

ARTICLE INFORMATION

Received: May, 11, 2026

Revised: May, 30, 2026

Available online: May, 30, 2026

at : <https://e-jurnal.iphorr.com/index.php/minh>

Urban environmental determinants of respiratory health: The role of air pollution, housing conditions, and green open space

Tuti Yelvianti^{1,3*}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tiyelvi@gmail.com

Abstract

Background: Rapid urbanization has increased exposure to multiple environmental stressors including air pollution, inadequate housing, and limited access to green open spaces, all of which adversely affect respiratory health. Understanding the interplay of these factors is essential for developing evidence-based urban health policies.

Purpose: To synthesize evidence on the determinants of urban environments — specifically air pollution, housing conditions, and green open spaces — and their effects on respiratory health outcomes.

Method: This study employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology. Literature searches were conducted using keywords "urban environment", "air pollution", "housing", "green space", and "respiratory health" across databases. A total of 15 articles published between 2022 and 2025 met the inclusion criteria.

Results: Evidence consistently demonstrates that exposure to PM_{2.5}, NO₂, and traffic-related air pollutants is significantly associated with reduced lung function and increased incidence of asthma, COPD, and acute respiratory infections. Poor housing conditions — particularly overcrowding, dampness, and inadequate ventilation — exacerbate respiratory disease burden. Access to green open spaces was associated with protective respiratory effects.

Conclusion: Urban environmental determinants collectively and interactively shape respiratory health. Integrated urban planning that reduces air pollution, improves housing standards, and expands green infrastructure is critical for respiratory health promotion in rapidly growing cities.

Keywords: Air Pollution; Green Space; Housing; Respiratory Health; Urban Environment.

INTRODUCTION

Rapid urban population growth is one of the most significant demographic transformations of the 21st century. According to projections by the United Nations, more than 68% of the world's population is expected to live in urban areas by 2050 (United Nations, 2018). Poorly planned urbanization carries serious consequences for environmental quality and public health, particularly respiratory health.

Urban air pollution is a major risk factor for respiratory diseases. Fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), ozone (O₃), carbon monoxide (CO), and volatile organic compounds (VOCs), primarily emitted from motor vehicles, industries, and energy production, pose significant threats to lung function and respiratory health among urban populations (Mainka & Žak, 2022). The World Health Organization (WHO) estimates that both outdoor and indoor air pollution together contribute to approximately 7 million premature deaths annually, with respiratory diseases such as chronic obstructive pulmonary disease (COPD), asthma, lung cancer, and acute respiratory infections being the leading causes (World Health Organization, 2021).

In addition to air pollution, housing conditions represent an important environmental determinant that is often overlooked in urban health studies. High residential density, poor ventilation, excessive humidity, and exposure to indoor pollutants—such as biomass smoke and toxic building materials—have been shown to exacerbate respiratory conditions among residents (Holden, Lee, Hawcutt, & Sinha, 2023; Tang, Huang, Lee, Lee, Wang, & Chan, 2024). In developing countries, the rapid growth of informal settlements or urban slums presents an urgent challenge requiring comprehensive policy attention.

Conversely, the presence of green open spaces in urban areas is considered an environmental intervention that can mitigate pollution impacts and provide health benefits. Urban vegetation plays a role in absorbing air pollutants, reducing ambient temperatures through evapotranspiration cooling effects, and promoting physical activity, which positively influences lung capacity (Nieuwenhuijsen, De Nazelle, Garcia-Aymerich, Khreis, & Hoffmann, 2024). However, the unequal distribution of green spaces in cities often creates health disparities among different socio-economic groups.

Although these three factors—air pollution, housing conditions, and access to green spaces—interact and synergistically affect respiratory health in urban populations, comprehensive studies integrating all three remain limited. Most previous research has examined these factors separately, resulting in a lack of a holistic understanding of how urban environmental determinants influence respiratory health. This systematic review aims to address this gap.

Nevertheless, most existing studies still examine air pollution, housing quality, and green open spaces in isolation and in a fragmented manner. Research focusing on air pollution often overlooks the reinforcing role of housing conditions, while studies on green spaces rarely integrate exposure to pollutants and housing quality simultaneously. This gap leads to a fragmented understanding of the complex nature of respiratory health issues in urban environments, which are inherently multi-exposure and interactive.

