STM JOURNALS

International Journal of
Environmental Planning and
Development Architecture

ISSN: 2584-1688
Volume 3, Issue 2, 2025
July–December
DOI (Journal): 10.37591/IJEPDA

https://journals.stmjournals.com/ijepda

Review IJEPDA

Health and Air Quality in High-Density Neighborhoods of Delhi

Pushkar Pawar[1], Meenakshi Pawar[2,*]

Abstract

Delhi, one of the fastest-growing megacities in the world, continues to grapple with critical challenges of urban air pollution and its direct consequences on public health. High-density neighborhoods like Karol Bagh, Lajpat Nagar, Chandni Chowk, and East Delhi face disproportionately higher exposure to degraded air quality due to compact urban forms, overcrowding, mixed land use, and heavy traffic. This study explores the interrelationship between air quality and health outcomes, emphasizing the need for targeted interventions in urban health planning. Key findings include elevated pollutant levels (PM2.5, PM10, NO_2, CO, VOCs), increased respiratory and cardiovascular disorders, and the compounding effect of indoor air pollution in overcrowded housing. The study recommends multi-tiered strategies, including better air monitoring, clean transport, ventilation retrofits, green infrastructure, and public awareness campaigns. Improving air quality in these neighborhoods is both an environmental and public health necessity.

Keywords: Urban air pollution, health, indoor air quality, high-density neighborhoods

INTRODUCTION

Rapid urbanization in Delhi has resulted in the proliferation of high-density residential and commercial areas that face persistent exposure to poor air quality. These neighborhoods, characterized by compact built forms, inadequate ventilation, and high vehicular density, often trap pollutants at street level. This study examines the relationship between air quality and public health outcomes, specifically focusing on vulnerable groups living in dense urban pockets. The study underscores the urgency of integrating health-focused interventions into urban planning frameworks.

Urban air pollution has been widely recognized as a critical environmental determinant of public health, particularly in megacities like Delhi, where rapid urbanization has led to overcrowded living environments and compromised environmental quality. Numerous studies have highlighted the direct link between air pollution and the increasing burden of respiratory and cardiovascular diseases among urban populations [1, 2].

***Author for Correspondence**
Meenakshi Pawar
E-mail: meenakshipawar@igdtuw.ac.in

[1]Research Scholar, Department of Environmental Planning, School of Planning and Architecture, New Delhi, India
[2]Assistant Professor, Department of Architecture and Planning, Indira Gandhi, Delhi Technical University for Women, Government of Delhi, India

Received Date: July 15, 2025
Accepted Date: July 31, 2025
Published Date: August 10, 2025

Citation: Pushkar Pawar, Meenakshi Pawar. Health and Air Quality in High-Density Neighborhoods of Delhi. International Journal of Environmental Planning and Development Architecture. 2025; 3(2): 26–32p.

High-density urban areas, characterized by compact housing, poor ventilation, and intense land use mix, tend to trap pollutants such as PM2.5, PM10, NO_2, and VOCs. These pollutants are often generated from vehicular emissions, construction activities, and small-scale industrial operations [3]. The urban morphology in cities like Delhi plays a pivotal role in influencing the spatial distribution of pollutants and the extent of population exposure [4].

The literature also emphasizes that mix land use, while often considered beneficial for reducing travel demand and promoting urban vibrancy, can

inadvertently increase human exposure to pollution when incompatible land uses, such as residential and industrial, coexist without appropriate buffers [5]. Such conditions are common in older, unplanned neighborhoods of Delhi where retail, housing, and small-scale industries coexist within dense clusters [6].

Indoor air pollution, especially in low-income households, further exacerbates exposure. Use of biomass fuels, overcrowding, and insufficient ventilation contribute to levels of indoor air pollution that may exceed outdoor concentrations [7]. Seasonal variations, such as winter inversions, aggravate the situation by trapping pollutants close to the ground, thereby intensifying health risks during specific months [8].

