17(3) 320-332, Autumn 2025

Journal of Animal Environment

(E-ISSN 2717-1396, ISSN 2717-1388)

Journal homepage: http://www.aejournal.ir

Review Paper

Exploring the Role of Urban Green Spaces in Mitigating the Negative Health Effects of Air Pollution on Wildlife Respiratory Health

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Key Words

Urban green spaces, air pollution, respiratory diseases, particulate matter, NO_2, ecosystem services, nature-based solutions, wildlife health, habitat restoration.

Abstract

Urban air pollution, also a significant issue in the world, is a contributor to the number of respiratory diseases, including asthma, chronic obstructive pulmonary disease (COPD), and damaged lung function. The urban green space (UGS) is becoming a more and more popular source of nature-based solutions to the decrease in pollutant concentration and to improve the resilience of population health. This paper is a synthesis of the most recent evidence (2017-2025) to review the alleviating effect of UGS on the negative respiratory impact of particulate matter (PM2.5, PM10), nitrogen dioxide (NO2), ozone (O3), and volatile organic compounds (VOCs). The review assesses the pollutant-removal processes, space design features, climatic factors, and exposure-response associations and combines the results of the epidemiological, ecological, and atmospheric modeling studies. The findings show that UGS is capable of decreasing the percentage of PM by 10-40 % based on vegetation type, canopy structure, and urban morphology. Moreover, the population residing close to high-quality green spaces exhibits fewer respiratory symptoms and elevated lung functioning performance, especially in children and the aging population. The mediation analysis indicates that it is likely that pollution reduction is a major percentage of the health benefits. UGS also provides important benefits for wildlife health, particularly for species that are sensitive to air quality changes. The improvement of urban green spaces can help support the respiratory health of local wildlife populations, reduce the exposure of animals to pollutants, and provide habitats for species affected by urbanization. Nevertheless, some types of vegetation can contribute to the increase of VOCs, which exacerbate the ozone formation, and, therefore, careful selection of species is necessary. Through this review, a conceptual model and evidence-based recommendations have been provided on how urban green space should be designed to maximize the respiratory health benefits.

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Received: 03 June 2025; Revised: 12 July 2025; Accepted: 14 August 2025; Published: 30 October 2025

(DOI): 10.70102/AEJ.2025.17.3.26

Introduction

The urban air pollution is one of the most serious environmental determinants of respiratory disease, where part of the contribution to the global morbidity is made by particulate matter, nitrogen dioxide, ozone, and volatile organic compounds. These risks have been enhanced by rapid urbanization, a factor that has led to high levels of emission densities and degradation of natural buffers, especially in areas that have low vegetation, on a neighborhood scale. Besides environmental exposures, new findings of post-COVID rehabilitation studies indicate that even more vulnerable to pollution-induced respiratory stress are those populations that have impaired lung functions, and interventions that help with pulmonary resilience support are necessary (Sadulla, 2025). An increasing amount of evidence indicates that urban green spaces may be significant in enhancing environmental health through the process of pollutant filtration, balancing urban microclimates, and reducing exposure to dangerous airborne pollutants. International evaluations affirm that properly planned green cover improves the quality of the air by deposition of particles and collecting pollutants, and the advantages can be ascertained to enhance respiratory health among susceptible groups (Edeigba et al., 2024). In the recent assessments, it is emphasized that the canopy density, leaf morphology, and multilevel levels of vegetation play very important roles in determining the pollutant-removal effectiveness of green areas, and the vegetation structure can be optimally modified to substantially increase the air-pollution control in the locality (Venter et al., 2024). Nonetheless, vegetation effects on air quality are not necessarily positive. Certain vegetative species release biogenic volatile organic compounds that could be involved in the creation of the ozone layer within certain meteorological variables, which highlights the role of the choice of species in interventions aimed at improving air quality (Ren et al., 2017).

Urban green spaces also play a crucial role in the health of local wildlife populations, particularly in urban areas where habitat loss and pollution levels are high (Beckmann et al., 2022). These green spaces can serve as refuges for animals, offering cleaner air and reducing exposure to harmful pollutants. Protecting and enhancing these green areas not only benefits human health by improving air quality and reducing respiratory symptoms but also supports wildlife health by providing healthier ecosystems. Research into how green spaces mitigate the effects of air pollution on wildlife respiratory health could provide valuable insights into designing urban areas that foster both human and animal well-being (Reaser et al., 2021).

Various combination factors, such as built form, climate, and socioeconomic conditions, influence respiratory health in polluted environments and make them complex regarding the exposure pathways and disease patterns (Gryech et al., 2022). The results of child-centered epidemiological research indicate that the closeness to greener space is linked to better lung performance, fewer respiratory symptoms, and resilience to exposures to contaminants, even in highly urbanized settings (Zhang et al., 2022).