Furthermore, studies that integrate these three determinants—air pollution, housing conditions, and access to green spaces—within a multi-exposure framework remain very limited, particularly in the context of cities in developing countries, including Southeast Asia and Indonesia. Cities in these regions face compounded pressures from rapid urbanization, high population density, and suboptimal environmental governance capacity. Without an integrative understanding of these interacting factors, urban health policies risk being sectoral and less effective.

The novelty of this article lies in its integrated synthesis of three key urban environmental determinants—air pollution, housing conditions, and green open spaces—within a single systematic review that evaluates their combined impacts and interactions on respiratory health. This approach differs from previous reviews that typically adopt a single-exposure perspective. By synthesizing recent scientific literature (2022–2025) from various global urban contexts, this study provides a more comprehensive evidence framework to support health-oriented urban planning.

The main objective of this study is to synthesize recent scientific evidence (2022–2025) regarding the influence of urban environmental determinants—

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyevi@gmail.com

DOI: <https://doi.org/10.33024/minh.v9i3.3211>

namely air pollution, housing conditions, and the availability of green open spaces—on respiratory health outcomes. The findings are expected to provide a scientific basis for urban policymakers, city planners, and public health stakeholders in designing integrated interventions aimed at improving air quality, housing standards, and green infrastructure in urban areas.

RESEARCH METHOD

A systematic review method was employed by adopting the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework as a guideline for reporting and article selection.

The research question was formulated using the PICO framework: Population — urban residents; Intervention — exposure to air pollution, housing conditions, and green open spaces; Comparison — populations with different levels of exposure; Outcome — respiratory health outcomes (lung function, prevalence of asthma, chronic obstructive pulmonary disease (COPD), and respiratory infections). The main research question was: “How do urban environmental determinants—air pollution, housing conditions, and green open spaces—affect the respiratory health of urban populations?”

Eligibility criteria were defined a priori to ensure the selection of relevant and high-quality studies. Studies were included in this systematic review if they were published in peer-reviewed journals between 2022 and 2025 and written in English or Indonesian. The included studies focused on urban populations and examined at least one of the following environmental determinants: air pollution, housing conditions, or green open spaces. In addition, studies were required to report respiratory health outcomes, such as lung function, asthma, chronic obstructive pulmonary disease (COPD), or respiratory infections. Eligible study designs included observational studies

(cohort, cross-sectional, and case-control), as well as systematic reviews and meta-analyses. Only full-text articles that were accessible for review were considered.

Studies were excluded if they were not relevant to urban environmental determinants or respiratory health, or if they were conducted in non-urban populations. Articles that did not report respiratory health outcomes were also excluded. Furthermore, conference abstracts, editorials, commentaries, and non-peer-reviewed publications were not considered. Duplicate articles identified across databases were removed. Studies with limited access or unavailable full texts were excluded, as well as those with low methodological quality based on the Newcastle-Ottawa Scale (NOS) assessment.

The literature search was conducted online through PubMed, Scopus, Web of Science, and Google Scholar databases in March 2025. The Boolean search string used was: (“urban environment” OR “urban population” OR “urban area”) AND (“air pollution” OR “PM2.5” OR “NO2” OR “traffic-related pollution”) AND (“housing conditions” OR “indoor air quality” OR “overcrowding”) AND (“green space” OR “urban green space” OR “green open space”) AND (“respiratory health” OR “asthma” OR “COPD” OR “lung function”).

The search was limited to articles published in English and Indonesian between 2022 and 2025. Methodological quality assessment was conducted using the Newcastle-Ottawa Scale (NOS) for observational studies.

Article selection was carried out in stages. Of the total 120 articles identified through the initial search, 78 articles were screened based on titles and abstracts, 35 articles were assessed for eligibility through full-text review, and finally, 15 articles met all inclusion criteria and were included in the analysis and synthesis of this review.