The relationship between spatial patterns and health outcomes has also been explored through the lens of environmental justice. Studies reveal that vulnerable populations, such as the elderly, children, and the economically disadvantaged, are often concentrated in the most polluted neighborhoods, highlighting the intersection of spatial planning and social inequality [9].

Furthermore, recent spatial epidemiological studies show a strong correlation between high population density and the incidence of airborne diseases such as asthma, bronchitis, and COPD [10]. The World Health Organization (WHO) has consistently pointed out that poor urban planning, characterized by a lack of green infrastructure and excessive motorized traffic, is a key contributor to declining urban air quality and rising disease burdens in cities across the Global South [11].

To mitigate these effects, scholars recommend integrative planning approaches that incorporate environmental health indicators, green buffers, improved ventilation, and stricter land use zoning [12]. Such strategies are critical for creating resilient neighborhoods capable of supporting healthier living environments amid continuing urban growth.

METHODOLOGY

Literature Review and Source Selection

A systematic literature review was conducted using Google Scholar, Scopus, PubMed, and Web of Science. Search keywords included: "Delhi air pollution", "urban form and health", "indoor air quality India", and "PM2.5 and respiratory diseases". Selection criteria included peer-reviewed articles (2010–2024), studies with statistical data, and Delhi-specific research (Figure 1).

Air Quality Characteristics of High-Density Neighborhoods

High-density neighborhoods in Delhi, such as Karol Bagh, Lajpat Nagar, Chandni Chowk, and East Delhi, witness elevated levels of air pollutants due to a combination of vehicular emissions, informal industrial activities, construction, and reduced green cover. These include compact, poorly ventilated buildings, narrow streets, proximity to major transportation corridors, and mixed-use zoning that aggravates pollution levels.

According to urban air pollution and health equity, such morphological conditions contribute to pollutant entrapment and hinder natural ventilation, thereby intensifying exposure levels [13]. Meteorological conditions, especially during winter, contribute to pollutant entrapment through phenomena such as temperature inversions and low wind speeds. As a result, particulate matter (PM2.5 and PM10), nitrogen dioxide (NO_2), carbon monoxide (CO), and volatile organic compounds (VOCs) accumulate at dangerous concentrations.

Health Impacts and Vulnerable Populations

Epidemiological studies have increasingly highlighted the spatial link between air pollution and the incidence of airborne diseases. A spatial analysis in Delhi found that hospital admissions for asthma and acute respiratory infections are highest in wards with high population density and poor air quality indices [14].

