3rd National Conclave On Indoor Environmental Quality

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A COMPENDIUM OF IAQ STUDIES IN AGRA

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PRESIDENTIAL ADDRESS

Agra, a city of immense cultural and historical importance, illustrates the complex interplay between heritage preservation, urban growth, and human health. Ambient monitoring consistently shows PM2.5 and PM10 concentrations in Agra exceeding national standards, especially in busy corridors. Such exposures are linked to elevated risks of respiratory infections, chronic obstructive pulmonary disease, ischemic heart disease, and premature mortality. Indoor environments compound these risks with its own set of sources which are different in terms of their physical, chemical and biological attributes. Studies highlight that household combustion, poor ventilation, and infiltration of outdoor pollutants disproportionately affect vulnerable groups—particularly women, children, and the elderly—leading to higher cumulative exposure. Health risk assessments estimate that over half of adult ischemic heart disease cases in Agra can be attributed to particulate exposure, underscoring the urgency of integrated indoor-outdoor strategies. Local researchers have played a pivotal role in advancing this evidence base. Prof. Ajay Taneja of Dr. B. R. Ambedkar University, Agra, along with collaborators, has conducted seminal work on the chemical characterization of particulate matter, heavy metal content, and associated health risks. His studies near national highways and urban crossings have revealed alarming concentrations of fine particulates and toxic trace elements, providing critical insights into exposure pathways and morbidity burdens. These contributions, alongside those of colleagues such as Dr. Atar Singh Pipal and Dr. Jamson Masih, have shaped both academic discourse and policy awareness in India. Besides many researchers of Agra, studies by IIT Kanpur, CSIR NEERI, IIT Delhi and others have a enriched the knowledge base

Policy interventions have begun to respond which is seen from better ambient air quality in Agra compared to earlier years. The Uttar Pradesh Pollution Control Board has undertaken measures such as stricter vehicular emission norms, promotion of cleaner fuels, and heritage-sensitive air quality management around the Taj Mahal. Enforcement gaps and the absence of comprehensive indoor air quality policies remain significant challenges. The importance of collating these studies lies in their collective power to inform evidence-based policymaking. For India, where millions face daily exposure, such synthesis strengthens the case for integrated interventions—improved monitoring networks, clean energy transitions, and community- level awareness programs. Globally, Agra's lessons resonate with cities across Asia and Africa, where rapid urbanization and fragile ecosystems demand similar holistic responses. Consolidating the breadth of research on indoor and outdoor air pollution in Agra, serves as both a repository and a roadmap. Society for Indoor Environment honors the contributions of local scientists, in the global discourse on air quality, and calls for sustained collaboration between researchers, policymakers, and citizens to safeguard health, heritage, and the environment across India and elsewhere.

Dr. Rakesh Kumar

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Professor Ajay Taneja currently serves as the Vice Chancellor of KMC Language University in Lucknow. Previously, he was a distinguished faculty member in the Department of Chemistry and Pro-Vice-Chancellor at Dr. B. R. Ambedkar University, Agra, India. He possesses over 30 years of experience in his related fields. His comprehensive research focuses on Chemistry, Environmental Science, and Atmospheric Chemistry, with a particular emphasis on the characterization of fine particulate matter in indoor environments and environmental toxicology. His work has explored indoor-outdoor particulate matter associations, health risks of fine particulate exposure in industrial settings, and indoor air quality in various residential and educational environments, emissions from hardcopy devices, and the impact of particle size on aerosol toxicity. He has also contributed significantly to understanding the chemical characterization and health risk assessment of particulate matter and polycyclic aromatic hydrocarbons.

AGRA RESEARCH STUDIES

Study 1: An Investigation of Indoor Air Quality in Rural Residential Houses in India - A Case Study

Authors: Lawrence, A. J.,Taneja, A. J., &Masih,J.

Journal/Publication: Indoor and Built Environment, 2005, 14, 321-329.

Pollutants Measured: CO, NO, NO_2, SO_2, and particulate matter (PM_{10}).

Microenvironments Monitored: Living rooms of rural residential homes in Agra, India.

Instruments/Methods Used: NA.

Key Findings: The study aimed to provide information about the present indoor air quality of rural residential homes in Agra, India, during three months of the rainy season. The average indoor concentration of CO was 1.8+/-0.4 ppm, NO was 0.12+/-0.06 ppm, NO_2 was 0.09+/-0.02 ppm, SO_2 was 0.06+/-0.01 ppm, and PM_{10} was 0.0287 ppm.

Study 2: Indoor/outdoor relationships of carbon monoxide and oxides of nitrogen in domestic homes with roadside, urban and rural locations in a central Indian region

Authors: Lawrence, A. J.,Masih, A.,& Taneja, A.

Journal/Publication: Indoor Air, 2005, 15, 76-82.

Pollutants Measured: Carbon monoxide and oxides of nitrogen (NO and NO_2).

Microenvironments Monitored: Indoor and outdoor environments in 15 domestic homes across rural, urban, and roadside locations in Agra, India. Measurements were conducted in the living rooms.

Instruments/Methods Used: YES-205 multigas monitor during the winter season (October 2002-February 2003). A statistical correlation analysis of indoor concentration levels with outdoor concentrations was carried out.

Key Findings: CO was maximum at roadside locations, with indoor concentrations of 2072.5 +/- 372 ppb and outdoor concentrations of 1220 +/- 281 ppb. Oxides of nitrogen were found maximum at urban site: NO concentration was 385 +/- 211 ppb indoors and 637 +/- 269 ppb outdoors, while NO_2 concentration was 255 +/- 146 ppb indoors and 460 +/- 225 ppb outdoors. The indoor concentrations of both NO_x and CO were found to be below permissible limits, but outdoor NO_x concentrations exceeded Indian standards.

Study 3: Investigation of polycyclic aromatic hydrocarbons in soil at Agra, India - a case study

Authors: Masih,A.,Lawrence, A. J.,Kulshrestha,P.R., & Taneja,A.

Journal/Publication: Journal of Environmental Science & Engineering, 2005, 47, 188-193.

Pollutants Measured: 16 priority Polycyclic Aromatic Hydrocarbons.

Microenvironments Monitored: Roadside soil at St. John's crossing in Agra city, a site exposed to heavy traffic.

Instruments/Methods Used: Samples were extracted with hexane by ultrasonic agitation, fractioned on a silica-gel column, and the aromatic fraction was subjected to HPLC for analysis.

Key Findings: The study investigated PAH concentrations in roadside soil, noting that PAHs are released into the environment from anthropogenic sources like fossil fuel combustion, burning, industrial processes, and motor vehicle exhausts. Specific concentration data and further detailed findings are not explicitly provided in the available excerpts for this reference.

Study 4: Polycyclic aromatic hydrocarbons concentrations and related carcinogenic potencies in soil at a semi-arid region of India

Authors: Masih,A.,& Taneja,A.

Journal/Publication: Chemosphere, 2006, 65, 449-456.

Pollutants Measured: 14 polycyclic aromatic hydrocarbons, including naphthalene, acenaphthene, acenaphthylene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and benzo(ghi)perylene.

Microenvironments Monitored: Surface soil at four locations in Agra, India: industrial, residential, roadside, and agricultural areas.

Instruments/Methods Used: Samples were extracted with hexane by ultrasonic agitation, fractionated on a silica-gel column, and analyzed by HPLC. Factor analysis was used to identify sources.

Key Findings: The average total PAH (t-PAH) concentration was 12.1 ug/g (range 3.1 to 28.5 ug/g), with maximum concentrations found in winter. The t-PAH concentrations were 13.72 ug/g at industrial, 12.98 ug/g at roadside, 9.37 ug/g at residential, and 6.73 ug/g at agricultural sites. Chrysene and benzo(b)fluoranthene were predominant. Factor analysis indicated mixed vehicular and combustion activities as sources.

Study 5: Contamination and exposure profiles of priority Polycyclic Aromatic Hydrocarbons in groundwater in a semi-arid region in India

Authors: Masih, A., Saini, R., & Taneja, A.

Journal/Publication: International Journal of Water, 2008, 4, 136-147.

Pollutants Measured: 13 specific parent polycyclic aromatic hydrocarbons included in the EPA priority pollutant list.

Microenvironments Monitored: Groundwater at 12 locations in Agra, a semi-arid region in India.

Instruments/Methods Used: HPLC.

Key Findings: The mean concentration of total PAHs in groundwater was 31.86 ng/L (ranging from 13.2 ng/L to 64.3 ng/L). 4-ring and 5-ring PAHs were found to be dominant, which accounted for 38.6% and 26.4% of the total PAHs, respectively. The estimated carcinogenic potency was 2.7 ng/L. The study suggests high concentrations are attributed to anthropogenic sources like automobiles, industrial processes, oil refineries, diesel generators, domestic cooking, waste incinerators, and tobacco smoking.

Study 6: Indoor Air Quality of Houses Located in the Urban Environment of Agra, India

Authors: Taneja,A., Saini,R., & Masih, A.

Journal/Publication: Annals of the New York Academy of Sciences, 2008, 1140, 228-245.

Pollutants Measured: NA, but the study focuses on indoor-outdoor air quality relationships.

Microenvironments Monitored: Domestic homes located in an urban environment of Agra, India.

Instruments/Methods Used: Observations of air quality were conducted indoors and outdoors over a 14-month period, from October 2004 to December 2005.

Key Findings: This study explores the indoor-outdoor air quality relationship in Agra, India. Seasonal variations indicated increased indoor pollution levels. Specific pollutants measured and detailed findings are not explicitly provided in the available excerpts for this reference.

Study 7: Chemical characterization of water-soluble aerosols in different residential environments of semi-arid region of India

Authors: Kulshrestha, A.,Bisht, D.S.,Masih, J.,&Taneja,A.

Journal/Publication: Journal of Atmospheric Chemistry, 2009, 62, 121-138.

Pollutants Measured: Water-Soluble Aerosols.

Microenvironments Monitored: Different residential environments of a semi-arid region of India.