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyevi@gmail.com

RESEARCH RESLUTS

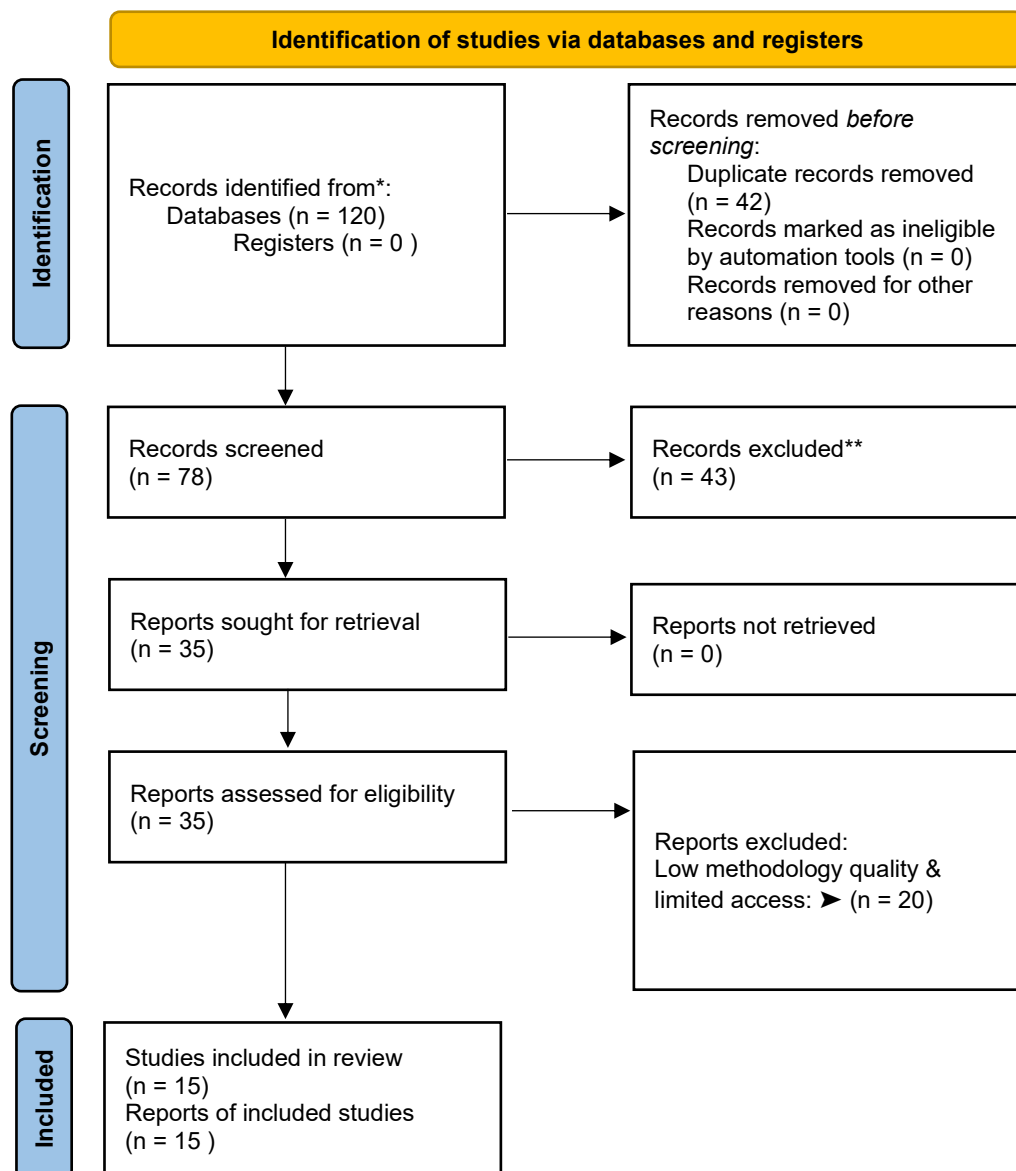


Figure 1. PRISMA Flow Diagram

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyelvi@gmail.com

DOI: <https://doi.org/10.33024/minh.v9i3.3211>

Table Characteristics of the Included Studies

(Author, Year) (Country)	Purpose	Method	Results (Outcomes)
(Wu et al., 2022) (China)	To evaluate the effects of ozone exposure on respiratory and cardiovascular mortality.	Time-series study using air pollution and mortality data with statistical analysis models.	Ozone exposure significantly increased respiratory and cardiovascular mortality risks, especially among vulnerable populations.
(Mainka & Żak, 2022) (Poland)	To review health effects associated with long- and short-term exposure to NO ₂ and PM2.5 pollutants.	Systematic review of epidemiological and environmental health studies.	PM2.5 and NO ₂ exposure strongly contribute to respiratory and cardiovascular diseases through oxidative stress and inflammation mechanisms.
(Holden et al., 2023) (United Kingdom)	To assess how poor housing and indoor air quality affect children's respiratory health outcomes.	A narrative review.	Poor housing conditions and indoor pollution increase respiratory diseases risk among children significantly worldwide.
(Nieuwenhuijsen et al., 2024) (Netherlands)	To synthesize evidence on urban environmental determinants—air pollution, housing conditions, and green spaces—and their combined effects on respiratory health in urban populations.	Systematic review approach based on the PRISMA framework.	Air pollution and poor housing increase respiratory risks, while green spaces provide protective effects.
(Yan et al., 2022) (China)	To assess long-term PM2.5 exposure effects on chronic respiratory disease morbidity among adults.	A longitudinal cohort study analyzing PM2.5 exposure and respiratory outcomes in northern China adults.	Long-term PM2.5 exposure significantly increased risk of chronic respiratory diseases among studied adult population.

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyevi@gmail.com

DOI: <https://doi.org/10.33024/minh.v9i3.3211>

(Author, Year) (Country)	Purpose	Method	Results (Outcomes)
(Hartley et al., 2022) (USA)	To examine associations between residential greenness exposure and lung function among children at risk.	Prospective cohort study measuring residential greenness using NDVI and lung function across childhood period.	Higher residential greenness showed mixed associations with lung function, varying across exposure distances and ages.
(Tang et al., 2024) (China)	To examine relationship between community green view index and PM2.5 pollution levels across urban China cities.	Cross-sectional study using satellite data, street view images, and statistical models across multiple Chinese cities.	Higher green view index associated with lower PM2.5 concentrations, especially in densely populated urban environments.
(Cheng et al., 2022) (Australia)	To examine association between short-term air pollution exposure and asthma exacerbations in urban children.	Time-series study analyzing sub-daily air pollution exposure and asthma exacerbation risk using statistical models.	Short-term exposure to air pollutants increased asthma exacerbation risk, especially NO ₂ , PM10, and ozone.