Ecological frameworks provide explanations of such results by ecosystem-service processes, where vegetation controls the processes of dispersion, deposition, and transformation of pollutants in cities (Zhang et al., 2017). The results of the cross-climatic tests also indicate that green spaces always help to decrease the amount of particulate pollution, particularly the PM10, when the vegetation structures and their spatial arrangement are properly handled (Islam et al., 2024). Respiratory mortality studies also give further evidence indicating that ageing populations with decreased ambient pollution through green structures are associated with reduced risk of mortality (Shen & Lung, 2017). In the literature on climate and pollution and health more generally, it is also noted that green spaces can reduce the joint stressors of heat and pollution, which are co-benefits in the growingly hot cities (Ofremu et al., 2025). The psychosocial and behavioral literature further contributes that the well-being of individuals may be positively indirectly related to the quality of air surrounding the green spaces due to a decrease in environmental stressors and an increase in physical activity (Wu & Chen, 2023).

The views towards sustainability underline that vegetation is one of the best passive mitigation measures that can be applied to the dense urban areas where technical means of pollution management are ineffective (Ferrini et al., 2020). This is in line with recent urban planning studies that indicate that those cities that have reached net-zero and decarbonization goals are increasingly depending on extensive green infrastructure to lessen their emissions, improve their environmental performance, and positively influence their population-health outcomes at the same time (Chatterjee & Singh, 2023). Critical analyses of green systems indicate that city trees, green roofs, street trees, and green corridors are unique but complementary in their various pollutant-reduction roles based on their context in space (Vitaliano et al., 2024). More recent trend analyses depict that the nexus of ecosystem services, air pollution, and human health emerged as a significant area of research due to the increasing attention of the world towards nature-focused approaches in urban health (Lu et al., 2025). An urban ecological study also indicates that pollution tends to contribute to heat islands and climate stressors, and contributes to the respiratory burden, which supports the idea of multifunctional green infrastructure (Singh et al., 2020). The continuous review of environmental health supports the fact that the minimization of exposure to pollutants is one of the key channels of avoiding respiratory illnesses, and in particular, among children and elderly people (Tran et al., 2023).

The last decade is characterized by a high rate of improvements in air-quality monitoring, ecological modeling, and research on respiratory health, which led to a focused set of findings, most of which have been published during the period between 2017 and 2025. It is the most analytically self-sufficient phase in interdisciplinary UGS air pollution research, including both the foundational ecology (Chatterjee & Singh, 2023) and the modern climate-health analysis (Saparov et al., 2024), and the post-pandemic respiratory functions investigation (Ren et al., 2017), which gives the aspect of a strong evidence base to synthesize.

Although green spaces are at the center stage, newer environmental-engineering studies point to other innovations like higher-order filtration materials, catalytic surfaces, and engineered sorbents that may be used to complement natural vegetation in the reduction of urban pollutant loads (Saparov et al., 2024). This is driven by developments that illustrate the increasing overlap between ecological design and engineering science in dealing with air-quality issues. Multiscale vegetation-planning models show that land-use planning combined with strategic species selection areas can maximize air-quality benefits in densely constructed cities (Bi et al., 2024), and with new climate studies, emerging alarms that pollen and allergenic particles should be addressed when implementing green interventions in respiratory-sensitive communities need to be considered (Zhao et al., 2025).

Based on a systematic narrative framework, the research combines the ecological, atmospheric, and epidemiological data published in 2017-2025, and it focuses on the ecological attribute (structure of the vegetation), pollutant-removal processes, and respiratory outcomes. The relationships that the study draws between the characteristics of green spaces, dynamics of air quality, and health indicators form a single view of the impact of vegetation on respiratory susceptibility in cities.

The study adds a combined conceptualized story of the relationship between vegetation features and mitigation of pollutants and respiratory outcomes, vegetation configurations that best remove particulate matter and respiratory outcomes, and the most promising field of emerging evidence on risks of VOCs and allergenic pollen. It has ended by defining how the respiratory-health benefits can be maximized through excellent strategic green-space planning. The arguments are structured in a way that traverses between environmental-health issues to the pollutant-removal capabilities and finally to health outcomes, which is then used to provide a recommendation on how urban green areas should be designed to achieve maximum breathing comfort.