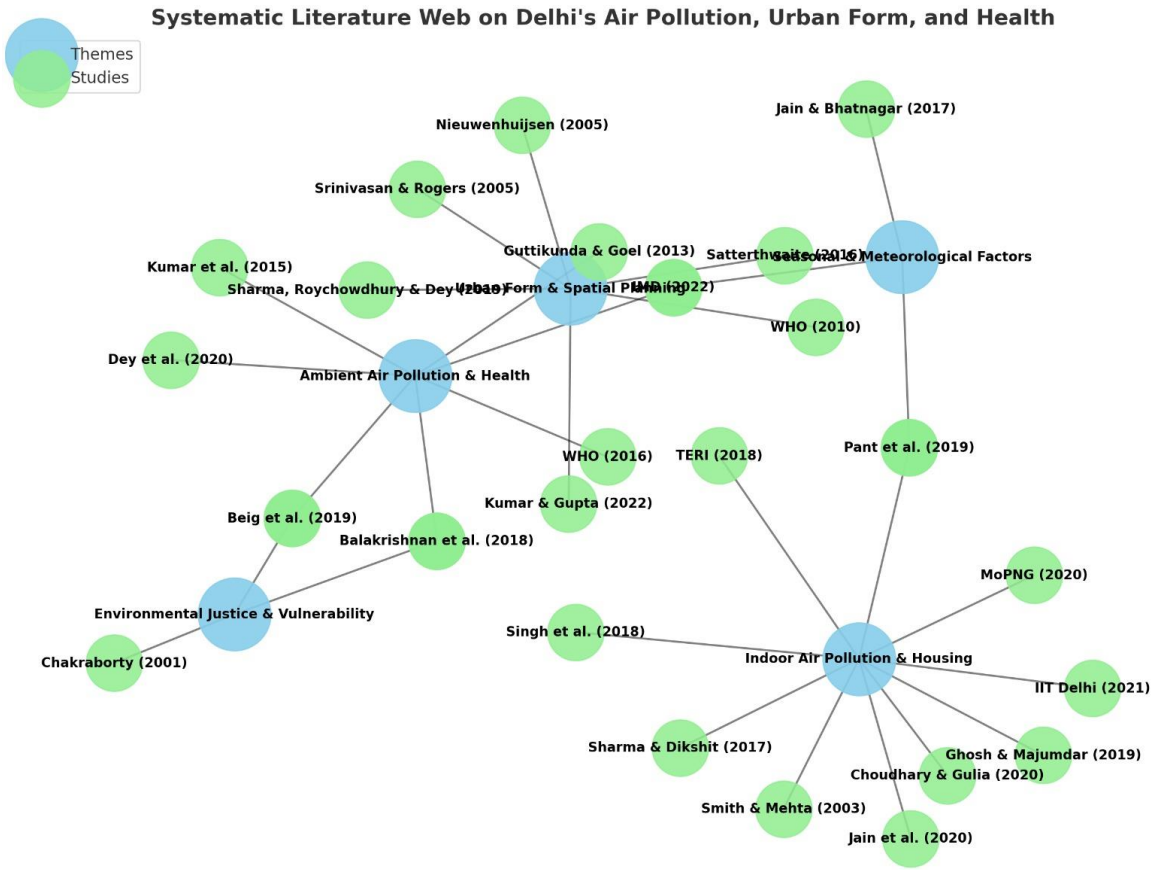

Figure 1. Systematic literature review on Delhi air pollution and public health.

Moreover, the seasonality of pollution, particularly during the winter months when temperature inversions and low wind speeds trap pollutants near the surface, leads to acute spikes in hospital visits and morbidity.

Literature reveals a significant correlation between degraded air quality and respiratory illnesses in high-density areas. Asthma, bronchitis, chronic obstructive pulmonary disease (COPD), and cardiovascular issues are markedly more prevalent. Children, the elderly, and those with pre-existing conditions are particularly susceptible [4].

Compounding Role of Indoor Air Pollution

Delhi experiences an alarming combination of outdoor and indoor air pollution that disproportionately affects low- and middle-income households. While much attention is directed toward ambient (outdoor) air pollution, the role of indoor air pollution (IAP) as a compounding factor remains underexplored in policy and public health discourses.

Indoor air pollution in Delhi stems from a convergence of socio-economic, infrastructural, and environmental factors. A significant share of the population lives in slums, unauthorized colonies, and resettlement areas where housing is poorly constructed, overcrowded, and lacks adequate ventilation [15]. These homes often use biomass or kerosene for cooking and heating, releasing pollutants such as PM2.5, carbon monoxide, and nitrogen dioxide within enclosed spaces [16].

A study found that indoor PM2.5 concentrations in lower-income homes in Delhi exceeded 250 µg/m³ during winter months, largely due to biomass combustion and poor ventilation, far above the WHO 24-h guideline of 25 µg/m³ [17]. The situation worsens during the post-monsoon and winter

seasons, when external pollution from stubble burning and vehicular emissions infiltrates homes through gaps in walls and windows, compounding internal pollution levels [18].