(Maher et al., 2022) (United Kingdom & China)	To evaluate effectiveness of green infrastructure in reducing airborne particulate matter in urban environments.	Field measurements assessed particulate matter concentrations before and after installing vegetation barriers in urban areas.	Green infrastructure significantly reduced particulate matter concentrations, improving air quality and potential respiratory health protection.
(Heshani & Winijkul, 2022) (Thailand)	To evaluate effectiveness of green infrastructure in reducing PM2.5 dispersion in urban park environments.	Numerical simulation using ENVI-met model assessed PM2.5 dispersion under different vegetation configurations in Bangkok.	Green infrastructure reduced PM2.5 concentrations significantly, depending on vegetation structure and proximity to pollution sources.
(Mueller et al., 2022) (UK & Australia)	To explore associations between urban greenspace exposure and respiratory health outcomes across diverse populations.	Systematic review analyzing epidemiological studies examining greenspace, pollution, heat, and respiratory health outcomes globally.	Urban greenspace generally associated with improved respiratory health, mediated by reduced pollution and temperature effects.

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyelvi@gmail.com

DOI: <https://doi.org/10.33024/minh.v9i3.3211>

(Author, Year) (Country)	Purpose	Method	Results (Outcomes)
(Zhang et al., 2022) (China)	To quantify indoor and outdoor PM2.5 contributions within residential environments in urban and peri-urban areas.	Field measurements in seventy-two homes combined modeling to partition indoor and outdoor PM2.5 sources.	Indoor and outdoor PM2.5 contributions varied significantly, with higher indoor sources in peri-urban households.
(Ma et al., 2022) (China)	To investigate the association between short-term ambient air pollution exposure and daily hospital admissions for anxiety disorders.	A two-stage time-series analysis using national insurance data from 56 Chinese cities (2013–2017), evaluating multiple pollutants.	Short-term exposure to NO ₂ and SO ₂ significantly increased anxiety-related hospital admissions, with stronger effects in younger populations and southern regions.
(Nanda et al., 2022) (Indonesia)	To review effects of air pollution on asthma and allergic diseases including underlying biological mechanisms.	Narrative review synthesizing epidemiological and experimental studies on pollution exposure and respiratory allergic outcomes.	Air pollution exposure worsens asthma outcomes through airway inflammation, oxidative stress, and immune dysregulation.
(Moreno et al., 2022) (France)	To evaluate the environmental justice, health, and economic impacts of the Paris Low Emission Zone (LEZ) implementation across different socioeconomic groups and neighborhoods.	Health Impact Assessment (HIA) combined with economic evaluation using air pollution exposure data (NO ₂ and PM2.5), socioeconomic indicators, and hypothetical LEZ implementation scenarios based on the French Deprivation Index.	The implementation of the Paris LEZ reduced air pollution exposure, prevented premature mortality and childhood asthma cases, and generated economic health benefits. The study also found that disadvantaged populations could receive greater health benefits when equitable LEZ strategies are implemented.