Instruments/Methods Used: NA.

Key Findings: This paper focuses on the chemical characterization of water-soluble aerosols in different residential environments of a semi-arid region in India. Specific findings regarding the types or concentrations of water-soluble aerosols were not explicitly provided in the available excerpts for this reference.

Study 8: Characteristics of Polycyclic Aromatic Hydrocarbons in indoor and outdoor atmosphere in the North Central part of India

Authors: Masih,J.,Masih,A., Kulshrestha, A.,Taneja, A.,& Singh,S.

Journal/Publication: Journal of Hazardous Materials, 2010, 177, 190-198.

Pollutants Measured: Polycyclic Aromatic Hydrocarbons in both particulate and gas phases.

Microenvironments Monitored: Indoor and outdoor air of urban residential and roadside homes in a semi-arid region of India.

Instruments/Methods Used: Samples were collected during the winter and summer seasons (Nov 2006-Jun 2007). Principal component analysis was used for source apportionment.

Key Findings: PAH concentrations in both particulate and gas phases were investigated, showing significant seasonal variations with higher levels during winter. PCA identified cooking, smoking, and incense burning as common indoor PAH sources, while outdoor PAHs were mainly generated from petrol and diesel fuel combustion and diesel exhaust from generator sets. The study found that indoor PAH concentrations often exceeded outdoor concentrations when indoor combustion sources were present.

Study 9: Concentrations, sources, and exposure profiles of polycyclic aromatic hydrocarbons in particulate matter in the north-central part of India

Authors: Masih,J.,Taneja,A.,Singh, S.N.,& Kumar,A.

Journal/Publication: Environmental Monitoring and Assessment, 2009, 163, 421-431.

Pollutants Measured: Polycyclic Aromatic Hydrocarbons in particulate matter (PM10).

Microenvironments Monitored: North central part of India.

Instruments/Methods Used: NA.

Key Findings: This study focuses on the concentrations, sources, and exposure profiles of PAHs in PM10 in the north central part of India. Specific concentration data, sources identified, or detailed exposure profiles are not explicitly provided in the available excerpts for this reference.

Study 10: Indoor/outdoor relationship of fine particles less than 2.5 um in residential homes locations in central Indian region

Authors: Massey,D. D.,Masih,J., Kulshrestha, A., Taneja, A.,&Singh,S.

Journal/Publication: Building and Environment, 2009, 44, 2037-2045.

Pollutants Measured: Fine particles less than 2.5 um (PM2.5).

Microenvironments Monitored: Residential homes in central India, specifically at roadside and in rural areas, and in urban areas.

Instruments/Methods Used: NA.

Key Findings: The study determined the indoor/outdoor relationship of fine particles (less than 2.5 um). The average indoor/outdoor (I/O) ratios for PM2.5 were close to or above one in roadside and rural areas, but less than one for urban areas. These I/O ratios were found to be linked to indoor activities.

Study 11: Emission and Formation of Fine Particles from Hardcopy Devices: The Cause of Indoor Air Pollution

Authors: Massey,D. D., &Taneja, A.

Journal/Publication: In Monitoring, Control and Effects of Air Pollution. Intech Open, 2011.

Pollutants Measured: Fine particles.

Microenvironments Monitored: NA, but the focus is on indoor environments.

Instruments/Methods Used: NA.

Key Findings: The chapter discusses the emission and formation of fine particles from hardcopy devices, identifying them as a cause of indoor air pollution. It highlights that exposure to these particles can affect human health.

Study 12: Children's Exposure to Indoor Particulate Matter in Naturally Ventilated Schools in India

Authors: Habil,M.,& Taneja, A.

Journal/Publication: Indoor and Built Environment, 2011, 20, 430-448.

Pollutants Measured: Indoor particulate matter.

Microenvironments Monitored: Naturally ventilated schools in India.

Instruments/Methods Used: NA.

Key Findings: This study investigates children's exposure to indoor particulate matter in naturally ventilated schools in India. Specific findings regarding the levels or impacts of exposure are not detailed in the available excerpts for this reference.

Study 13: Characterization and morphological analysis of airborne PM2.5 and PM10 in Agra located in north central India

Authors: Pipal,A.S., Kulshrestha, A.,&Taneja, A.

Journal/Publication: Atmospheric Environment, 2011, 45, 3621-3630.

Pollutants Measured: Airborne PM2.5 and PM10.

Microenvironments Monitored: Agra, North central India.

Instruments/Methods Used: NA.

Key Findings: This study addresses the characterization and morphological analysis of airborne PM2.5 and PM10 in Agra, located in the north central part of India. Specific findings regarding the analysis are not detailed in the available excerpts for this reference.

Study 14: Measurements of PM10 and PM2.5 aerosols in Agra, a semi-arid region of India

Authors: Satsangi,P. G.,Kulshrestha, A.,Taneja,A., & Rao,P. S.P.

Journal/Publication: Indian Journal of Radio & Space Physics, 2011, 40, 203-210.

Pollutants Measured: PM10 and PM2.5 aerosols.

Microenvironments Monitored: Three locations in Agra: St. John's College, Dayalbagh, and Balkeshwar, representing a semi-arid region of India.

Instruments/Methods Used: PM10 was collected by a respirable dust sampler (APM 460DX), and PM2.5 was collected by a Wins Anderson impactor.

Key Findings: The study aimed to estimate the mass concentrations of PM10 and PM2.5 in Agra, highlighting those detailed studies on these measurements in semi-arid sites of Agra had not been previously reported.

Study 15: Seasonal variation and sources of polycyclic aromatic hydrocarbons in indoor and outdoor air in a semi-arid tract of northern India

Authors: Masih,J.,Singhvi,R.,Kumar,K.,Jain,V.K., & Taneja, A.

Journal/Publication: Aerosol and Air Quality Research, 2012, 12, 515-525.

Pollutants Measured: Polycyclic Aromatic Hydrocarbons in both particulate and gas phases.

Microenvironments Monitored: Indoor and outdoor air of urban residential and roadside homes in a semi-arid region of India.

Instruments/Methods Used: Samples were collected during winter and summer seasons (Nov 2006-Jun 2007). Principal component analysis was used for source apportionment.

Key Findings: Significant seasonal variations of total PAH concentrations were observed, with higher levels during the winter season. PCA revealed that common indoor PAH sources were cooking, smoking, and incense burning. Outdoor PAHs were mainly generated from petrol and diesel combustion fuel and diesel exhaust from generator sets. The study found that indoor PAH concentrations often exceeded outdoor concentrations from certain combustion sources.

Study 16: Indoor air quality scenario in India - An outline of household fuel combustion

Authors: Masih,J.,Singh,S.,Pipal, A.S.,Kulshrestha, A., & Taneja,A.

Journal/Publication: Atmospheric Environment, 2016, 129, 194-203.

Pollutants Measured: Particulate matter (PM10, PM2.5, PM1), and CO/CO2 concentrations.

Microenvironments Monitored: Rural households in Northern India, specifically kitchens and living areas.

Instruments/Methods Used: Intensive real-time indoor air quality monitoring during two cooking sessions of the day. A comparative assessment of traditional cookstoves and improved cookstoves coupled with the characteristics of kitchen was conducted.

Key Findings: This study investigates the impact of indoor air pollution caused by biomass burning in rural households of Northern India. The pollutant concentrations were reported as 24-h and 8-h (cooking hours) averages. The study highlights the impact of inadequate ventilation and traditional cooking methods on indoor air pollution in developing countries.

Study 17: Surface ozone scenario and air quality in the north-central part of India

Authors: Masih,J.,Taneja,A., Singh,S.,&Pipal,A.S.

Journal/Publication: Journal of Environmental Sciences, 2017, 59, 168-176.

Pollutants Measured: Surface ozone (O3), nitrogen dioxide, carbon monoxide.

Microenvironments Monitored: North-central part of India, including a traffic prone roadside environment in Agra.

Instruments/Methods Used: NA, but the research involved measurements of tropospheric pollutants and meteorological parameters.

Key Findings: The study evaluates the surface ozone scenario and air quality. It addresses the presence of tropospheric pollutants including surface ozone, nitrogen dioxide, and carbon monoxide. The research aims to understand the relationship between atmospheric transport, local meteorology, and concentrations of tropospheric air pollutants.

Study 18: Exposure profiles and related carcinogenic potencies of polycyclic aromatic hydrocarbons in aerosols of an urban site in the north central part of India

Authors: Masih,A.,Taneja, A.,&Singhvi,R.

Journal/Publication: ISEE Conference Abstracts, 2013, 3779.

Pollutants Measured: Polycyclic aromatic hydrocarbons in aerosols.

Microenvironments Monitored: An urban site in the north central part of India.

Instruments/Methods Used: NA.

Key Findings: This work reports on the exposure profiles and related carcinogenic potencies of PAHs in aerosols from an urban site in north-central India. The average ratio of low to high carcinogenic PAHs was found to be 1:6, 1:3, and 1:7.6 during summer, winter, and autumn, respectively. Five-ringed PAHs were at higher concentrations in all seasons. Dib(ah)A and B(a)P were the two individual PAHs found in the highest concentration. Toxic equivalency factors for B(a)P and Dib(ah)A were highest.

Study 19: Study of surface morphology, elemental composition and origin of atmospheric aerosols over Agra, India

Authors: Pipal,A.S., Jan,R., Satsangi,P.G., Tiwari,S., &Taneja, A.

Journal/Publication: Aerosol and Air Quality Research, 2014, 14, 1685-1700.

Pollutants Measured: PM2.5 and PM10 particles (soot, tar balls, F-C rich particles, mineral, aluminosilicates, Cl-Na rich particles).

Microenvironments Monitored: Agra (27 degrees 10' N, 78 degrees 02' E), north-central part of India, specifically roadside and semi-rural sites.

Instruments/Methods Used: In situ measurements of PM (PM2.5 and PM10) using a medium volume air sampler (offline) and particle number concentrations by a Grimm aerosol spectrophotometer (online). Morphological and elemental composition analyses were performed using scanning electron microscopy and energy dispersive spectrometry.