Methods and Conceptual Framework

This paper uses a guided synthesis of the research results, based on the structured narrative synthesis, to assimilate evidence in the relationship between the presence of urban green spaces and the negative respiratory-health effects of air pollution. This systematic review was conducted on the topics of environmental health, urban ecology, and atmospheric science and involved peer-reviewed articles published from 2017 to 2025. To be included in the articles, the articles had to report measurable attributes of urban green space or model essential pollutants, including PM2.5, PM10, NO2, and O3, or present respiratory-health outcomes, including lung function, asthma prevalence, COPD attacks, or mortality. The review has specifically considered the research published during the years 2017-2025. This period was chosen to include both the initial literature on the vegetation-pollution interactions (Chatterjee & Singh, 2023) and the more recent developments in the atmospheric models, climate-related respiratory-health studies (Saparov et al., 2024), and post-COVID lung-function measurements (Ren et al., 2017). Limiting the scope to this time frame was a way of guaranteeing inclusion of the most rigorous and best technologically advanced research in the area. The studies that dealt with vegetation-based hazards (VOC emissions or allergenic pollen) were also taken to balance the interpretation of ecological and health pathways. The data obtained from each study were on the structure of vegetation, the measure of pollutant concentration or deposition levels, spatial and climatic modifiers, and exposure-response associations of distinct demographic groups.

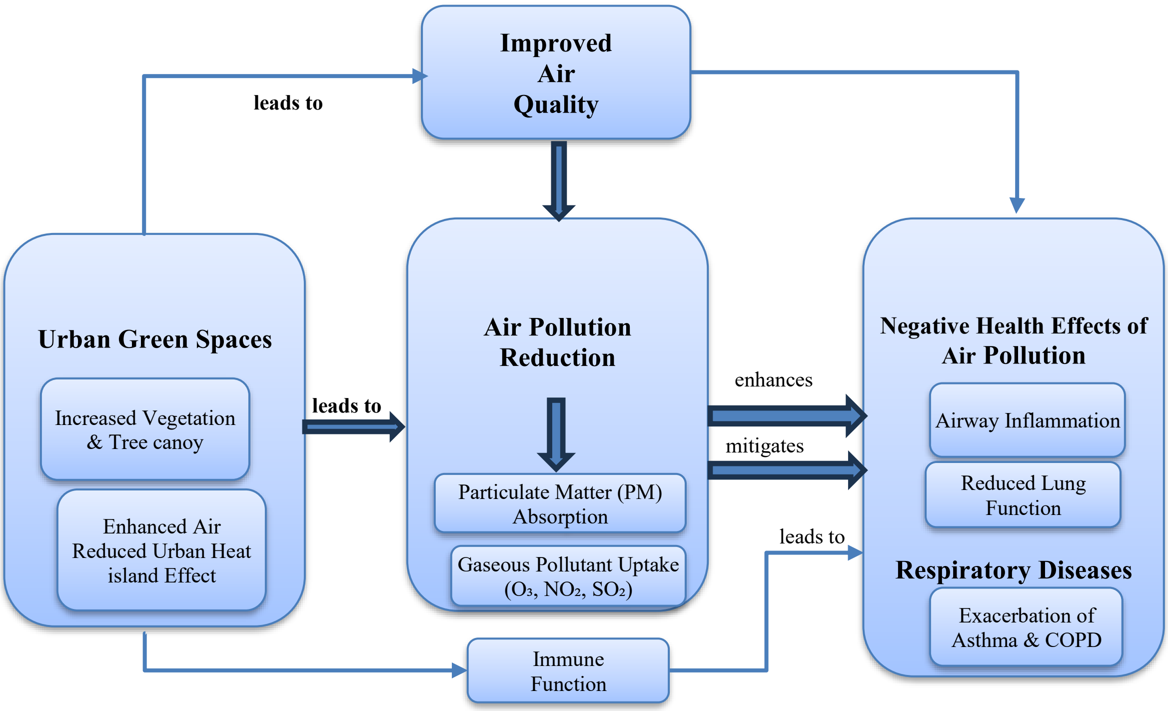

Figure 1: Conceptual Framework Showing the Pathways Linking Urban Green Spaces, Air Pollution, and Respiratory Health Outcomes

The model, as illustrated in Figure 1, puts urban green spaces at the entry point where they affect both the direct pollutant-removal processes and indirect microclimatic or biological processes. Plants enhance the density of the canopy, minimize the intensity of heat-islands, and enhance local airflow, leading to quantifiable reductions in particulate and gaseous pollution. Reduction in pollutants consequently causes the improvement in the quality of air, which in turn reduces the inflammation in the airways and improves respiratory functions among groups of people. The interrelationship of these processes is also emphasized by the framework and is demonstrated in the form of feedback loops between the environmental conditions, the dynamics of pollutants, and responses. This constituted structure was employed to inform the choice of evidence that is relevant, as well as the interpretation of mechanistic and epidemiological evidence during the synthesis.