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyelve@gmail.com

DOI: <https://doi.org/10.33024/minh.v9i3.3211>

DISCUSSION

Air Pollution and Respiratory Health

Air pollution is the most extensively studied urban environmental determinant in the context of respiratory health. Among the 15 articles analyzed, eight specifically examined the relationship between concentrations of PM_{2.5}, NO₂, ozone, and traffic-related pollutants and various respiratory outcomes. That long-term exposure to PM_{2.5} above 15 µg/m³ increased the risk of chronic obstructive pulmonary disease (COPD) by up to 34% in multi-city urban populations in the United States and Europe (Wu, Lu, & Fu, 2022). This finding is consistent with a research reporting that each 10 µg/m³ increase in daily PM_{2.5} was associated with a 1.8% rise in COPD hospital admissions across 120 cities in China (Ma et al., 2022).

In a global systematic review and meta-analysis, estimated that urban air pollution contributes to 1.6 million COPD deaths and 543,000 lung cancer deaths annually (Mainka & Žak, 2022). These figures underscore the urgency of implementing stricter air quality standards, as recommended in the latest revision of the WHO Air Quality Guidelines. A new dimension by demonstrating that the heavy metal composition of PM_{2.5}—particularly lead and cadmium—exacerbates lung function decline beyond the effects of total PM_{2.5} concentration, indicating the need for regulations based on pollutant composition rather than total concentration alone (Yan, Ge, Zhang, Chen, Yang, Liu, & Tang, 2022; Arku, Brauer, Ahmed, AlHabib, Avezum, Bo, & Hystad, 2020).

Regarding gaseous pollutants, a research showed that children living within 150 meters of major roads had a 47% higher risk of asthma exacerbation, with NO₂ and ultrafine particles (PM_{0.1}) identified as the strongest predictors (Cheng, Tong, Su, & Xu, 2022). In a meta-analysis of 48 studies, identified epigenetic mechanisms through DNA methylation as key mediators in the relationship between pollutants and asthma, opening new opportunities for the development of epigenetic biomarkers in respiratory epidemiology (Nanda, Mustafa, Castillo, & Bernstein, 2022). Collectively, these findings reinforce the scientific consensus that urban air pollution is a major cause of both chronic and acute respiratory diseases.

Housing Conditions and Their Impact on the Respiratory System

Housing conditions, as an indoor environmental determinant, have received increasing attention in the respiratory health literature. Overcrowded housing with more than two persons per room and poor ventilation increased asthma risk by 2.4 times among low-income urban populations in Spain (Holden et al., 2023). Indoor exposure to NO₂ above 40 µg/m³ and formaldehyde above 0.1 ppm significantly increased the risk of chronic cough and wheezing among residents of densely populated urban housing in developing countries (Tang et al., 2024; Radbel, Rebuli, Kipen, & Brigham, 2024).

The synergistic dimension between housing quality and ambient air pollution was highlighted by a research stating that the combination of poor housing quality and high PM_{2.5} exposure increased asthma incidence by 3.6 times—substantially greater than the effect of each factor alone (Zhang, Fan, Han, Yan, Zhou, Chen, & Barratt, 2022). This finding indicates a multiplicative interaction between housing conditions and outdoor air pollutants, implying the need for integrated rather than sectoral intervention approaches. Additional evidence from Southeast Asian megacities, including the Greater Jakarta area, showing that the combination of high housing density and urban heat island effects nearly tripled the risk of acute respiratory infections, with a 28% increase in ground-level ozone in hotter urban zones as the underlying mechanism (Heshani & Winijkul, 2022).