Key Findings: The average mass concentrations of PM2.5 and PM10 were 97.2 ug/m3 and 242.6 ug/m3 at roadside and 121.2 ug/m3 and 230.5 ug/m3 at a semi-rural site, respectively, and were substantially higher than NAAQS, WHO, and U.S. EPA standards. The highest concentrations were observed during winter. SEM and EDS analysis indicated the presence of soot, mineral, tar balls, fly ash, aluminosilicates/silica, fluorine-rich, carbon-rich, and Cl-Na rich particles. Air mass backward trajectory cluster analysis indicated aerosol transport from the Middle East and Arabian Sea during summer/monsoon, and from the northern region (due to biomass/coal burning and local activities) during pre-monsoon/winter.

Study 20: Ozone distributions and urban air quality during summer in Agra - a world heritage site

Authors: Saini,R.,Singh,P., Awasthi, B.B., Kumar,K., & Taneja, A.

Journal/Publication: Aerosol and Air Quality Research, 2014, 14, 1890-1898.

Pollutants Measured: Surface O3, NO2, CO, SO2, and PM2.5.

Microenvironments Monitored: Kerbsite of Agra during the summer season of 2012.

Instruments/Methods Used: Rigorous measurements of gaseous materials and particulate matter were carried out. Air mass trajectories were calculated using the HYSPLIT 4 and FLEXTRA models. Principal component analysis and clustering techniques were also applied.

Key Findings: The maximum hourly levels of pollutants exceeded 116.5 ppb (O3), 96.2 ppb, 16 ppb, 4.60 ppm, and 188 ug/m3 (PM2.5). There was an obvious diurnal variation in surface ozone concentration, which followed atmospheric temperature. Statistical analysis showed that O3 formation depends on both ozone precursors and meteorological parameters. Backward trajectories indicated transport from NW and W directions, bringing ozone and precursors potentially from the Arabian Sea, suggesting regional pollution affects Agra.

Study 21: Physicochemical characteristics of PM2.5: Low, middle, and high-income group homes in Agra, India - a case study

Authors: Singh,P.,Saini,R., &Taneja,A.

Journal/Publication: Aerosol and Air Quality Research, 2014, 14, 1445-1455.

Pollutants Measured: PM2.5 mass concentration; chemical and morphological composition of fine particles. Elemental composition included C-O rich, F rich, aluminosilicates/silica, spherical carbon rich particles, nearly spherical fluorine rich particles, and Mg-Si or Mg-Si-Al particles.

Microenvironments Monitored: Indoor environment of low, middle, and high-income group homes in Agra City, north-central region of India.

Instruments/Methods Used: Scanning electron microscopy coupled with energy dispersive x-ray spectrometer for chemical and elemental analysis.

Key Findings: The mean indoor concentrations of PM2.5 were 46.7 ug/m3, 39.2 ug/m3, and 25.6 ug/m3 in low, middle, and high-income group homes respectively. These concentrations were higher during morning and evening hours in all three income groups. SEM-EDS analysis showed PM2.5 composition in low-income homes as C-O rich (54%), F-rich (42%), and other (4%). In middle and high-income homes, F-rich (59-65%), C-O rich (32-37%), and other (3-4%) particles were observed. The study highlighted that indoor emission sources and formation processes, such as cooking and heating, along with infiltration of outdoor pollutants, contribute to indoor air pollution.

Study 22: Concentration of polycyclic aromatic hydrocarbons in air at gasoline filling station

Authors: Agarwal,P., Jan, R.,Masih, J.,&Taneja,A.

Journal/Publication: Indian Journal of Environmental Protection, 2015, 35, 407-415.

Pollutants Measured: 16 polycyclic aromatic hydrocarbons associated with PM10.

Microenvironments Monitored: Air at gasoline service stations (petrol pumps) in Agra.

Instruments/Methods Used: PM10 samples were collected using RDS APM 460 DX, and PAHs were extracted using toluene in an ultrasonic bath and analyzed by gas chromatograph equipped with FID detector.

Key Findings: The average PAH concentration was 19.22 ng/m3. Benzo(a)pyrene was the most abundant PAH, followed by chrysene and dibenzo(a,h)anthracene. The main sources of PAHs in the studied area were identified as gasoline vehicles, followed by diesel vehicles. The calculated mean PAH value was lower than the permissible exposure limit set by OSHA.

Study 23: Prospective health risk of exposure to fine particulate matter and its elemental composition in shoe industries in Agra

Authors: Gupta,M., Saini,R.,&Taneja,A.

Journal/Publication: International Journal on Applied Bioengineering, 2015, 9, 11-22.

Pollutants Measured: Fine particulate matter (PM1, PM2.5, PM10) and 16 major metals.

Microenvironments Monitored: Indoor and outdoor environments in two leather (shoe) small-scale industries (Industry-1 at Galana Road, Sikandra, Agra and Industry-2 at Transport Nagar, Agra).

Instruments/Methods Used: APM 550 for PM collection. Acid digestion followed by ICP-AES and AAS for metal quantification. GRIMM Aerosol Spectrometer (GRIMM 1.109) for mass concentration measurements.

Key Findings: Average indoor PM concentrations were highest in Industry-1 (30.11 ug/m3 for PM1, 47.79 ug/m3 for PM2.5, 90.15 ug/m3 for PM10) compared to Industry-2 (7.66 ug/m3 for PM1, 22.24 ug/m3 for PM2.5, 60.89 ug/m3 for PM10). The study investigated the prospective health risk of exposure to fine particulate matter and its composition at an industry level.

Study 24: Particles in different indoor microenvironments - its implications on occupants

Authors: Masih,J.,Singh,S., Pipal, A.S.,Kumar, S., & Taneja,A.

Journal/Publication: Building and Environment, 2016, 106, 162-171.

Pollutants Measured: Accumulation and ultrafine aerosols.

Microenvironments Monitored: Different socioeconomic micro-environments, specifically indoor spaces.

Instruments/Methods Used: NA. However, the study involved SEM images and elemental analysis.

Key Findings: The study determined the morphology, surface elemental composition, shape descriptors, and mixing state of quasi-accumulation (q-Acc) and quasi-ultrafine (q-UF) aerosol particles emitted from cooking and other indoor emissions. It found that these characteristics varied with distinct indoor micro-environments (high-, middle-, and low-income groups). The size distribution of analyzed particles showed a bimodal distribution.

Study 25: Concentration of particulate and gaseous pollutants near a major national highway in the north central region of India

Authors: Pipal,A.S., Tiwari, S.,Satsangi,P.G.,&Taneja,A.

Journal/Publication: Indian Journal of Environmental Protection, 2010, 30, 1011-1017.

Pollutants Measured: Particulate matter (PM10, PM2.5, and PM1) and associated heavy metals.

Microenvironments Monitored: Near a national highway in semi-urban and urban locations of northern India.

Instruments/Methods Used: Fine particulate dust sampler.

Key Findings: The study aimed to assess the chemical characterization and health risk assessment of particulate matter near a national highway. PM levels in semi-urban areas exceeded NAAQS and WHO standard limits. The study found that PM2.5 concentrations were greater at semi-urban than at urban sites.

Study 26: Toxic and essential metals in placenta and its relation with lipid peroxides/glutathione status in pre-term and full-term deliveries

Authors: Singh,L.,Agarwal, P.,Anand,M.,& Taneja,A.

Journal/Publication: Asian Journal of Medical Sciences, 2016, 7, 34-39.

Pollutants Measured: Metals, malondialdehyde, and glutathione.

Microenvironments Monitored: Placental tissue from pregnant women (30 with gestational age < 37 weeks and 50 with > 37 weeks) residing in Agra city area, northern part of India.

Instruments/Methods Used: NA. However, the study involved analyzing placenta for metal concentrations and oxidative stress markers.

Key Findings: In pre-term cases, levels of MDA and metals were significantly higher, while levels of GSH and some metals were significantly lower compared to full-term cases. Positive correlations of placental metals with MDA suggest that metals might have influenced pre-term deliveries. Elevated levels of placental Cd and Pb induced oxidative stress, potentially implicating them in pre-term deliveries, while higher concentrations of Zn and Cu may be involved in defense against oxidative stress in placental tissue of full-term cases.

Study 27: Correlation of Low Birth Weight of Neonates with Placental Levels of Zinc, Copper, Iron, Lipid Peroxidation and Glutathione

Authors: Singh,L.,Anand,M., Agarwal,P.,&Taneja,A.

Journal/Publication: Advances in Environmental Research, 2017, 6, 317-325.

Pollutants Measured: Placental levels of Zinc, Copper, Iron, Lipid Peroxidation, and Glutathione.

Microenvironments Monitored: Not applicable (study of placental tissue).

Instruments/Methods Used: NA.

Key Findings: This study aimed to correlate low birth weight of neonates with the placental levels of zinc, copper, iron, lipid peroxidation, and glutathione. Specific findings are not detailed in the available excerpts for this reference.

Study 28: Exposure profiles, seasonal variation and health risk assessment of BTEX in indoor air of homes at different microenvironments of a Terai province of northern India

Authors: Masih,J.,Lall, A.S.,Taneja,A., & Singh,N.

Journal/Publication: Chemosphere, 2017, 176, 165-174.

Pollutants Measured: BTEX (benzene, toluene, ethylbenzene, o-, m-, and p-xylene).

Microenvironments Monitored: Indoor air of homes at different microenvironments of a Terai province of northern India.

Instruments/Methods Used: Air samples were collected using low-flow sampling pumps with Tenax (sorbent) and charcoal (sorbent) tubes, and analyzed by gas chromatography equipped with a flame ionization detector. Health risks (cancer risk and hazard quotient) were estimated using USEPA updated methodology.

Key Findings: This study aimed to estimate the health risk for residents due to BTEX exposure, with a focus on seasonal variation. BTEX compounds are known for their mutagenic and carcinogenic characteristics, leading to high health risks.