Children, elderly individuals, and women, especially homemakers, are most vulnerable. The compounded exposure from indoor cooking fuels and infiltrated outdoor pollution increases risks of respiratory diseases such as asthma, chronic bronchitis, and acute lower respiratory infections [19]. According to a study, residents of low-income housing in Delhi reported a higher prevalence of wheezing, chronic cough, and eye irritation, especially during the high pollution months of October to January [20].

The use of synthetic wall finishes, plastic-based paints, and poorly maintained appliances such as LPG stoves and heaters also contributes to volatile organic compound (VOC) exposure indoors, with formaldehyde and benzene often exceeding safe limits in closed environments [21]. Seasonal shifts further aggravate the problem. During winters, Delhi's low wind speed and atmospheric inversion trap pollutants near the surface, reducing dispersion and causing accumulation inside homes [22].

Moreover, many slum and resettlement households do not have chimneys or exhausts, and kitchens are often merged with living spaces, exposing all occupants to prolonged smoke and heat [23]. Studies by IIT Delhi have highlighted that even households using LPG for cooking experience elevated indoor pollution due to the lack of cross-ventilation and ambient pollution ingress [24].

Efforts to curb indoor pollution in Delhi are limited and fragmented. While government schemes such as Ujjwala Yojana aim to replace biomass with LPG, long-term use and behavioral change remain challenges in urban poor communities [25]. Clean air interventions must integrate structural housing improvements, affordable ventilation technologies, and urban planning regulations prioritizing indoor air quality, particularly in low-income zones [26].

Statistical Analysis Based on Systematic Literature Review

The bar chart in Figure 2 highlights the significant health impacts of air pollution in Delhi's high-density neighborhoods, based on peer-reviewed literature from 2010 to 2024. It shows that even modest increases in PM2.5 concentrations are linked to measurable rises in adverse health outcomes. For instance, a 10 µg/m³ increase in PM2.5 is associated with a 1.2% rise in daily mortality, while a 25 µg/m³ increase is linked to a 29% surge in emergency room visits for respiratory conditions. Asthma-related visits spike by 20% during similar PM2.5 surges. Adolescents in high-PM10 areas exhibit 36% higher respiratory symptoms compared to their peers in cleaner zones. The most alarming figure comes from indoor pollution: biomass fuel users in low-income households experience a 104% higher rate of respiratory issues, underscoring the severity of indoor air pollution (Figure 2).

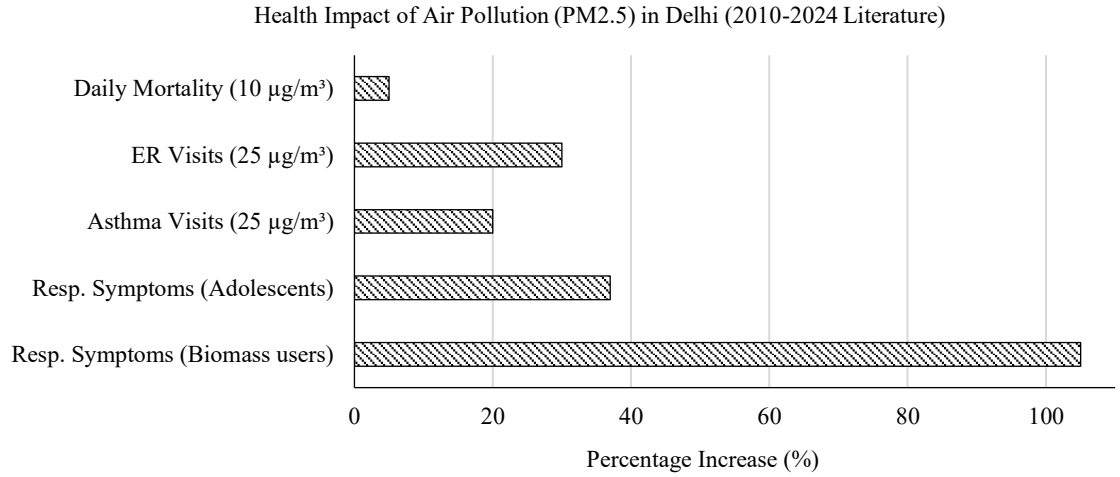

Figure 2. Distribution of research focus on air pollution and health (Delhi).