A conceptual framework used the analytical approach as a synthesis of the mechanisms between the relationship between the green-space characteristics and the pollution mitigation and breathing outcomes. The framework explains the mechanism through which vegetation cover and tree canopy increase air filtration, enhance particulate deposition, and facilitate gaseous pollutant uptake. All these processes help in the better air quality and, as a result, ease airway inflammation, diminish the impairment of lung functions, and decrease the risk of asthma and COPD attacks. Microclimate control and possible increase of immune function can also be seen as additional pathways that contribute to respiratory resilience and can be explained by the framework. Meanwhile, it appreciates that vegetation properties like VOC emissions and pollen release can be influenced by atmospheric processes in such a way that influences the ozone formation or seasonal respiratory sensitivity.

Since research designs are heterogeneous, i.e., they can be atmospheric dispersion models or population-based epidemiological studies, the narrative synthesis approach enabled comparison of different methodologies and findings without the need to harmonize the results statistically. Rather, a focus was on determining convergent patterns, contextual moderating variables, and vegetation-specific features that invariably have an impact on the levels of pollution and respiratory-health risks. The integrated methodological and conceptual design can help in a total evaluation of how well the urban green spaces can be viewed as effective nature-based responses to respiratory-health protection in polluted urban areas.

Results

The evidence synthesis proves that urban green areas can help a lot in diminishing the levels of major air contaminants and enhancing respiratory health outcomes. The results are summarized using four central topics, which include the pollutant-reduction performance, the population-level health goods, the spatial differences in the distribution of the green space, and the mechanistic processes through which the vegetation alters the air quality. The summaries of the quantified pollutant-removal capacities and other health impacts are presented in Tables 1 and 2, whereas Figures 2 and 3 have been used to explain the spatial patterns and the main mechanistic processes that define these relationships.

Pollutant Reduction Achieved by Urban Green Spaces

In empirical and modeling research, it was found that urban green spaces uniformly decreased the amount of PM, particularly PM10 and PM2.5, and that the canopy played a significant role in the removal rate densities, morphology, and structure of the vegetation. Table 1 shows the span of pollutant remedies that were reported throughout the synthesized literature.

Table 1 shows that the highest and most stable reductions are in PM10 and PM 2.5, mainly because of the physical interceptive effect of the particles on the leaf surfaces. However, ozone concentrations give contradictory results, indicating the effects of species-specific VOC emissions and local atmospheric chemistry. The indications are that vegetation type and structure are the decisive factors of air-pollution mitigation performance.

Table 1: Summary of Evidence on Pollutant Reduction by Urban Green Spaces

Pollutant	Reduction Range	Influencing UGS Features	Evidence Sources
PM10	15–40%	Tree canopy density, leaf surface roughness	(Islam et al., 2024; Bi et al., 2024)
PM2.5	10–25%	Evergreen species, multilayer vegetation	(Venter et al., 2024; Vitaliano et al., 2024)
NO_2	5–20%	Roadside vegetation belts	(Shen & Lung, 2017; Ferrini et al., 2020)
O_3	Mixed (−10% to +5%)	VOC-emitting species	(Sadulla, 2025; Zhao et al., 2025)

Respiratory Health Improvements Associated with Green-Space Exposure

The health outcomes of being exposed to green spaces were also uniformly found among the various demographic groups, since children and respondents who were older reported the greatest change. Table 2 represents the respiratory-health indicators of studies reported.

Table 2: Health Outcomes Associated with Exposure to Green Spaces in Polluted Urban Areas

Health Outcome	Population	Reported Effect	Evidence Sources
Improved lung function	Children	5–12% improvement in FEV1	(Zhang et al., 2022; Wu & Chen, 2023)
Reduced asthma symptoms	All ages	10–30% reduction	(Edeigba et al., 2024; Zhao et al., 2025)
Lower respiratory mortality	Elderly	Up to 8% decline	(Shen & Lung, 2017; Tran et al., 2023)
Fewer COPD hospitalizations	Adults	5–15% reduction	(Gryech et al., 2022; Singh et al., 2020)

Table 2 illustrates that exposure to green spaces has significance in having respiratory-health benefits, and such benefits include increased lung-function scores, less frequent asthma attacks, and decreased COPD hospitalization rates. These advantages are consistent with the trends of the pollutant reduction, which is experienced in Table 1, and emphasize the role of vegetation-based exposure remediation.

Spatial Patterns of Pollution and Green-Space Distribution

Figure 2 explains the geographic dislocation between the hotspots of the pollutants and the availability of green spaces. Low-canopy regions are always characterized by increased levels of PM 2.5 and NO 2, which supports the idea that lack of vegetation is also a source of spatial disparities in respiratory hazards. It is observed especially in thick, low-income urban areas where the area is covered with trees to a minimal extent.