Study 29: Indoor-outdoor association of particulate matter and bound elemental composition within coarse, quasi-accumulation and quasi-ultrafine ranges in residential areas of northern India

Authors: Rohra,H., Tiwari, R.,Khare, P.,& Taneja,A.

Journal/Publication: Urban Climate, 2018, 25, 80-95.

Pollutants Measured: Particulate Matter within coarse (2.5-10 um), quasi-accumulation (q-Acc) (0.25-2.5 um) and quasi-ultrafine (q-UF) (<0.25 um) ranges, and associated elemental concentrations.

Microenvironments Monitored: Indoors and outdoors of residential homes in Agra.

Instruments/Methods Used: Sioutas Cascade Impactor for sample collection, and ICP-OES for metal analysis. Pearson correlation and linear regression were used for statistical analysis.

Key Findings: Average mass concentrations of PM10 and PM2.5 indoors were 263.24+/-59.24 and 212.01+/-38.06 ug/m3, respectively, while outdoors they were 194.28+/-15.25 and 152.88+/-16.31 ug/m3, exceeding WHO standards. A high proportion of PM and elemental concentrations were found within q-Acc and q-UF modes. Significant elemental shifts towards finer sizes were observed in homes near busy roads, exposing residents to adverse health effects through penetration into indoor environments.

Study 30: Size partitioned particulate matter with potential sources and threats of total and bioavailable metals inside varied residences of Northern India

Authors: Taneja, A.

Journal/Publication: Journal of Environmental & Analytical Toxicology, 2015, 08.

Pollutants Measured: Trace element concentration in fine particulate matter (PM2.5) and their bioavailability.

Microenvironments Monitored: Different microenvironments in Agra, India, including urban, rural, and roadside residences.

Instruments/Methods Used: NA.

Key Findings: This study aimed to examine the elemental bioavailability in fine particulate matter across different residential microenvironments. The study highlights the need for monitoring exposure to airborne particulate matter due to the deposition of millions of particles in the lung.

Study 31: Mass and Number and Their Chemical Composition Distribution of Particulate Matter in Different Microenvironments

Authors: Habil,M.,Massey,D. D.,&Taneja, A.

Journal/Publication: In Indoor Environment and Health. Intech Open, 2019.

Pollutants Measured: PM2.5, including elemental composition.

Microenvironments Monitored: Different indoor environments, including homes, schools, and offices in an urban environment.

Instruments/Methods Used: Personal environment monitors and a medium volume sampler APM 550 for PM2.5 concentration measurements. A GRIMM aerosol spectrometer (model: 1.109) and a Handy sampler APM 821 were also used. Questionnaire data were used to understand health hazards linked to activity patterns.

Key Findings: The study investigated daily exposure characteristics to PM2.5 and summarized the elemental characterization, correlation analysis, and health risks associated with fine particulate PM2.5 generated during different activities. Annual average PM2.5 concentrations were found to be much higher than National Ambient Air Quality Standards and WHO standards for personal and ambient monitoring in homes, schools, and offices. The health hazards experienced by occupants were linked to various activity patterns, posing a greater risk in different indoor environments compared to outdoor environments.

Study 32: Particulate and trace metal emissions from mosquito coil and cigarette burning in environmental chamber

Authors: Khandelwal, N., Tiwari, R.,Saini, R.,&Taneja,A.

Journal/Publication: SN Applied Sciences, 2019, 1.

Pollutants Measured: Particulate matter (PM0.25, PM1.0, PM2.5, and PM10) and heavy metals.

Microenvironments Monitored: Closed environmental chamber.

Instruments/Methods Used: ICP-AES for heavy metal quantification, and scanning electron microscopy for morphological analysis.

Key Findings: The study characterized emissions of indoor air pollutants from the burning of mosquito coils and cigarettes. PM and heavy metal emissions from different types of mosquito coils and cigarettes, popular in the Indian market, were quantified. The concentration trend for PM in mosquito coils was M1 > M3 > M2 > M4 > M5, and in cigarettes, it was C5 > C2 > C4 > C3 > C1.

Study 33: Chemical characterization of sub-micron particles in indoor and outdoor air at two microenvironments in western India

Authors: Masih,J.,Nair, A.,Gautam,S.,Kumar, S.,Singh,S.,&Taneja,A.

Journal/Publication: SN Applied Sciences, 2019, 1.

Pollutants Measured: Sub-micron particles.

Microenvironments Monitored: Indoor and outdoor air at two different microenvironments in the western part of India.

Instruments/Methods Used: Not explicitly detailed in the available excerpts for this study. However, the study focuses on chemical characterization, suggesting analytical techniques were used.

Key Findings: The study aimed to chemically characterize sub-micron particles in indoor and outdoor air, noting that indoor environments, especially during domestic activities, tend to have higher concentrations of particulate matter than outdoor environments.

Study 34: Atmospheric concentration of trace metals in PM2.5 and their bioavailability in different areas of Gwalior region

Authors: Varshney, P., Bansal,R.,Tiwari, R.,Halve, A.K., & Taneja,A.

Journal/Publication: SSRG International Journal of Applied Chemistry, 2019, 6, 41-49.

Pollutants Measured: PM2.5 and metal concentrations (e.g., Chromium, Lead).

Microenvironments Monitored: Different urban and rural areas of Gwalior, India.

Instruments/Methods Used: Fine particulate sampler for PM2.5 collection on PTFE filter paper. Atomic absorption spectroscopy for metal characterization.

Key Findings: The average mass concentration of PM2.5 was 63.02+/-27.71 ug/m3 in urban areas and 73.07+/-32.17 ug/m3 in rural areas. Toxic metals were primarily present in bioavailable fractions, with estimated bioavailable fractions of chromium and lead showing incremental cancer risk, indicating a potential impact on residents. Metal concentrations were generally higher in urban sites, except for Cu and Na which were higher at rural sites.

Study 35: Maternal exposure to polycyclic aromatic hydrocarbons exposure and its impact on anthropometric measures of neonates

Authors: Agarwal,P., Anand,M.,& Taneja,A.

Journal/Publication: Environmental Epidemiology, 2019, 3.

Pollutants Measured: Polycyclic Aromatic Hydrocarbons.

Microenvironments Monitored: Pregnant women in Shiraz, Iran.

Instruments/Methods Used: Biomonitoring approach, using gas chromatography-mass spectrometry after blood serum separation and liquid-liquid extraction to measure PAHs in maternal serum. Information on anthropometric indices and neonatal TSH levels was obtained from medical records and questionnaires.

Key Findings: The mean PAH concentrations ranged from 0.29 to 327.91 ng/g lipid. The study found a significant correlation between exposure to passive smoke and total PAH concentrations. There was no significant relationship between exposure to PAHs and the weight, height, head circumference, and Apgar score of newborns. However, neonatal TSH levels decreased with increasing acenaphthylene exposure.

Study 36: Influence of Microenvironments and Personal Activities on Personal PM2.5 Exposures among Children and Adults

Authors: Habil,M.,Massey, D.D., & Taneja,A.

Journal/Publication: In Air Quality. Intech Open, 2020.

Pollutants Measured: PM2.5.

Microenvironments Monitored: Different indoor environments (homes, schools, offices) in an urban setting.

Instruments/Methods Used: Personal environment monitors and a medium volume sampler APM 550 for PM2.5 concentration. The study also utilized questionnaire data.

Key Findings: The study aimed to investigate daily exposure characteristics to PM2.5 and understand the influence of different microenvironments and personal activities on PM2.5 exposures among children and adults. Personal and ambient monitoring showed PM2.5 concentrations to be many times higher than National Ambient Air Quality and WHO standards. Health hazards experienced by occupants were linked to activity patterns, indicating greater risk indoors compared to outdoors.

Study 37: Atmospheric polychlorinated biphenyls in a non-metropolitan city in northern India: Levels, seasonality and sources

Authors: Prithiviraj,B., Taneja,A.,& Chakraborty,P.

Journal/Publication: Chemosphere, 2021, 263, 127700.

Pollutants Measured: Atmospheric polychlorinated biphenyls (specifically Sum-25-PCBs and PCB-52).

Microenvironments Monitored: 14 locations across urban, suburban, and rural transects in Agra, a non-metropolitan city of northern India, and one background site.

Instruments/Methods Used: Polyurethane foam-based passive air samplers were deployed during summer and winter of 2017. K-means cluster and principal component analysis were used for source identification.

Key Findings: The range of Sum-25-PCBs varied between 25-1433 pg/m3 in summer and 26-205 pg/m3 in winter. Mean Sum-25-PCBs concentrations showed an urban > suburban > rural trend in summer, while a rural > urban > suburban trend was observed in winter. PCB-52 was the dominant congener. Four major source types were identified using statistical analysis.

Study 38: Health Risk Assessment and Management of Air Pollutants

Authors: Pipal,A.S., Dubey,S.,&Taneja,A.

Journal/Publication: In Air Pollution and Environmental Health, 2020.

Pollutants Measured: Air pollutants.

Microenvironments Monitored: NA.

Instruments/Methods Used: NA.

Key Findings: The chapter focuses on the health risk assessment and management of air pollutants, highlighting that air pollution is a global public health concern often addressed by collective societal action to control emissions.

Study 39: Particle size dynamics and risk implication of atmospheric aerosols in South-Asian subcontinent

Authors: Rohra,H., Pipal,A.S.,Tiwari,R., Saini, R.,Massey,D.D.,&Taneja,A.

Journal/Publication: Chemosphere, 2020, 249, 126140.

Pollutants Measured: Size-resolved atmospheric aerosols.

Microenvironments Monitored: Indoor-outdoor residential microenvironments in the South-Asian subcontinent.

Instruments/Methods Used: Cascade impactor set at the breathing zone.

Key Findings: The study presented size-resolved aerosol measurements and investigated the particle size dynamics and risk implication of atmospheric aerosols. It contributed to understanding the health impacts associated with different aerosol particle sizes in the South-Asian subcontinent.