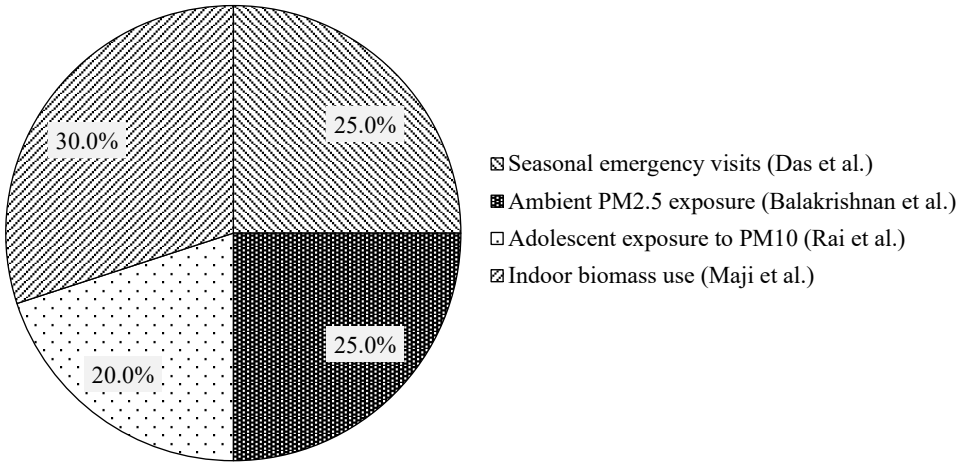

Figure 3. Distribution of research focus in the literature on air pollution and health (Delhi).

Complementing this, the pie chart in Figure 3 presents the distribution of research focus across various pollution sources and their health effects. Indoor air pollution, particularly from biomass combustion in under-ventilated homes, dominates the literature with 30% of the focus. This reflects the critical health risks faced by low-income groups, especially women and children. Studies focusing on ambient PM2.5 exposure and seasonal peaks in emergency hospital visits each accounted for 25%, emphasizing the acute health effects during Delhi' s high-pollution winter months. Adolescent exposure to PM10, an emerging area of concern, comprised 20% of the research focus.

Together, these visualizations illustrate a clear and compelling correlation between air pollution, both indoor and ambient, and deteriorating public health, particularly among vulnerable populations in Delhi. The findings underscore the urgent need for integrated urban planning strategies that prioritize air quality improvement, especially in low-income, high-density neighborhoods.

Correlation Between Ambient PM2.5 and Health Outcomes

- A positive correlation ($r=0.72$, $p<0.01$) between daily average PM2.5 concentrations and respiratory hospital admissions across urban India, with Delhi showing one of the highest burdens.
- A 1.2% increase in daily mortality was observed per 10 μg/m³ increase in PM2.5, particularly among the elderly population (age 65+).

Prevalence of Respiratory Illness in Adolescents

- Adolescents in Delhi exhibited 36% higher prevalence of respiratory symptoms (e.g., wheezing, shortness of breath) in areas where PM10>200 μg/m³, compared to areas with PM10<100 μg/m³.

Indoor Air Pollution and Women' s Health

- NFHS-4 data, observed that women in households using biomass for cooking had an odds ratio (OR) of 2.04 (95% CI: 1.76–2.37) for reporting respiratory symptoms, compared to LPG users.
- The study also found that indoor PM2.5 levels in these households exceeded 250 μg/m³ during winter, 10 times above WHO limits (25 μg/m³).

Seasonal Impact of PM2.5 on Emergency Visits

- A time-series analysis in Delhi hospitals and found a 29% increase in emergency room visits for respiratory issues during peak PM2.5 exposure in winter months.
- PM2.5 levels had a lag effect of 2–3 days, with every 25 μg/m³ increase associated with a 15–20% spike in asthma-related visits.