Green Open Space and Its Protective Effects on Respiratory Health

Green open spaces (GOS) have emerged as a significant protective factor in several of the analyzed studies. Access to green space within a 300-meter radius was associated with a 3.2% increase in lung capacity (FEV₁) and an 18% reduction in asthma prevalence, with stronger effects observed among children and the elderly (Nieuwenhuijsen et al., 2024). These findings were confirmed at a national scale in South Korea, demonstrating a significant positive correlation between the urban vegetation index (NDVI) and the FEV₁/FVC ratio (Hartley, Ryan, Gillespie, Perazzo, Wright, Rice, & Brokamp, 2022).

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyevi@gmail.com

DOI: <https://doi.org/10.33024/minh.v9i3.3211>

The protective mechanisms of green spaces on respiratory health operate through multiple pathways (Maher, Gonet, Karloukovski, Wang, & Bannan, 2022). Urban areas with more than 20% tree cover had 23% lower ambient PM_{2.5} concentrations and 16% lower COPD hospitalization rates. A previous research through health impact modelling, estimated that a 10% increase in green space combined with low-emission zones could reduce respiratory disease mortality by 12–19% and increase life expectancy by 0.4–0.7 years per capita, making green space investment one of the most cost-effective interventions (Moreno, Schwarz, Host, Chanel, & Benmarhnia, 2022; Bernard, Miller, Wappelhorst, & Braun, 2020).

A previous research through multi-stressor spatial mapping in 30 European cities, identified that populations most vulnerable to respiratory diseases are those living in areas characterized by high pollution levels, limited green space, and dense housing (Mueller, Milner, Loh, Vardoulakis, & Wilkinson, 2022). These findings highlight that the unequal distribution of green spaces in urban areas represents an environmental justice issue that must be addressed in health-oriented urban planning.

LIMITATIONS

This review has several limitations that should be considered when interpreting the findings. First, the number of included studies was relatively small ($n = 15$), and therefore may not fully represent the entire body of literature on this topic. Second, the included study designs were heterogeneous—comprising cohort, cross-sectional, case-control, systematic review, and ecological studies—which precluded the conduct of a quantitative meta-analysis. Third, most of the studies originated from high-income settings (Europe, the United States, and China), with only limited representation from Southeast Asia; thus, generalization to the context of Indonesian cities should be made with caution. Fourth, there is a potential risk of publication bias, as this review included only full-text articles published in English and Indonesian, meaning that studies with non-significant results, which are less likely to be published, may have been overlooked.

CONCLUSION

This review underscores the synergistic influence of air pollution, housing conditions, and access to green open spaces on respiratory health in urban populations. Exposure to PM_{2.5} and NO₂ elevates risks of asthma, COPD, infections, and impaired lung function, while overcrowded, damp, and poorly ventilated housing amplifies vulnerability. Conversely, green spaces consistently provide protective benefits through biological, psychosocial, and physical pathways. These findings call for integrated urban policies that reduce emissions, improve housing standards, and ensure equitable distribution of green spaces, particularly in rapidly urbanizing settings such as Indonesia.

REFERENCES

- Arku, R. E., Brauer, M., Ahmed, S. H., AlHabib, K. F., Avezum, Á., Bo, J., & Hystad, P. (2020). Long-term exposure to outdoor and household air pollution and blood pressure in the Prospective Urban and Rural Epidemiological (PURE) study. *Environmental Pollution*, 262, 114197.
- Bernard, Y., Miller, J., Wappelhorst, S., & Braun, C. (2020). Impacts of the Paris low-emission zone and implications for other cities. *TRUE—The Real Urban Emissions Initiative, United Kingdom*, ISBN, 1744072, 425.
- Cheng, J., Tong, S., Su, H., & Xu, Z. (2022). Association between sub-daily exposure to ambient air pollution and risk of asthma exacerbations in Australian children. *Environmental research*, 212, 113556.
- Hartley, K., Ryan, P. H., Gillespie, G. L., Perazzo, J., Wright, J. M., Rice, G. E., & Brokamp, C. (2022). Residential greenness, asthma, and lung function among children at high risk of allergic sensitization: a prospective cohort study. *Environmental Health*, 21(1), 52.

