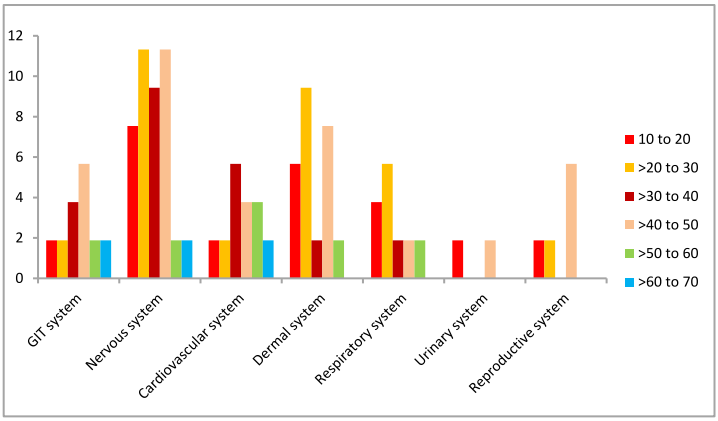

Fig. 5: Graph Showing age wise percentage of affected organs due to the exposure of Particulate Matter

Figure 5: illustrates the age-wise clinical effects on the studied subject population. Since the elevated results were seen in the nervous system, followed by the dermal system, it is suggestive that the effects are not just due to PM2.5 and PM10 exposures. The age group >20 to 30 is the most efficient and hard-working; they can frequently notice the symptoms of headache, depression, anxiety, etc. The >40 to 50 is the age group in which the population is predominantly older adults. They are on the verge of retiring from their services and other occupations. The stress levels can be detected in them, thus leading the symptoms that might affect the nervous system.

The dermal system might be affected in different age groups due to the polluted environment because of the emissions of various gases and other pollutants and not mainly by particulate matter. Both >20 to 30 and >40 to 50 age groups have significantly mobile populations in the vicinity of polluted areas of the city, and thus the probable effects are observed. Since other age groups are less mobile, they notice minor effects.

The respiratory system is also affected, and the age group >20 to 30 is most prone to it. The immunity of the human population in this age group is still developing, and exposure to many foreign particles, such as PM2.5 and PM10 could unfold most of the respiratory symptoms such as cough, chest pain, irritation in the nose, breathlessness, etc. Thus, we can discover the elevated effects. These high effects can produce chronic diseases like asthma, bronchitis, tuberculosis, etc [10].

Conclusion

As a whole, it can be concluded from the study that the concentration of PM2.5 and PM 10 was under the Permissible Exposure Limit (PEL).

AQI for the Mangala region over 24-hour duration was found to be "moderate," and established that the RTS colony was to be "good." The effect on the nervous system was found to be the highest; with an average concentration of 45.28% compared to the impact of other systems, which indicates that particulate matter may not be the only reason for the studied health manifestation. Males were adversely affected compared to females in significant aspects of clinical manifestations. This may be due to the reason that the number of working males is more than females in the studied area.

Future aspect

This study is particularly based on Bilaspur city. Furthermore, these studies conducted in central India are significantly fewer than in other regions of India. Therefore, such types of study should be conducted all over the world to bring out the health-related effects observed in the affected population.

Statements and Declaration

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contribution

All authors contributed to the study conception and design. Material preparation, data mining, and analysis were performed by Sanjida Shabnam, Dr. T. L. Chandra and Dr. Sudhir Yadav. The first draft of the manuscript was written by Sanjida Shabnam and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request at any time.

REFERENCES

1. Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in public health*, *8*, 14. https://doi.org/10.3389/fpubh.2020.00014

2. Bano, Pervez, Chow, Matawle, Watson, Sahu, Srivastava, Tiwari, F. Pervez, Deb. (2018). Coarse particle (PM10–2.5) source profiles for emissions from domestic cooking and industrial process in Central India. *Science of the Total Environment 627 (2018) 1137–1145.* https://doi.org/10.1016/j.scitotenv.2018.01.289

3. Liang, C. S., Duan, F. K., He, K. B., & Ma, Y. L. (2016). Review on recent progress in observations, source identifications and countermeasures of PM2.5. *Environment international*, *86*, 150–170. https://doi.org/10.1016/j.envint.2015.10.016

4. Paciorek, C. J., Liu, Y., & HEI Health Review Committee (2012). Assessment and statistical modeling of the relationship between remotely sensed aerosol optical depth and PM2.5 in the eastern United States. *Research report (Health Effects Institute)*, (167), 5–91.