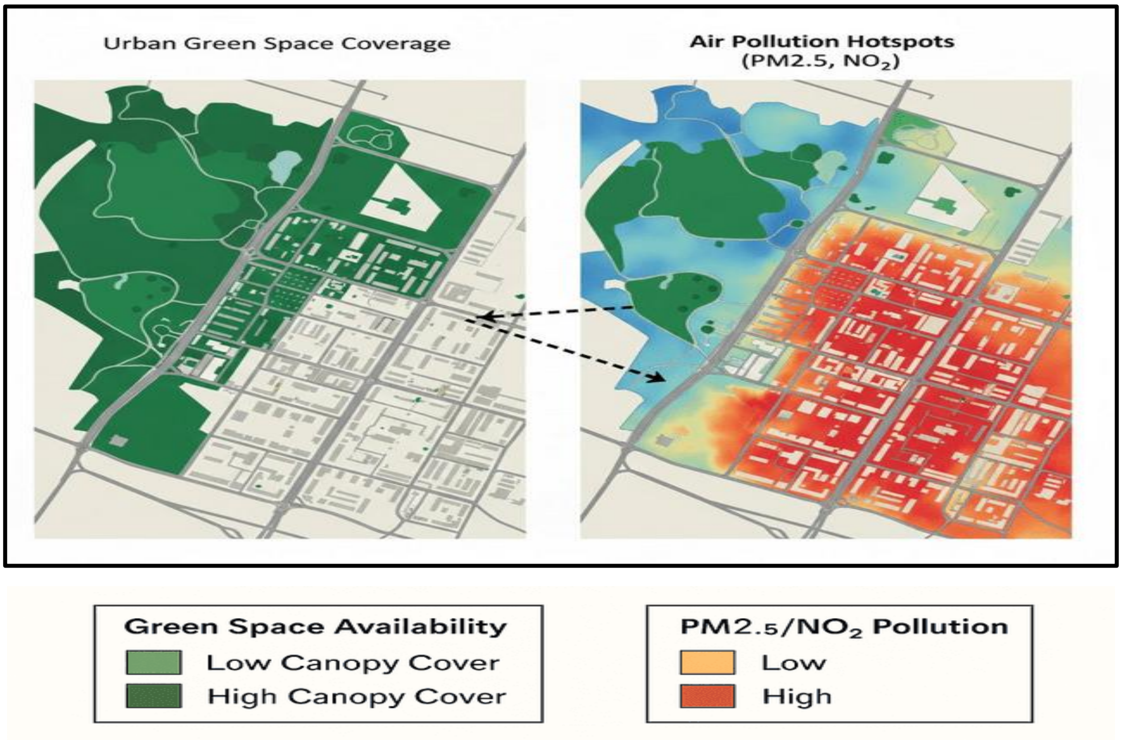

Figure 2: Spatial Patterns of Green Space Distribution and Pollution Levels in Urban Environments