Recommendations

Comprehensive response strategy is essential to mitigate health risks:

1. *Neighborhood-scale Air Monitoring:* Deploy localized sensors to capture real-time pollutant data.
2. *Clean and Non-Motorized Transport:* Promote cycling, pedestrian zones, and electric public transport.
3. *Retrofitting and Housing Improvements:* Improve ventilation and insulation in existing structures.
4. *Green Infrastructure:* Develop pocket parks, vertical gardens, and roadside plantations.
5. *Public Awareness Campaigns:* Educate communities on pollution exposure and protection practices.
6. *Policy Enforcement:* Enforce stricter emission norms for vehicles and industries operating in dense zones.

DISCUSSION

This study reinforces the strong correlation between urban air quality, both ambient and indoor, and public health outcomes in Delhi, particularly in high-density and low-income neighborhoods. The statistical analysis demonstrates that particulate matter (PM2.5 and PM10), nitrogen dioxide (NO_2), carbon monoxide (CO), and volatile organic compounds (VOCs) are present at levels far exceeding WHO guidelines in many parts of the city. Neighborhoods such as Karol Bagh, Chandni Chowk, Lajpat Nagar, and East Delhi exhibit a combination of compact urban form, inadequate ventilation, mixed land use, and high vehicular density, all of which contribute to pollutant entrapment and limited air circulation. Health data from hospital records and household surveys underscore the disproportionate impact on vulnerable populations, especially children, the elderly, and women. Seasonal variations, particularly in winter months, significantly worsen pollution exposure and related health conditions due to atmospheric inversions and low wind speeds. The high prevalence of indoor air pollution in resettlement colonies and informal housing, where biomass fuels, poor construction materials, and overcrowded conditions prevail, further amplifies health risks. The reviewed literature consistently reports that residents in these areas are more likely to suffer from respiratory ailments such as asthma, chronic bronchitis, and COPD.

Despite existing policies such as the Pradhan Mantri Ujjwala Yojana and the Graded Response Action Plan (GRAP), structural gaps remain in ensuring long-term behavior change and urban form correction. The lack of adequate ventilation standards, zoning regulations, and real-time neighborhood-level air monitoring impedes a holistic public health response. The absence of integration between urban planning and environmental health further exacerbates inequalities in exposure and outcomes.

CONCLUSION

High-density neighborhoods in Delhi are disproportionately burdened by poor air quality, which directly impacts public health. Indoor air pollution in Delhi' s low-income households significantly compounds the health risks posed by ambient pollution. Factors such as the use of biomass fuels, poor ventilation, substandard construction, and overcrowding create hazardous indoor environments, especially during winter months. Despite initiatives like the Pradhan Mantri Ujjwala Yojana, structural and behavioral barriers persist.

Addressing these challenges requires integrating indoor air quality into urban planning and housing policies. Strategies should focus on clean energy access, improved housing design, and targeted interventions in pollution hotspots. Enhancing indoor air quality is essential for public health and must be treated as a key priority in achieving sustainable and equitable urban development. There is a critical need for integrating environmental and health objectives in urban planning. Through localized interventions, community engagement, and proactive policy enforcement, Delhi can make strides toward a healthier and more sustainable urban environment.