5. Galindo, N., & Yubero, E. (2017). Day-night variability of water-soluble ions in PM_{10} samples collected at a traffic site in southeastern Spain. *Environmental science and pollution research international*, *24*(1), 805–812. https://doi.org/10.1007/s11356-016-7836-1

6. Li, J., Chen, B., de la Campa, A. M. S., Alastuey, A., Querol, X., & de la Rosa, J. D. (2018). 2005-2014 trends of PM10 source contributions in an industrialized area of southern Spain. *Environmental pollution (Barking, Essex : 1987)*, *236*, 570–579. https://doi.org/10.1016/j.envpol.2018.01.101

7. Gupta, Dhir. (2017). Air quality assessment of Mandi Gobindgarh city of Punjab, India. *Springer Science+Business Media B.V., part of Springer Nature 2017. Environ Dev Sustain.* https://doi.org/10.1007/s10668-017-0065-z

8. Jaiswal, Ramteke, Chakradhari, Patel, Saathoff, Karnae, John. (2020). Distribution, Sources, and Hazards of Ambient Carbonaceous Particulates in Central India. *Journal of Hazardous, Toxic, and Radioactive Waste · July 2019 Researchgate publication.* https://doi.org/10.1061/(ASCE)HZ.2153-5515.0000447

9. Kumar, Raman. (2020). Source Apportionment of Fine Particulate Matter over a National Park in Central India. *Elsevier puublications.* https://www.sciencedirect.com/science/article/pii/S0048969720310226

10. Mahilang, Deb (2019). Seasonal variation and health implications of long-range transported and provincial size distributed aerosols at eastern central India. *J. Indian Chem. Soc., Vol. 97, January 2020, pp. 85-10.* https://www.researchgate.net/publication/339301552

11. Panda, Nagendra. (2018). Chemical and morphological characterization of respirable suspended particulate matter (PM10) and associated heath risk at a critically polluted industrial cluster. *1309-1042/ © 2018 Turkish National Committee for Air Pollution Research and Control. Production and hosting by Elsevier B.V.* Panda, S., Atmospheric Pollution Research (2018), https://doi.org/10.1016/j.apr.2018.01.011

12. Singh, D. Singh, Kumar, Jain. (2021). Study of seasonal variation of PM2.5 concentration associated with meteorological parameters at residential sites in Delhi, India. *Journal of Atmospheric Chemistry* Springer Nature B.V. 2021. https://doi.org/10.1007/s10874-021-09419-8

13. Panwar, Prabhu, Soni, Punetha, Shridhar. (2020). Sources and health risks of atmospheric particulate matter at Bhagwanpur, an industrial site along the Himalayan foothills. *A Springer Nature Journal Publications SN Applied Sciences (2020) 2:632.* https://doi.org/10.1007/s42452-020-2420-1

14. Pervez, Sahu, Tripathi, Bano, Matawle, Tiwari, Deb, F. Pervez. (2020). Assessment and evaluation of ambient PM2.5 in relation to its health effects in mineral-based coal-fired areas. *Original scientific paper GEOFIZIKA VOL. 37 2020.* https://doi.org/10.15233/gfz.2020.37.1

15. Pervez, Verma, Tiwari, Chakrabarty, Watson, Chow, Panicker, Deb, Siddiqui, Pervez. (2018). Household solid fuel burning emission characterization and activity levels in India. *Science of the Total Environment 654 (2019) 493–504.*https://doi.org/10.1016/j.scitotenv.2018.11.019

16. Prabhu, Shridhar, Choudhary. (2019). Investigation of the source, morphology, and trace elements associated with atmospheric PM10 and human health risks due to inhalation of carcinogenic elements at Dehradun, an Indo-Himalayan city. *A Springer Nature Journal Publications SN Applied Sciences(2019) 1:429*. https://doi.org/10.1007/s42452-019-0460-1

17. Rabha, Saikia, Singh, Gupta. (2021). Meteorological Influence and Chemical Compositions of Atmospheric Particulate Matters in an Indian Urban Area. *ACS Earth Space Chem. 2021, 5, 1686−1694.* https://doi.org/10.1021/acsearthspacechem.1c00037

18. Sahu, Pervez, Matawle, Bano, F. Pervez. (2019). Physico-Chemical Characteristics and Sources of Ambient Aerosol in India During 2001-2015: A Review. *Asian Journal of Chemistry; Vol. 31, No. 12 (2019), 2707-2718*. https://doi.org/10.14233/ajchem.2019.22309

19. Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in public health*, *8*, 14. https://doi.org/10.3389/fpubh.2020.00014

20. Shah, Patel. (2021).A comparison between national air quality index, india and composite air quality index for Ahmedabad, India. *Elsevier B.V.Environmental Challenges 5 (2021) 10035.* https://doi.org/10.1016/j.envc.2021.100356