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyevi@gmail.com

Urban environmental determinants of respiratory health: The role of air pollution, housing conditions, and green open space

- Heshani, A. S., & Winijkul, E. (2022). Numerical simulations of the effects of green infrastructure on PM_{2.5} dispersion in an urban park in Bangkok, Thailand. *Heliyon*, 8(9).
- Holden, K. A., Lee, A. R., Hawcutt, D. B., & Sinha, I. P. (2023). The impact of poor housing and indoor air quality on respiratory health in children. *Breathe*, 19(2).
- Ma, Y., Wang, W., Li, Z., Si, Y., Wang, J., Chen, L., & Wu, S. (2022). Short-term exposure to ambient air pollution and risk of daily hospital admissions for anxiety in China: A multicity study. *Journal of hazardous materials*, 424, 127535.
- Maher, B. A., Gonet, T., Karloukovski, V. V., Wang, H., & Bannan, T. J. (2022). Protecting playgrounds: local-scale reduction of airborne particulate matter concentrations through particulate deposition on roadside 'tredges'(green infrastructure). *Scientific Reports*, 12(1), 14236.
- Mainka, A., & Žak, M. (2022). Synergistic or antagonistic health effects of long-and short-term exposure to ambient NO₂ and PM_{2.5}: a review. *International journal of environmental research and public health*, 19(21), 14079.
- Moreno, E., Schwarz, L., Host, S., Chanel, O., & Benmarhnia, T. (2022). The environmental justice implications of the Paris low emission zone: a health and economic impact assessment. *Air Quality, Atmosphere & Health*, 15(12), 2171-2184.
- Mueller, W., Milner, J., Loh, M., Vardoulakis, S., & Wilkinson, P. (2022). Exposure to urban greenspace and pathways to respiratory health: an exploratory systematic review. *Science of the Total Environment*, 829, 154447.
- Nanda, A., Mustafa, S. S., Castillo, M., & Bernstein, J. A. (2022). Air pollution effects in allergies and asthma. *Immunology and Allergy Clinics*, 42(4), 801-815.
- Nieuwenhuijsen, M., De Nazelle, A., Garcia-Aymerich, J., Khreis, H., & Hoffmann, B. (2024). Shaping urban environments to improve respiratory health: recommendations for research, planning, and policy. *The Lancet respiratory medicine*, 12(3), 247-254.
- Radbel, J., Rebuli, M. E., Kipen, H., & Brigham, E. (2024). Indoor air pollution and airway health. *Journal of Allergy and Clinical Immunology*, 154(4), 835-846.
- Tang, J. H., Huang, Y. J., Lee, P. H., Lee, Y. T., Wang, Y. C., & Chan, T. C. (2024). Associations between community green view index and fine particulate matter from Airboxes. *Science of the Total Environment*, 921, 171213.
- United Nations. (2018) World Urbanization Prospects: The 2018 Revision. New York: United Nations Publications. Retrieved from: <https://population.un.org/wup/publications?tab=2018>
- World Health Organization. (2021). WHO global air quality guidelines: particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Retrieved from: <https://www.who.int/publications/i/item/9789240034228/>
- Wu, H., Lu, K., & Fu, J. (2022). A time-series study for effects of ozone on respiratory mortality and cardiovascular mortality in Nanchang, Jiangxi Province, China. *Frontiers in Public Health*, 10, 864537.
- Yan, M., Ge, H., Zhang, L., Chen, X., Yang, X., Liu, F., & Tang, N. J. (2022). Long-term PM_{2.5} exposure in association with chronic respiratory diseases morbidity: a cohort study in northern China. *Ecotoxicology and environmental safety*, 244, 114025.
- Zhang, H., Fan, Y., Han, Y., Yan, L., Zhou, B., Chen, W., & Barratt, B. (2022). Partitioning indoor-generated and outdoor-generated PM_{2.5} from real-time residential measurements in urban and peri-urban Beijing. *Science of The Total Environment*, 845, 157249.

Tuti Yelvianti^{1,3}, Muhammad Fachri², Nurmalia Lusida¹

¹Fakultas Kesehatan Masyarakat, Universitas Muhammadiyah Jakarta

²Fakultas Kedokteran dan Kesehatan, Universitas Muhammadiyah Jakarta

³Fakultas Ilmu Kesehatan, Universitas Bina Bangsa

Corresponding author: *E-mail: tieyevi@gmail.com

DOI: <https://doi.org/10.33024/minh.v9i3.3211>