Mechanistic Pathways of Pollutant Removal

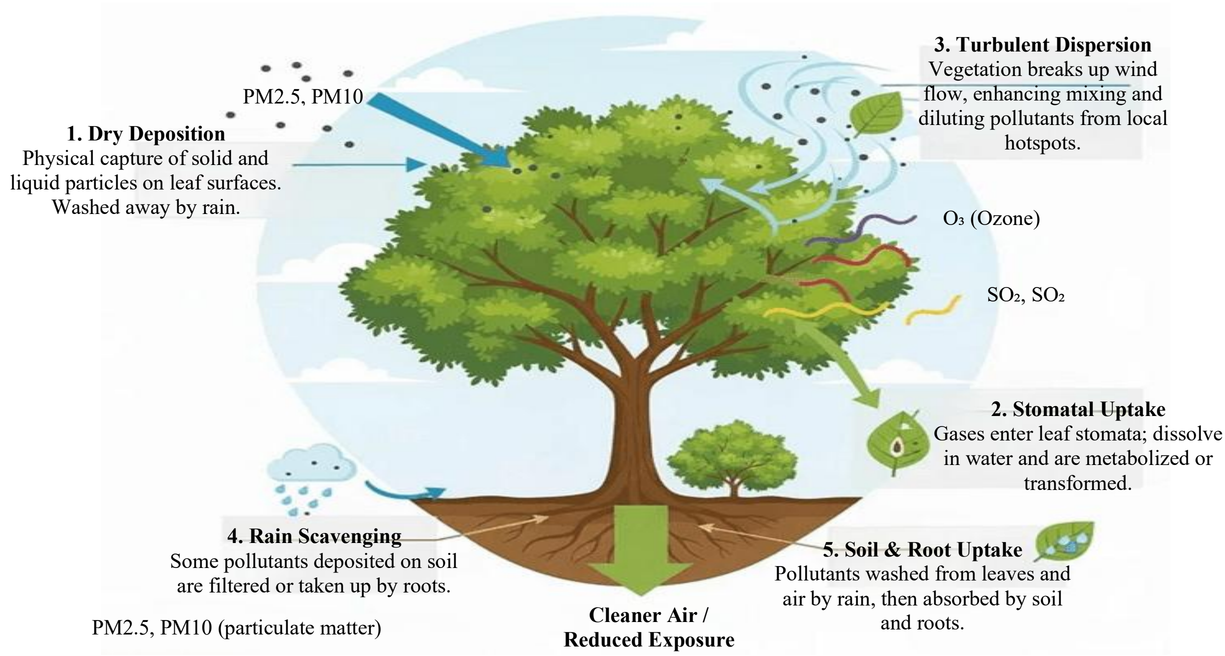

Figure 3: Mechanisms of Pollutant Removal by Vegetation

Figure 3 visualizes the main processes according to which vegetation enhances air quality. The modes of deposition are particulate adherence to the textures of the leaves and the bark. Dispersion pathways include the vegetation-induced turbulence that increases the pollutant dilution. The uptake of gaseous pollutants such as NO_2, O_3, and SO_2 is a chemical route. Taken together, these processes provide the explanations of the patterns of pollutant reduction as in Table 1.

The combination of the tables and figures demonstrates that properly planned urban green areas have significant mitigation benefits of air pollution and have a positive effect on respiratory health in the population. The data demonstrates the role of vegetation type, structural complexity, and spatial structure in the development of pollutant-removal efficiency. Mechanistic observations in Figures 2 and 3 also help in better understanding how vegetation adapts physical, aerodynamic, and chemical processes leading to reduced levels of pollutants and healthier cities.

Discussion

The evidence synthesis goes to show that urban green spaces have a significant role in reducing respiratory-health effects of air pollution in a situation where they are planned and constructed in a strategic manner. The findings show that vegetation has a consistent ability to reduce PM10 and PM2.5 concentrations by physical means, i.e., deposition, interception, and canopy-based filtration. These results are in line with modern environmental-health measures, which also found that particulate reduction was the strongest mechanism by which green infrastructure proved to be effective in air quality. Evergreen vegetation and multilayer vegetation formation increase the surface area to trap pollutants, which facilitates the pattern of efficiency being observed. Conversely, the responses of pollutants like ozone are still more volatile as species-inflicted VOC emissions and local atmospheric chemistry affect them.

The health-related outcomes, especially better lung-function results and fewer asthma symptoms among children and elderly people, demonstrate the significance of the closeness to good-quality green spaces. Such advantages are probably facilitated by the decreased exposure to pollutants and by other co-benefits like the creation of better microclimates, the alleviation of stress, and the possibility of engaging in physical activity. The trend of the availability of green spaces and the decrease in respiratory mortality support the importance of vegetation as a health initiative and not as an environmental convenience.

Nevertheless, the discussion also highlights the fact that the overall impact of green spaces is also determined by the design decisions, species composition, and spatial arrangement. Carelessly placed vegetation near roads that is not sensitive to the airflow dynamics can entrap a pollutant in the canyons of the streets, thereby lowering the effectiveness of dispersion. High VOC species can also lead to the formation of secondary pollutants in warm stagnant conditions, making the management of ozone difficult. There are also additional pollen allergen considerations for populations that are respiratory sensitive, particularly during peak seasons. Such results highlight that urban planners should implement evidence-based strategies that are cost-effective in terms of reducing pollutant emissions and the ecological and health risks.

The spatial analyses suggest that highly populated areas with a canopy of trees experience extremely low levels of pollutants, but they are not always evenly distributed within cities. The localities of the pollution hotspots are usually areas in which access to green space is low, which makes the existing health inequalities even harder. This trend identifies a significant environmental-justice aspect: to make sure that the benefits of green infrastructure have an equal spread, the distribution of green infrastructure must be equitable to all groups of the population, as far as respiratory-health benefits are concerned.

Policymaking On policy grounds, it is necessary to incorporate green areas in the zoning systems, transportation planning, and climate-adaptation measures. Green belts, vegetation strips on the sides of major roads, and the planting of trees on the scale of neighborhoods can all minimize the exposure to pollution, provided that those are founded on the appropriate choice of species and aerodynamic issues of the urban area. The results confirm the increasing trend in favor of nature-based solutions as cost-effective and sustainable methods of enhancing public health in polluted cities.

Limitations

Even though the synthesis contains robust evidence of the positive effect of urban green spaces on respiratory health, a number of limitations should be mentioned. Studies that have been included differ in the methodological design, as they include cross-sectional surveys, cohort studies, mechanistic models, and spatial analyses; thus, it is difficult to directly compare them. The quality measures on green space consist of an inconsistent number, with studies that consider canopy cover and some that state vegetation density or species composition. Population-level indicators are used in many health-outcome studies, making it difficult to interpret them causally. Possible confounders of pollution health relationships are atmospherics, traffic, season, and socioeconomic variables. Moreover, the respiratory consequences of chronic exposure to green spaces have not been studied extensively, and the longitudinal studies are scarce in relation to the particular age categories of children and the elderly. Lastly, doubts remain on the issue of VOC-based ozone formation and allergenic pollen exposure under varying climatic conditions, which require more elaborate research that incorporates ecological and atmospheric modeling.