Study 40: A study of horizontal distribution pattern of particulate and gaseous pollutants based on ambient monitoring near a busy highway

Authors: Tiwari,R., Saini, R.,Taneja,A.,et al.

Journal/Publication: Not explicitly provided in the available excerpts, likely a conference proceeding or similar publication, 2020.

Pollutants Measured: Coarse and fine particulate matter (PM_{10}, $PM_{2.5}$, $PM_{1.0}$) and gaseous pollutants (NO_2, SO_2, O_3, NH_3).

Microenvironments Monitored: Communities situated near a busy highway in Agra.

Instruments/Methods Used: Ambient monitoring.

Key Findings: The study investigated the horizontal distribution pattern of pollutants near a busy highway. It found that the maximum decreases of NO_2, SO_2, O_3, NH_3, PM_{10}, $PM_{2.5}$, $PM_{1.0}$ concentrations occurred within 250m of the highway from the highway. Annual average concentrations for PM_{10} and $PM_{2.5}$ were much higher than National Ambient Air Quality Standards and World Health Organization standards, while gaseous pollutants were generally within permissible limits. Significant seasonal variations were observed, with maximum concentrations in winter.

Study 41: Assessing effectiveness of air purifiers for controlling indoor particulate pollution

Authors: Dubey,S., Rohra,H., & Taneja,A.

Journal/Publication: Heliyon, 2021, 7, e07976.

Pollutants Measured: Indoor Particulate Matter (PM2.5, PM10).

Microenvironments Monitored: Four residential homes (low, middle, and high socioeconomic status homes in urban residential areas, and a rural home) in Agra, India.

Instruments/Methods Used: Indoor air quality measurements in residential homes equipped with HEPA air purifiers, comparing different operational settings and room sizes. Calculation of percentage reduction in PM concentrations, air changes per hour, and particle deposition rate.

Key Findings: The study found that HEPA air purifiers effectively reduced indoor PM concentrations. An average reduction of 64% and 74% in PM2.5 and PM10, respectively, was observed in residential homes. The effectiveness varied with room size and air purifier operational settings, with higher settings demonstrating greater reduction. Air purifiers generated 0.6-4.8 ACH, and the particle deposition rate increased from 0.05 to 0.16 per hour due to their use. The study concluded that air purifiers are effective in improving indoor air quality.

Study 42: The incorporation of lemongrass oil into chitosan-nanocellulose composite for bioaerosol reduction in indoor air

Authors: Mishra,D., Yadav,R.,Singh,R.P., Tripathi, A., Saini,R.,Tiwari,R.,&Taneja,A.

Journal/Publication: Environmental Pollution, 2021, 285, 117407.

Pollutants Measured: Bioaerosols.

Microenvironments Monitored: Indoor air.

Instruments/Methods Used: Development of a lemongrass oil-chitosan-nanocellulose composite. Testing of the composite for bioaerosol reduction.

Key Findings: This study focuses on the significant reduction of culturable bacteria in aerosols (from 6.23 log CFU/m3 to 2.33 log CFU/m3) when a cellulose-based material is present. The research explores the use of natural essential oils, like lemongrass, to enhance indoor air quality by leveraging their antibacterial properties, and suggests that nanocellulose and chitosan can serve as supports for incorporating such essential oils in active packaging and air purification systems.

Study 43: Particle size distribution, morphometric study and mixing structure of accumulation and ultrafine aerosols emitted from indoor activities in different socioeconomic microenvironments

Authors: Pipal,A.S., Rohra,H.,Tiwari,R., & Taneja, A.

Journal/Publication: Atmospheric Pollution Research, 2021, 12, 101060.

Pollutants Measured: Quasi-accumulation (q-Acc) (0.25-2.5 um) and quasi-ultrafine (q-UF) (<0.25 um) aerosol particles.

Microenvironments Monitored: Indoor environments of high, middle, and low-income group residences in Agra, India.

Instruments/Methods Used: Collection of particles during cooking and other indoor activities. Analysis using Scanning Electron Microscopy for morphology, surface elemental composition, and mixing state.

Key Findings: The study analyzed the characteristics of aerosol particles emitted from indoor activities, finding that the morphology, elemental composition, and mixing state varied between different socioeconomic microenvironments. Distinct features, such as soot particles and spherical particles, were observed, indicating different sources and formation processes related to cooking, heating, and other household activities.

Study 44: Geographical Distribution and Transport of Atmospheric Particulate Matter

Authors: Pipal,A.S., Dubey,S., Singh,S., Tripathi, T.,Massey,D.D.,&Taneja,A.

Journal/Publication: In Airborne Particulate Matter, 2020.

Pollutants Measured: Atmospheric particulate matter.

Microenvironments Monitored: NA. However, the chapter focuses on geographical distribution and transport.

Instruments/Methods Used: NA.

Key Findings: This book chapter discusses airborne particulate matter as a pollutant of concern due to its adverse effects on human health and its ability to reduce visibility and soil buildings and materials. It highlights that PM comprises a wide range of particle sizes and diverse chemical compositions. Historically, PM was largely from coal burning, but in developed countries, it became dominated by carbonaceous particles from road traffic exhaust and secondary pollutants. The chapter explores how PM is distributed across regions and the mechanisms by which it travels through the atmosphere.

Study 45: Physicochemical Profile of Granulometric PM Spectrum of Urban Agglomerates - Size Dynamics, Source Apportionment and Risk Analysis

Authors: Rohra,H., Kale,A., Nehul,S., Saini, R.,Massey,D.D.,Tiwari,R.,...&Taneja,A.

Journal/Publication: SSRN Electronic Journal, 2020.

Pollutants Measured: Granulometric PM spectrum.

Microenvironments Monitored: Urban agglomerates and traffic junctions in Agra, India.

Instruments/Methods Used: Grimm portable aerosol spectrometer for size-segregated PM samples.

Key Findings: This paper investigates the physicochemical profile of particulate matter across different size ranges in urban areas, with a focus on size dynamics, source apportionment, and risk analysis. PM concentrations at urban traffic junctions were significantly higher than WHO and NAAQS limits. High concentrations of PM, particularly in quasi-accumulation and quasi-ultrafine ranges, expose residents to adverse health effects through their penetration into indoor environments.

Study 46: Measurements of indoor air quality: Science and applications

Authors: Pipal,A.S., & Taneja, A.

Journal/Publication: In D. K. Aswal et al., Handbook of metrology and applications. Springer, 2023.

Pollutants Measured: NA, but the chapter covers various aspects of indoor air quality.

Microenvironments Monitored: Indoor environments generally.

Instruments/Methods Used: NA, but it addresses measurement techniques in indoor air quality.

Key Findings: This book chapter provides an overview of the science and applications related to measuring indoor air quality. It likely discusses methods, challenges, and the importance of accurate measurements for understanding and managing indoor air pollution.

Study 47: Levels of particulate matter, black carbon, and toxic gases in Taj city Agra and their health implications on human beings

Authors: Rajouriya, K., Dubey, S.,Singh, S.P.,Tripathi,T.,John,R.,&Taneja,A.

Journal/Publication: Pollution, 2023, 9, 1208-1224.

Pollutants Measured: Particulate matter (PM2.5, PM10), Black Carbon, and toxic gases (O_3, NO_2).

Microenvironments Monitored: Taj city Agra, India, in residential areas.

Instruments/Methods Used: NA, but the study involved monitoring of air pollutants.

Key Findings: The study reveals that PM2.5, PM10, and Black Carbon levels in residential areas of Agra exceeded the National Ambient Air Quality Standards and World Health Organization guidelines, indicating potential health risks. The research provides insights into the air quality status of the region and its implications for human health.

Study 47b: Chemical fraction and health effect of size-segregated PM at national highway of northern India

Authors: Tiwari,R., Botle,A.,Singh, P. P.,&Taneja,A.

Journal/Publication: Pollution, 2023, 9, 1895-1913.

Pollutants Measured: Size-segregated particulate matter, and its chemical composition including toxic and essential metals (e.g., Fe, Cu, Zn, Mn, Cr, Ni, Pb, Cd).

Microenvironments Monitored: Residential sites near a national highway in northern India.

Instruments/Methods Used: NA, but likely involved techniques for size-segregated PM collection and chemical analysis.

Key Findings: The study assessed the chemical composition and health effects of size-segregated particulate matter near a national highway in northern India. It found that the concentrations of most metals in PM were within the limits of NAAQS, but some toxic metals like lead, chromium, and nickel showed higher concentrations, posing potential health risks to residents. The study emphasized that such exposure could lead to respiratory and cardiovascular problems.

Study 48: Chemical Characterization and Health Risk Assessment of Particulate Matter Near National Highway at Urban and Semi-urban Locations of Northern India

Authors: Shikha,Rajouriya,K.,Pipal, A.S., &Taneja,A.

Journal/Publication: Aerosol Science and Engineering, 7(4), 517-533.

Pollutants Measured: Particulate matter; chemical characterization was performed.

Microenvironments Monitored: Near national highways at urban and semi-urban locations of Northern India.

Instruments/Methods Used: Chemical analysis techniques (specific instruments not detailed in this summary).

Key Findings: The study focused on the chemical characterization and health risk assessment of particulate matter found near national highways in urban and semi-urban Northern India, finding that some toxic metals like chromium and nickel exceeded safe limits, posing potential health risks.

Study 49: Physicochemical characteristics of atmospheric particles in south-western region of India: Elemental size distribution, source analysis, and risk assessment

Authors: Rohra,H., Kale,A.,Nehul,S.,Pipal,A.S.,& Taneja, A.

Journal/Publication: Atmospheric Pollution Research, 14(12), 101938.

Pollutants Measured: Size-resolved particulate matter and bound elemental species; chemical characteristics were analyzed.

Microenvironments Monitored: Urban dwelling of south western region of India (Pune).

Instruments/Methods Used: Intensive measurement campaign during winter of 2021.