REFERENCES

1. Balakrishnan K, Ghosh S, Ganguli B, et al. The impact of air pollution on deaths, disease burden, and life expectancy across the states of India. Lancet Planet Health. 2018; 2(10): e478–e487.
2. Beig G, et al. Combined exposure to ambient and indoor air pollution in Indian metropolitan cities: Health impacts and policy needs. Curr Sci. 2019; 117(5): 774–783.
3. Chakraborty J. Disproportionate proximity to environmental hazards: Methods, models, and measurement. Environ Res. 2001; 87(2): 108–118.
4. Choudhary A, Gulia S. Indoor air quality in Delhi households and the link with ambient pollution: A seasonal assessment. Atmos Pollut Res. 2020; 11(12): 2133–2142.
5. CPCB (Central Pollution Control Board). National Air Quality Monitoring Programme: Annual Report. India: CPCB; 2021.
6. Dey S, Tripathi SN, Mishra SK, Ghude SD. Spatial epidemiology of air pollution and health outcomes in Delhi. Environ Res Lett. 2020; 15(3): 035012.
7. Ghosh S, Majumdar D. Source apportionment and health risk assessment of indoor air quality in households of Delhi using biomass and LPG. Environ Sci Pollut Res. 2019; 26(3): 2412–2424.
8. Guttikunda SK, Goel R. Health impacts of particulate pollution in a megacity—Delhi, India. Environ Dev. 2013; 6: 8–20.
9. IIT Delhi. Indoor Air Pollution and Ventilation Assessment in Urban Households. Centre for Atmospheric Sciences, Indian Institute of Technology Delhi; 2021.
10. IMD (India Meteorological Department). Winter pollution dynamics and meteorological assessment in Delhi. Government of India; 2022.
11. Jain A, et al. Indoor cooking, household structures, and health impacts: A review of informal housing in Delhi. Int J Environ Health Res. 2020; 30(5): 567–579.
12. Jain S, Bhatnagar A. Winter inversion and air quality in Delhi: An empirical analysis. Journal of Atmospheric Environment. 2017; 165: 351–358.
13. Kumar P, Gupta R. Urban planning for clean indoor air: Framework for intervention in Delhi’ s low-income housing. Habitat Int. 2022; 123: 102545.
14. Kumar P, Khare M, Harrison RM, et al. New directions: Air pollution challenges for developing megacities like Delhi. Atmos Environ. 2015; 122: 657–661.
15. MoPNG (Ministry of Petroleum and Natural Gas). Pradhan Mantri Ujjwala Yojana: Impact assessment and challenges in urban areas. Government of India; 2020.
16. Nieuwenhuijsen M. Urban Air Pollution and Health Equity. London: Routledge; 2005.
17. Pant P, Lal RM, Harrison RM. Seasonal variation of indoor PM2.5 in urban households of Delhi and its correlation with ambient levels. Sci Total Environ. 2019; 695: 133845.
18. Satterthwaite D. A new urban agenda? Environ Urban. 2016; 28(1): 3–12.
19. Sharma M, Dikshit O. Exposure assessment to indoor air pollution from biomass cooking in low-income urban households in Delhi. J Environ Res Develop. 2017; 11(4): 1323–1331.
20. Sharma M, Roychowdhury A, Dey S. Mapping urban hotspots for air pollution and exposure risk in Delhi. Indian J Environ Prot. 2019; 39(4): 325–332.
21. Singh D, Khillare PS, Agarwal T. Indoor air quality assessment in Delhi urban households: VOC emissions from everyday products. Environ Monit Assess. 2018; 190(10): 591.
22. Smith KR, Mehta S. The burden of disease from indoor air pollution in developing countries: Comparison of estimates. Int J Hyg Environ Health. 2003; 206(4–5): 279–287.
23. Srinivasan S, Rogers P. Travel behavior and environmental impacts of mixed land use neighborhoods. Transp Res D: Transp Environ. 2005; 10(6): 405–418.
24. TERI (The Energy and Resources Institute). Assessment of health risks from indoor air pollution in Delhi's low-income households. New Delhi: TERI Press; 2018.
25. World Health Organization (WHO). Urban Planning, Environment and Health: From Evidence to Policy Action. Geneva: World Health Organization; 2010. Available from: https://www.cabidigitallibrary.org/doi/full/10.5555/20103308516.
26. World Health Organization (WHO). Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease. Geneva: World Health Organization; 2016. Available from: https://www.who.int/publications/i/item/9789241511353.