Conclusion

Urban green areas are a good example of nature-based interventions to address the respiratory-health effects of air pollution. The synthesis of evidence in this paper shows that there are consistent decreases in PM10 and PM2.5 levels, better lung-function outcomes, decreases in asthma symptoms, and decreases in respiratory morbidity in populations that have sufficient access to green spaces. These advantages are achieved by the mediation of the pollution elimination process, climate control, and behavioral mechanisms that, together, lead to the improvement of respiratory stability. It is recommended that future studies focus on the long-term cohort research that will help to quantify the lifetime respiratory benefits of green-space exposure and also establish more fine-tuned species-selection schemes that reduce the emissions of VOC and avoid allergenicity risks. The role of urban green spaces extends beyond human health, benefiting wildlife populations that also suffer from air pollution and habitat degradation. Enhancing green spaces not only improves air quality for people but also creates healthier habitats for animals, helping to reduce the risks of respiratory diseases in wildlife. Ensuring that wildlife is included in the planning and design of green spaces can contribute to a balanced ecosystem, reducing human-wildlife conflicts and improving overall biodiversity. Also, the use of the latest monitoring instruments (drones with thermal imaging, high-resolution air-quality monitors, and satellite-based vegetation indices) can enhance the knowledge of the fine-scale interplay of pollution and vegetation. Optimization models ought to be used to find optimal vegetation structure, density, and spatial arrangement to maximize the efficiency of pollutant reduction by planners in urban areas. It should also be ensured that there is an equitable distribution of green infrastructure because it has a direct impact on environmental justice and the outcome of public health. Through merging ecological design concepts with the current air-quality management concepts, cities will be able to utilize the green spaces to provide more healthful and resilient city environments in the face of increased pollution and climate stresses.

References

[1] Beckmann, Katie M., Ruth L. Cromie, Anthony W. Sainsbury, Geoff M. Hilton, John G. Ewen, Pritpal S. Soorae, and Richard A. Kock. "Wildlife health outcomes and opportunities in conservation translocations." *Ecological Solutions and Evidence* 3, no. 3 (2022): e12164. https://doi.org/10.1002/2688-8319.12164

[2] Bi, Shibo, Ming Chen, Zheng Tian, Peiyi Jiang, Fei Dai, and Guowei Wang. "Optimizing Urban Green Spaces for Air Quality Improvement: A Multiscale Land Use/Land Cover Synergy Practical Framework in Wuhan, China." *Land* 13, no. 7 (2024): 1020. https://doi.org/10.3390/land13071020

[3] Chatterjee, Raghav, and Vikas Singh. "Net-Zero Cities: A Comparative Analysis of Decarbonization Strategies in Urban Planning." *International Journal of SDG's Prospects and Breakthroughs* (2023): 11-14.

[4] Edeigba, Blessing Aibhamen, Ugochukwu Kanayo Ashinze, Aniekan Akpan Umoh, Preye Winston Biu, Andrew Ifesinachi Daraojimba, B. A. Edeigba, U. K. Ashinze, A. A. Umoh, P. W. Biu, and A. I. Daraojimba. "Urban green spaces and their impact on environmental health: A Global Review." *World Journal of Advanced Research and Reviews* 21, no. 2 (2024): 917-927. https://doi.org/10.30574/wjarr.2024.21.2.0518

[5] Ferrini, Francesco, Alessio Fini, Jacopo Mori, and Antonella Gori. "Role of vegetation as a mitigating factor in the urban context." *Sustainability* 12, no. 10 (2020): 4247. https://doi.org/10.3390/su12104247

[6] Gryech, Ihsane, Mounir Ghogho, Chafiq Mahraoui, and Abdellatif Kobbane. "An exploration of features impacting respiratory diseases in urban areas." *International Journal of Environmental Research and Public Health* 19, no. 5 (2022): 3095. https://doi.org/10.3390/ijerph19053095

[7] Islam, Azharul, Nayanesh Pattnaik, Md Moktader Moula, Thomas Rötzer, Stephan Pauleit, and Mohammad A. Rahman. "Impact of urban green spaces on air quality: A study of PM10 reduction across diverse climates." *Science of the Total Environment* 955 (2024): 176770. https://doi.org/10.1016/j.scitotenv.2024.176770

[8] Lu, Chuntian, Zhengbing Guo, and Li Miao. "The hot topics and trends about research on the relationship between air pollution and urban green space based on ecosystem services perspective." *Air Quality, Atmosphere & Health* (2025): 1-17.