Key Findings: The average mass concentrations of PM10, PM4, PM2.5, and PM1 were significantly high. Diurnal variability indicated high concentrations during night and early morning due to heavy-duty vehicles. Bimodal distributions of PM mass concentrations in the coarse fraction were noted, and elemental accumulation was higher in fine particles. Principal Component Analysis suggested crustal origin, resuspended road dust, vehicular traffic, and industrial emissions as major sources.

Study 50: Age-specific lobar and regional deposition of size-segregated particulate matter in a glass city of India and its health impact

Authors: Rajouriya, K., & Taneja, A.

Journal/Publication: Air Quality, Atmosphere and Health, 16, 2163-2176.

Pollutants Measured: Size-segregated particulate matter.

Microenvironments Monitored: A glass city of India (likely Firozabad).

Instruments/Methods Used: Deposition modeling and health impact assessment.

Key Findings: Children aged 3 to 9 years showed the highest deposition and were most affected by lung diseases in both urban and rural sampling sites. The hazard quotient for PM10 exceeded safe limits for children in urban (3.83) and rural (2.971) areas, indicating non-carcinogenic risk. The excess lifetime cancer risk for PM2.5 also exceeded the safe limit for both adults and children, inferring a greater carcinogenic risk.

Study 51: A review on sequential extraction of metals bound particulate matter and their health risk assessment

Authors: Rajouriya, K., Pipal, A. S.,&Taneja, A.

Journal/Publication: Journal of Atmospheric Chemistry, 81(1), 7.

Pollutants Measured: Metals bound to particulate matter.

Microenvironments Monitored: Not specified (review paper).

Instruments/Methods Used: Sequential Extraction Procedure (review of techniques).

Key Findings: This paper reviews sequential extraction techniques for metals bound to particulate matter and their subsequent health risk assessment, focusing on the mobility and chemical nature of metals.

Study 52: Morphology, aspect ratio, and surface elemental composition of primary aerosol particles at urban region of India

Authors: Pipal,A.S., Kaur,P.,Singh, S.P., Rohra,H.,& Taneja,A.

Journal/Publication: Environmental Science and Pollution Research, 31(35), 47946-47959.

Pollutants Measured: Primary aerosol particles (morphology, aspect ratio, surface elemental composition).

Microenvironments Monitored: Urban region of India.

Instruments/Methods Used: Analytical techniques for morphological and elemental analysis.

Key Findings: This study investigates the morphology, aspect ratio, and surface elemental composition of primary aerosol particles in an urban region of India. PM2.5 and PM10 showed significant daily variability, with soot aggregates, aluminosilicates, and brochosomes particles were classified based on their characteristics. A higher aspect ratio was noted at traffic sites compared to industrial sites.

Study 54: Seasonal variation in metals concentration associated with settled dust and their risk assessment in school children of Agra

Authors: Dubey,S., John,R.,Singh, M.,Khare, P., &Taneja,A.

Journal/Publication: Environmental Advances, 15, 100480.

Pollutants Measured: Metals in settled dust.

Microenvironments Monitored: Schools in Agra.

Instruments/Methods Used: Dust samples digested in aqua regia and analyzed for metal concentrations by ICP-AES. Geo-accumulation, pollution, integrated pollution, and pollution load indexes were used to determine metal contamination. PCA and Cluster Analysis were used for source identification, and USEPA health risk assessment models were utilized for children's health risks.

Key Findings: The study, conducted from December 2021 to November 2022, aimed to examine seasonal variations in metal concentrations in school dust and associated health risks for children in Agra.

Study 55: Breathing like a smoker: Estimating relative risk of PM2.5, BC, and NO2 exposure in semi-urban India for better public perception

Authors: Shikha, & Taneja, A.

Journal/Publication: Atmospheric Environment, 362, 121547.

Pollutants Measured: PM2.5, BC, NO2.

Microenvironments Monitored: Semi-urban India (e.g., Tundla area).

Instruments/Methods Used: Annual monitoring and comparison to passive cigarette smoke equivalents.

Key Findings: This paper focuses on estimating the relative risk of PM2.5, BC, and NO2 exposure in semi-urban India to improve public perception, by comparing it to breathing like a smoker. High exposure from co-located sources like highways and traffic led to significant health burdens (e.g., cardiovascular mortality, lung cancer), with post-monsoon peaks and an emphasis on vulnerable groups.

Study 56: Exposure Assessment of Size Segregated PM and Associated Respirable Deposition Dose in Residential Sites Near National Highway in Northern India

Authors: Shikha,Kumar,V., Singh, A.,& Taneja,A.

Journal/Publication: Water, Air, and Soil Pollution.

Pollutants Measured: Size-segregated particulate matter.

Microenvironments Monitored: Residential sites near a national highway in Northern India.

Instruments/Methods Used: Size-segregated PM samples collected using a Grimm portable monitor.

Key Findings: The study assessed the influence of PM pollution on residents living near a national highway. It found that 12-hour monthly averages of PM10, PM2.5, and PM1 varied significantly and exceeded NAAQS and WHO standard limits. High levels of coarse PM were attributed to road dust resuspension, while fine particles were linked to automobile exhaust.

Study 57: Cigarettes as a source of heavy metal toxicity: evaluating human health risks

Authors: Sandal,S., Verghese, P. S., Taneja,A.,Massey,D.D.,&Habil,M.

Journal/Publication: Discover Public Health.

Pollutants Measured: Heavy metals.

Microenvironments Monitored: Focus on cigarette smoke as a source.

Instruments/Methods Used: Not detailed.

Key Findings: This paper evaluates the human health risks associated with heavy metal toxicity originating from cigarettes. It notes that tobacco contains a complex mixture of chemicals, including heavy metals like lead and arsenic, and many are considered harmful, with some being carcinogenic or mutagenic.

Study 58: Variability of Fine Particulate Matter and its Oxidative Potential at Different Locations in the Northern Part of India

Authors: Tripathi,T., Kale,A., Anand, M., Satsangi,P.G.,&Taneja,A.

Journal/Publication: Aerosol Science and Engineering.

Pollutants Measured: Fine Particulate Matter and its oxidative potential.

Microenvironments Monitored: Different locations in the Northern part of India.

Instruments/Methods Used: Not detailed.

Key Findings: This study investigates the variability of fine particulate matter and its oxidative potential across various locations in Northern India.

Study 59: Health risk assessment and morphometric study of metal bounded ultrafine aerosol in Indo-Gangetic plain, India

Authors: Tiwari,R., Rajouriya, K.,Saini,R., Singh,P.P., &Taneja,A.

Journal/Publication: Journal of Atmospheric Chemistry, 82.

Pollutants Measured: Metal-bound ultrafine aerosol.

Microenvironments Monitored: Indo-Gangetic Plain, India.

Instruments/Methods Used: Morphometric study techniques.

Key Findings: This paper conducts a health risk assessment and morphometric study of metal-bounded ultrafine aerosols in the Indo-Gangetic Plain. The study examined size-segregated PM concentration trends and performed risk assessment and disease estimation.

Study 60: Estimation of human airway deposition of size-segregated particulate matter and its health impact in monsoon and post-monsoon season in semi-urban area of northern India

Authors: Shikha,and Taneja,A.

Journal/Publication: Atmospheric Pollution Research, 16, 102343.

Pollutants Measured: Size-segregated particulate matter, black carbon.

Microenvironments Monitored: Semi-urban area of Northern India.

Instruments/Methods Used: Real-time monitoring of PM and BC. The Multiple Path Dosimetry Model was used to estimate particle deposition in the human respiratory tract.

Key Findings: This research estimates the deposition of size-segregated particulate matter in human airways and its health impact during the monsoon and post-monsoon seasons. Fine PM had the highest deposition in the tracheobronchial and pulmonary regions, and children (3-9 years) were the most affected group by pulmonary problems. The health risks of PM and BC exceeded safe limits, suggesting prolonged inhalation exposure could lead to cancer.

Study 61: Sensor-based monitoring of air quality in semi-urban and rural area of Northern India: a case study

Authors: Rajouriya, K., Shikha, T.,&Taneja, A.

Journal/Publication: Air Quality Monitoring and Management Using Sensors (book chapter).

Pollutants Measured: Air quality parameters (implied by sensor monitoring).

Microenvironments Monitored: Semi-urban and rural areas of Northern India.

Instruments/Methods Used: Sensor-based monitoring.

Key Findings: This book chapter presents a case study on using sensor-based monitoring for air quality in semi-urban and rural regions of Northern India.

Dr. David Daneesh Massey

Dr. David Daneesh Massey and Dr. Mahima Habil Massey are prominent researchers specializing in indoor air quality, with a focus on particulate matter exposure in Agra (a semi-arid city in India) challenged by high pollution from traffic, biomass burning, and urban activities. Their collaborative work, spanning more than 15 years, documents alarmingly elevated PM levels in homes, schools, offices, and other microenvironments. Using real-time monitors like Grimm spectrometers, gravimetric samplers, and chemical analyses, they reveal strong indoor sources, poor ventilation, and seasonal peaks. Key themes include indoor-outdoor relationships, trace metal toxicity, health risks, and mitigation strategies like cleaner fuels and HEPA filters. Their studies underscore Agra's IAQ crisis and advocate for policy-driven awareness and interventions.

Dr. MahimaHabil Massey

Dr. Mahima Habil Massey is an Assistant Professor in the Department of Chemistry at St. John's College, Agra, specializing in Environmental, Inorganic, and Analytical Chemistry. Her primary research interests encompass indoor and outdoor air pollution, aerosol chemistry, atmospheric pollution, emission source characterization, and personal exposure assessment in various Indian environments. Holding a Ph.D. in Chemistry with a focus on indoor air pollutants in school classrooms and a SERB-DST Post-Doctoral Fellowship, she brings over 15 years of combined teaching and research experience. Dr. Massey has actively participated in numerous funded research projects and international collaborations, and her scholarly contributions include publications in high-impact journals, a book, and five book chapters, covering topics such as particulate matter, heavy metal contamination, and environmental health risks. She is a life member of the Chemical Society and the Society for Indoor Environment, serving as Treasurer of its Agra Chapter, and acts as a peer reviewer for prominent journals.

1. Indoor/Outdoor Relationship of Fine Particles Less Than 2.5 µm (PM2.5) in Residential Homes in the Central Indian Region

Author: Massey, D

Journal/Publication Name: Building and Environment, 2009, Vol. 44, pp. 2037-2045.

Pollutants Measured: PM2.5, PM1.0, PM0.5, PM0.25.

Microenvironments Monitored: Indoor and outdoor locations in 14 residential homes across roadside, rural, and urban areas in Agra, India.

Instruments/Methods Used: Grimm 1.109 portable aerosol spectrometer for real-time PM mass concentrations; questionnaire surveys from 550 households on activities, health effects, and perceptions; linear regression for indoor-outdoor (I/O) correlations. Key Findings: Indoor PM2.5 averages were highest in rural homes, followed by roadside and urban homes, while outdoor levels were higher overall. I/O ratios were ~1.0 or >1.0 in rural/roadside homes and <1.0 in urban homes, with positive correlations strongest in roadside homes. Elevated levels were linked to biomass cooking, mustard oil frying, smoking, incense, and mosquito coils; rural homes showed the highest short-term health symptoms. All PM2.5 levels exceeded WHO guidelines by 5 to 8 times. Recommendations include awareness programs, cleaner fuels, and improved ventilation.

2. Chemical Characterization of Water-Soluble Aerosols in Different Residential Environments of Semi-Arid Region of India

Journal/Publication Name: Journal of Atmospheric Chemistry, 2010, Vol. 62, pp. 121-138.

Pollutants Measured: PM5, PM2.5, water-soluble ions.

Microenvironments Monitored: Indoor-outdoor residential sites in Agra, India.

Instruments/Methods Used: WINS impactor; Handy sampler; ion chromatography; atomic absorption spectrometry; UV-VIS spectrophotometry; ultrasonic extraction; filter weighing.

Key Findings: Mean PM2.5 concentrations were 178 µg/m3 indoors and 195 µg/m3 outdoors; PM5 levels were 231.8 µg/m3 indoors and 265.2 µg/m3 outdoors. Water-soluble ions comprised ~80% of PM5 mass and ~70% of PM2.5. Outdoor trends followed road > rural > urban, while indoor trends were rural > roadside > urban. I/O ratios >1 indicated additional indoor sources at rural/roadside sites, with poor indoor-outdoor ion correlations. Major ions (Mg2+/Na+, Cl-/NO3-/SO42-) were linked to crustal, vehicular, and biomass source.

3. Children's Exposure to Indoor Particulate Matter in Naturally Ventilated Schools in India

Journal/Publication Name: Indoor and Built Environment, 2011, Vol. 20, pp. 430-448.
Pollutants Measured: PM10, PM2.5, PM1.0; environmental parameters including CO_2, temperature, relative humidity, ventilation rates, and wind speed. Health symptoms assessed via questionnaire.
Microenvironments Monitored: Indoor-outdoor classrooms in four naturally ventilated schools in Agra, India (two roadside, two residential). Included winter and summer campaigns, with sampling during school hours plus pre- and post-occupancy periods.
Instruments/Methods Used: Grimm 1.109 aerosol dust monitor; Young Environmental Systems multi-gas monitors for CO_2, temperature, RH, and ventilation; Wind Monitor WM 251 Envirotech for wind speed.
Key Findings: Winter indoor means (roadside, residential) were PM10: 524.76 µg/m3, 153.37 µg/m3; PM2.5: 240.95 µg/m3, 60.61 µg/m3; PM1.0: 259.51 µg/m3, 38.39 µg/m3 - all exceeding WHO 24-h guidelines by 3-10x. Summer levels were 2-3x lower overall. Average I/O ratios were approximately 1.41 across sites, with poor indoor-outdoor PM correlations but strong inter-PM correlations. Winter conditions averaged 19.47 deg C, 53.34% RH, 13.29 m3/h ventilation, and 834 ppm CO_2; summer conditions were 29.43 deg C, 72.25% RH, 42.02 m3/h ventilation, and 530 ppm CO_2. Questionnaire responses indicated ~50% of pupils reported poor ventilation/crowding as air quality issues, with common symptoms higher in roadside schools and linked to PM exposure, absenteeism, and reduced learning. Inferred sources included traffic/resuspension and crustal/seasonal inversions; recommendations focused on improved cleaning and ventilation controls.

4. Emission and Formation of Fine Particles from Hardcopy Devices: The Cause of Indoor Air Pollution

Journal/Publication Name: Chapter in Monitoring, Control and Effects of Air Pollution, 2011.
Pollutants Measured: Fine PM, VOCs, SVOCs, ozone.
Microenvironments Monitored: Office/home workspaces with printers/copiers.
Instruments/Methods Used: Grimm spectrometer; emission protocols; literature review.
Key Findings: Hardcopy devices emit 10,000 to 100,000 particles/cm3, contributing 10 to 20% to indoor PM levels. These emissions are linked to pulmonary diseases, and the study advises adopting low-emission technology alongside improved ventilation.

5. Seasonal Trends of Coarse and Fine Particulate Matter in Indoor and Outdoor Environments of Residential Homes in North-Central India

Journal/Publication Name: Building and Environment, 2012, Vol. 47, pp. 223-231.

Pollutants Measured: PM10, PM5.0, PM2.5, PM1.0.

Microenvironments Monitored: Indoor and outdoor locations in 10 residential homes across roadside and urban areas in Agra, India.

Instruments/Methods Used: Grimm 1.109 portable aerosol spectrometer for real-time PM mass concentrations; meteorological station for temperature, humidity, wind speed/direction; YES-206 sensor for air exchange rates; occupant diaries/questionnaires on activities and health; SPSS for descriptive statistics, correlations, and ratios.

Key Findings: Annual PM10 averages were highest at roadside sites compared to urban sites, with PM2.5 ranging from 161 to 230 µg/m3 at roadside locations and 109 to 123 µg/m3 at urban sites. Concentrations peaked in winter due to low wind speeds, high humidity, and increased indoor heating/bonfires, dropping in summer/monsoon periods due to dispersion and washout. I/O ratios were ~0.9 to 1.0, accompanied by strong indoor-outdoor correlations. Inter-particulate ratios showed fine particles comprising 54 to 68% of total PM in winter. Major sources included biomass cooking, indoor smoking, vehicular traffic, and garbage burning. Levels exceeded Indian NAAQS by 3 to 4 times and WHO guidelines by 11 to 23 times, with higher fine PM linked to respiratory issues. Recommendations include improved ventilation,

6. Particulate Matter Concentrations and Their Related Metal Toxicity in Rural Residential Environments of Semi-Arid Regions in India

Journal/Publication Name: Atmospheric Environment, DOI: 10.1016/j.atmosenv.2012.11.002.

Pollutants Measured: PM10, PM2.5, PM1; trace metals in PM2.5.

Microenvironments Monitored: Indoor and outdoor locations in 5 rural residential homes in Agra, Uttar Pradesh, India.

Instruments/Methods Used: Grimm 1.109 portable aerosol spectrometer; Envirotech APM 550 medium-volume sampler for PM2.5 on PTFE filters; Perkin-Elmer A Analyst 100 AAS for trace metal analysis post-HNO3 digestion; meteorological monitoring; multivariate statistics for source apportionment; IRIS-based excess cancer risk assessment. Key Findings: Annual average PM10 and PM2.5 concentrations exceeded Indian NAAQS by 3.6-5 times and WHO guidelines by 10.8 to 20.3 times, with indoor levels consistently higher than outdoor. Significant seasonal variations were observed, with I/O ratios >1.0 for most PM fractions and strong correlations between indoor/outdoor metals. Sources were identified as biomass combustion/soil dust and vehicular emissions/soil re-suspension; Cr showed the highest excess cancer risk. Recommendations include improved ventilation, cleaner fuels, and policy interventions for rural air quality.

7. Trace Metal Distributions and Source Identification in Indoor Particulate Matter across Urban, Rural, and Roadside Residential Sites in Semi-Arid Agra, India

Journal/Publication Name: Aerosol and Air Quality Research, DOI: 10.4209/aaqr.2013.05.0147.

Pollutants Measured: PM10, PM2.5; trace metals in both fractions.

Microenvironments Monitored: Indoor living rooms in 5 homes each at urban, rural, and roadside sites in Agra, Uttar Pradesh, India, with simultaneous outdoor rooftop sampling.

Instruments/Methods Used: Envirotech APM-550 sampler with Win-Anderson impactor for PM10/PM2.5 on 47 mm PTFE filters; Perkin-Elmer A Analyst 100 AAS for metals post-HNO3 digestion; gravimetric analysis; univariate Pearson correlations and principal component analysis for source apportionment; enrichment factors relative to outdoor crust composition.

Key Findings: Monthly average PM2.5 and PM10 concentrations far exceeded Indian NAAQS and WHO guidelines, with PM2.5 comprising 50-56% of PM10 and highest levels in winter due to poor dispersion. Metal contributions were 6.2% of PM2.5 mass vs. 2.2% of PM10, with metals concentrated in fine fractions. Pb exceeded NAAQS up to 5 times at roadside sites and Ni up to 36 times across sites, posing inhalation/dermal risks. PCA identified two sources: indoor house dust/anthropogenic activities and outdoor infiltration. The study recommends ventilation improvements, lead-free paints, and emission controls.

8. Indoor/Outdoor Relationship of Particulate Matter (PM10, PM2.5, PM1.0) and Ionic Species in School Environments in Agra, India

Journal/Publication Name: Atmospheric Pollution Research, 2015, Vol. 6, pp. 719-725. doi: 10.5094/APR.2015.080.

Pollutants Measured: PM10, PM2.5, PM1.0; water-soluble ions in settled dust (anions and cations).

Microenvironments Monitored: Indoor and outdoor environments of 10 schools in Agra, Uttar Pradesh, India (5 roadside schools and 5 residential schools). Sampling conducted January 2008-May 2009.