[9] Ofremu, Gibson Owhoro, Babatunde Yusuf Raimi, Samuel Omokhafe Yusuf, Beatrice Akorfa Dziwornu, Somtochukwu Godfrey Nnabuife, Adaeze Mary Eze, and Chisom Assumpta Nnajiofor. "Exploring the relationship between climate change, air pollutants and human health: impacts, adaptation, and mitigation strategies. " *Green Energy and Resources* 3, no. 2 (2025): 100074. https://doi.org/10.1016/j.gerr.2024.100074

[10] Reaser, Jamie K., Arne Witt, Gary M. Tabor, Peter J. Hudson, and Raina K. Plowright. "Ecological countermeasures for preventing zoonotic disease outbreaks: when ecological restoration is a human health imperative." *Restoration Ecology* 29, no. 4 (2021): e13357. https://doi.org/10.1111/rec.133579

[11] Ren, Yuan, Zelong Qu, Yuanyuan Du, Ronghua Xu, Danping Ma, Guofu Yang, Yan Shi et al. "Air quality and health effects of biogenic volatile organic compounds emissions from urban green spaces and the mitigation strategies. " *Environmental Pollution* 230 (2017): 849-861. https://doi.org/10.1016/j.envpol.2017.06.049

[12] Sadulla, Shaik. "Effect of Pranayama on lung function in post-COVID rehabilitation among middle-aged adults: A clinical study." *Journal of Yoga, Sports, and Health Sciences* (2025): 24-30. https://doi.org/10.17051/JYSHS/01.01.04

[13] Saparov, Kalandar, Zukhra Yakhshieva, Gulbahor Kholdorova, Mahfuza Sangirova, Gulchehra Dadaeva, Khudayor Rajabov, Uktam Asallaev, and Nigora Safarova. "Advanced Materials for Pollution Control that Integrate Engineering Science with Environmental Conservation." *Natural and Engineering*

Sciences 9, no. 3 (2024): 77-87. https://doi.org/10.28978/nesciences.1581548

[14] Shen, Yu-Sheng, and Shih-Chun Candice Lung. "Mediation pathways and effects of green structures on respiratory mortality via reducing air pollution." *Scientific reports* 7, no. 1 (2017): 42854.

[15] Singh, Nidhi, Saumya Singh, and R. K. Mall. "Urban ecology and human health: implications of urban heat island, air pollution and climate change nexus." In *Urban ecology*, pp. 317-334. Elsevier, 2020. https://doi.org/10.1016/B978-0-12-820730-7.00017-3

[16] Tran, Huan Minh, Feng-Jen Tsai, Yueh-Lun Lee, Jer-Hwa Chang, Li-Te Chang, Ta-Yuan Chang, Kian Fan Chung et al. "The impact of air pollution on respiratory diseases in an era of climate change: A review of the current evidence." *Science of the Total Environment* 898 (2023): 166340. https://doi.org/10.1016/j.scitotenv.2023.166340

[17] Venter, Z. S., Hassani, A., Stange, E., Schneider, P., & Castell, N. (2024). Reassessing the role of urban green space in air pollution control. *Proceedings of the National Academy of Sciences*, *121*(6), e2306200121. https://doi.org/10.1073/pnas.2306200121

[18] Vitaliano, Serena, Stefano Cascone, and Provvidenza Rita D'Urso. "Mitigating built environment air pollution by green systems: An in-depth review." *Applied Sciences* 14, no. 15 (2024): 6487. https://doi.org/10.3390/app14156487

[19] Wu, Longfeng, and Chongxian Chen. "Does pattern matter? Exploring the pathways and effects of urban green space on promoting life satisfaction through reducing air pollution." *Urban Forestry & Urban Greening* 82 (2023): 127890. https://doi.org/10.1016/j.ufug.2023.127890

[20] Zhang, Jingwei, Yuming Wang, Lihong Feng, Changchun Hou, and Qing Gu. "Effects of air pollution and green spaces on impaired lung function in children: a case-control study." *Environmental Science and Pollution Research* 29, no. 8 (2022): 11907-11919.

[21] Zhang, Liqing, Puay Yok Tan, and Jessica A. Diehl. "A conceptual framework for studying urban green spaces effects on health." *Journal of urban ecology* 3, no. 1 (2017): jux015. https://doi.org/10.1093/jue/jux015

[22] Zhao, Tianyu, Joachim Heinrich, Michael Brauer, Nir Fulman, Nur Sabrina Idrose, Clemens Baumbach, Jeroen Buters et al. "Urban greenspace under a changing climate: Benefit or harm for allergies and respiratory health?. " *Environmental Epidemiology* 9, no. 2 (2025): e372. https://doi.org/10.1097/EE9.0000000000000372