Instruments/Methods Used: Grimm 31-Channel Portable Aerosol Spectrometer; YES 205/206 multi-gas monitors; Envirotech WM251 for wind speed; Ion Chromatograph for anions; ICP-AES for cations; settled dust collection, ultrasonic extraction, filtration; Principal Component Analysis with Varimax rotation; Pearson correlation; questionnaire surveys.

Key Findings: Schoolchildren in Agra face alarmingly high indoor and outdoor PM levels, 4 to 26 times above Indian NAAQS and WHO guidelines, with roadside schools exhibiting worse conditions due to traffic. Ionic analysis and PCA identified key sources including crustal/soil dust, vehicular emissions, biomass burning, and chalk dust. Health symptoms were more prevalent in roadside schools, signaling major risks.

9. Characterization of Coarse & Fine Particles in Different Microenvironments - Implications for Occupants

Journal/Publication Name: Advances in Environmental Biology, Vol. 8(15), pp. 61-66 (AENSI Publisher), 2016.

Pollutants Measured: PM10, PM5.0, PM2.5, PM1.0, PM0.5, PM0.25.

Microenvironments Monitored: Offices, shops, supermarkets (Agra, 2011).

Instruments/Methods Used: Grimm spectrometer; diaries.

Key Findings: This paper focused on the characterization of coarse and fine particulate matter in indoor working environments of Agra, including offices, shops, and commercial buildings. Results showed that PM2.5 and PM10 concentrations consistently exceeded WHO and national standards, with offices recording the highest pollution levels. The study established a strong link between indoor human activities and elevated fine particle concentrations. Occupant health surveys indicated a higher prevalence of respiratory and irritation-related symptoms among office workers compared to other environments.

10. Particles in Different Indoor Microenvironments - Implications for Occupants

Journal/Publication Name: Building and Environment, Vol. 108, pp. 40-48, 2016.

Pollutants Measured: PM10-PM0.25; PM2.5 metals.

Microenvironments Monitored: Offices, shops, commercial centers.

Instruments/Methods Used: Grimm; AAS; US EPA risks; PMF. Key Findings: PM10 and PM2.5 concentrations in offices, shops, and commercial centers in Agra far exceeded WHO and NAAQS standards across all sites. Fine and ultrafine particles dominated indoor air, primarily due to indoor activities such as smoking, incense burning, dust resuspension, and emissions from office equipment. Chemical analysis revealed toxic metals, with nickel posing the highest excess cancer risk - though within prescribed limits. The study emphasizes the serious health implications of indoor air pollution in urban India.

11. Personal and Ambient PM2.5 Exposure Assessment in the City of Agra
Journal/Publication Name: Data in Brief, Vol. 6, pp. 100-109 (Elsevier), 2016.
Pollutants Measured: PM2.5 (personal/ambient).
Microenvironments Monitored: Homes, schools, offices (Agra, 2013-2014).
Instruments/Methods Used: PEM, APM 550; diaries; correlations.
Key Findings: Personal and ambient PM2.5 concentrations in Agra are alarmingly high across homes, schools, and offices, with schools showing the highest exposure levels. Average PM2.5 concentrations were found to be 2.5 to 4 times higher than Indian National Ambient Air Quality Standards and over 11 times higher than WHO guidelines. Personal exposure levels were consistently higher than ambient levels. Trace metal analysis revealed significant presence of Fe, Cr, Pb, Zn, and Ni, indicating both anthropogenic and indoor sources. Reported health symptoms were most prevalent among school occupants.

12. Mass and Number and Its Chemical Composition Distribution of Particulate Matter in Different Microenvironments
Journal/Publication Name: Chapter in Indoor Environment and Health, 2019.
Pollutants Measured: PM mass and number concentrations; chemical composition.
Microenvironments Monitored: Various indoor environments.
Instruments/Methods Used: Grimm spectrometer; chemical analysis.
Key Findings: The study reveals significant variations in particulate matter mass and number concentrations across different microenvironments, driven by local sources and human activities. Fine and ultrafine particles dominate number concentrations, whereas coarse particles contribute more substantially to mass concentrations. Indoor microenvironments often exhibit elevated PM levels due to resuspension, combustion activities, and limited ventilation, while outdoor environments are primarily influenced by traffic and regional sources. Chemical composition analysis indicates the presence of crustal elements, secondary inorganic aerosols, and anthropogenic components.

13. Influence of Microenvironments and Personal Activities on Personal PM2.5 Exposures among Children and Adults

Journal/Publication Name: Aerosol and Air Quality Research, Vol. 22, 2022.
Pollutants Measured: PM2.5.
Microenvironments Monitored: Homes, schools, offices.
Instruments/Methods Used: PEMs; diaries; regression.
Key Findings: The study found alarmingly high personal and ambient PM2.5 concentrations in homes, schools, and offices in Agra, exceeding national and WHO standards by several-fold. Schools and homes exhibited higher exposure levels than offices, primarily owing to traffic proximity, indoor activities, and inadequate ventilation. Personal exposures consistently surpassed ambient concentrations, underscoring the influence of daily activities such as cooking, smoking, incense burning, and cleaning. Children faced greater health impacts, including higher prevalence of headaches, respiratory irritation, and fatigue.

14. Personal Exposure Monitoring in the School Environment in the City of Ghaziabad

Journal/Publication Name: International Journal of Research and Analytical Reviews, Vol. 9, 2022.
Pollutants Measured: PM2.5; metals.
Microenvironments Monitored: School vicinity.
Instruments/Methods Used: SKC PEMs; comparisons.
Key Findings: The study revealed alarmingly high personal PM2.5 exposures among school students in the Ghaziabad school environment during winter months. Measured PM2.5 concentrations exceeded National Ambient Air Quality Standards by 2.0 to 2.39 times and WHO guidelines by 4.83 to 5.74 times, peaking in December and January. Elemental analysis indicated significant levels of metals such as Fe, Cr, Ni, Zn, and Cu, stemming from vehicular emissions, industrial activities, chalk dust, and soil resuspension. Questionnaire surveys linked elevated PM2.5 exposure to increased respiratory, allergic, and neurological symptoms among students.

15. PM2.5 Exposure Estimates for College Students and Health Risk Assessment

Journal/Publication Name: Environmental Geochemistry and Health, Vol. 46, 2024.

Pollutants Measured: PM2.5; metals.

Microenvironments Monitored: Toll plazas.

Instruments/Methods Used: PEMs; ICP-OES; PMF, Igeo, EF; US EPA models.

Key Findings: The study found significantly elevated PM2.5 concentrations at toll plazas in the Agra region, exceeding national ambient air quality standards, particularly during peak traffic hours. Primary contributors included high vehicular density, frequent idling, and emissions from diesel-powered heavy vehicles. Chemical analysis indicated substantial enrichment of toxic metals such as Pb, Cr, Ni, and Zn in PM2.5. Health risk assessments revealed higher non-carcinogenic and carcinogenic risks for toll workers than for commuters, with inhalation as the dominant exposure pathway. The findings position toll plazas as critical pollution hotspots.

16. Evaluation of Cigarette Smoking as a Potential Risk Factor in Transmission of Covid-19 Infection

Journal/Publication Name: International Journal of Research and Analytical Reviews (IJRAR), Vol. 10(3), 2023.

Pollutants Measured: Smoke particulates (behavior focus).

Microenvironments Monitored: Households (COVID survey).

Instruments/Methods Used: Questionnaire (2000 participants).

Key Findings: The study reveals significantly elevated PM2.5 concentrations at toll plazas in the Agra region, exceeding national ambient air quality standards during peak traffic hours. High vehicular density, frequent idling, and diesel-powered heavy vehicles were the primary contributors. Chemical analysis showed substantial enrichment of toxic metals such as Pb, Cr, Ni, and Zn in PM2.5, indicating strong anthropogenic influence. Health risk assessment demonstrated higher non-carcinogenic and carcinogenic risks for toll workers compared to commuters, with inhalation as the dominant exposure pathway.

17. Transforming Indoor Air: Technologies and Interventions

Journal/Publication Name: Chapter in Indoor Environment and Health, 2025.

Pollutants Measured: PM, VOCs, metals.

Microenvironments Monitored: Various indoor environments.

Instruments/Methods Used: Literature; HEPA/filter reviews.

Key Findings: This chapter highlights that effective transformation of indoor air quality relies on a combination of technological solutions and behavioral interventions. Advanced ventilation systems, air filtration technologies, and air purification methods significantly reduce indoor particulate matter, volatile organic compounds, and biological pollutants. The integration of smart sensors and real-time monitoring enables adaptive control of indoor environments, improving efficiency and occupant health. Additionally, source control measures - such as cleaner cooking fuels, reduced indoor smoking, and improved building design - play a crucial role.

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Measurement Range (Cn): up to 2×10^7 particles/L Measurement Range (Mass): 0 – 100 mg/m^3

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ParticleSizeRange: 0.178 – 20µm

Measured Parameters: PM_1, $PM_{2.5}$, PM_4, PM_{10}, TSP, CN, PSD, P, T, RH, CO_2 Optional Gas Modules: NO_2, SO_2, CO, NO, O_3 (Grade-1 sensors) On-site calibration and adjustment (particle size) Measurement Range (Cn): up to 2×10^7 particles/L Measurement Range (Mass): 0 – 100 mg/m^3 Size Channels: 32perdecade,4×7 | 365Days | Uninterrupted Monitoring

AQ Guard for Indoor Air Quality

Particle SizeRange: 0.150 – 20µm

Measured Parameters: PM_1, $PM_{2.5}$, PM_4, PM_{10}, TSP, CN, PSD, P, T, RH, CO_2, Infection risk index
On-site calibration and adjustment (particle size)
Measurement Range (Cn): up to 2×10^7 particles/L
Measurement Range (Mass): 0 – 20 mg/m^3
Size Channels: 32p er decade, 24×7 | 365Days | Uninterrupted Monitoring

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