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REVIEW

A Review of Urban Planning Approaches to Reduce Air Pollution Exposures

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Abstract

Purpose of review With only 12% of the human population living in cities meeting the air quality standards set by the WHO guidelines, there is a critical need for coordinated strategies to meet the requirements of a healthy society. One pivotal mechanism for addressing societal expectations on air pollution and human health is to employ strategic modeling within the urban planning process. This review synthesizes research to inform coordinated strategies for a healthy society. Through strategic modeling in urban planning, we seek to uncover integrated solutions that mitigate air pollution, enhance public health, and create sustainable urban environments.

Recent findings Successful urban planning can help reduce air pollution by optimizing city design with regard to transportation systems. As one specific example, ventilation corridors i.e. aim to introduce natural wind into urban areas to improve thermal comfort and air quality, and they can be effective if well-designed and managed. However, physical barriers such as sound walls and vegetation must be carefully selected following design criteria with significant trade-offs that must be modeled quantitatively. These tradeoffs often involve balancing effectiveness, cost, aesthetics, and environmental impact. For instance, sound walls are highly effective at reducing noise, provide immediate impact, and are long-lasting. However, they are expensive to construct, visually unappealing, and may block views and sunlight. To address the costly issue of sound walls, a potential solution is implementing vegetation with a high leaf area index or leaf area density. This alternative is also an effective method for air pollution reduction with varying land-use potential. Ultimately, emission regulations are a key aspect of all such considerations.

Summary Given the broad range of developments, concerns, and considerations spanning city management, ventilation corridors, physical barriers, and transportation planning, this review aims to summarize the effect of a range of urban planning methods on air pollution considerations.

Keywords Air pollution · Urban planning · Transportation planning · Particulate matter · Physical barrier · Wind corridor

Introduction

More than 56% of the global population lives in urban areas, and by 2050, nearly 7 out of 10 people will live in cities [1]. In the urbanization process—marked by rural-to-urban migration, physical expansion of cities, increased economic activity, increased population density, and development of urban character—urban air pollution increases with the rising number of inhabitants due to greater emissions from transportation, industries, and other urban sources. Over the past 20 years, $PM_{2.5}$ and NO_2 concentrations have increased in 65% and 71% of cities worldwide, respectively. In addition, O_3 concentrations have risen at 89% of monitoring stations [2].

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A major source of air pollution in urban areas is traffic emissions, which is especially important for people living near busy roadways, i.e., within 150 to 300 m (about 500 to 1000 feet) from busy roadways. A study indicated that 18% of Americans live near high-volume roads [3]. Other sources of air pollution include manufacturers, construction, and indoor air pollution. However, this is beyond the scope of this review, and we will mainly focus on reducing traffic-related air pollution. Traffic emissions mainly consist of $PM_{2.5}$, ultrafine particles (UFPs, particle diameter ≤ 100 nm), NO_2, elemental carbon, and volatile organic carbons (VOCs). In the USA, UK, and Germany, traffic emissions are responsible for one-fifth of deaths from air pollution [4]. People living in near-roadway environments have displayed an increase in dementia, Parkinson's disease, all-cause mortality, circularity mortality, ischaemic heart disease mortality, lung cancer mortality, autism spectrum disorders, obesity, skin aging, and asthma [5–10].

Effective urban planning strategies can play a crucial role in reducing air pollution levels and improving human health outcomes in cities [11]. Urban planning aims to give shape, design, and structure to cities and towns. It involves various processes, including the arrangement and design of buildings, transport systems, public spaces, and amenities. Urban planning is crucial for the development of urban land. It serves as a framework for growth and helps cities cultivate long-term, sustainable systems and infrastructure. Urban planning is not only important for the urban economy but is also crucial for improving public health in cities. For instance, urban planning can reduce air pollution by enhancing energy use and alternative transport systems. One way that urban planning can reduce air pollution is by promoting energy efficiency in the built environment, including supporting building designs that capture solar energy and piloting initiatives for infrastructure upgrades to improve insulation and access to renewable power. Additionally, comprehensive city planning facilitates the adoption of alternative renewable energy transport systems like zero-emissions electric vehicle fleets, green hydrogen fuelling stations to support hydrogen vehicles, wide distribution of electric vehicle charging ports, bike lane networks, and robust public transit systems like rail and bus rapid transit that minimize reliance on fossil fuel combustion. Urban planning can also spur active transportation options like safe, walkable streets and neighborhoods, allowing residents to limit short car trips. Public–private partnerships can be leveraged to implement sustainable urban services, such as efficient waste management systems and green building initiatives, which can contribute to reducing air pollution in cities. Planting trees and incorporating the care of city green spaces as a key element in urban planning can also help reduce air pollution.

Kurtzweg is one of the first few studies that reviewed the relationship between air pollution control and urban planning [12]. Government legislation and policies thus already require the consideration of air pollution problems in urban planning. It is emphasized that the interrelationships between air quality and the intensity and spatial distribution of human activity need to be identified more precisely. There are two general streams of strategies for controlling air pollution: restriction of emissions and direction of the location and spatial distribution of emission sources. Based on these strategies, Gross established a simulation model to capture the relationship between urban planning decisions and air quality [13]. Legislation is often used to restrict emissions, while wind corridors and physical barriers (e.g., sound barriers, and vegetation) can be used to direct the location and spatial distribution of emission sources (Fig. 1). This review paper aims to discuss these different air pollution reduction strategies.

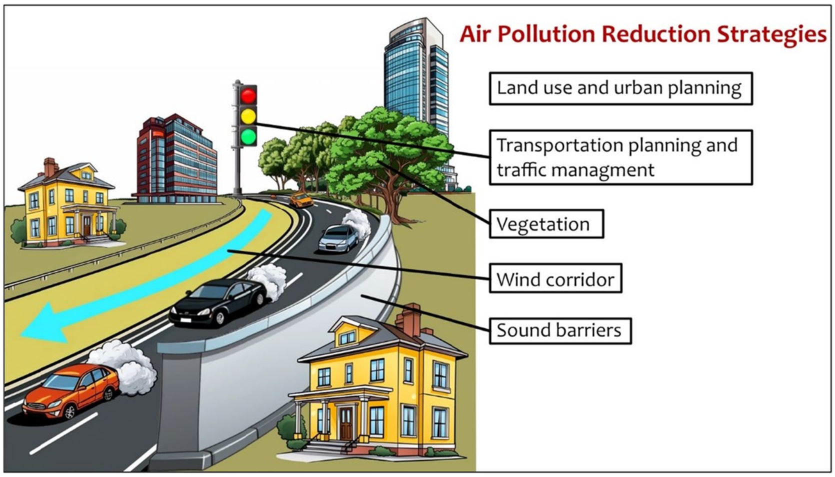

Fig. 1 Schematic figure of different urban air pollution reduction strategies

Methods

We used the bibliographical database "Web of Science" for searching under the following criteria: (1) Research only includes search and review papers, (2) Results are ranked with respect to relevance, and (3) Results are mostly from the past 15 years. The search terms are "air pollution" AND "urban planning"; "air pollution" AND "land use"; "air pollution" AND "transportation planning"; "air pollution" AND "transportation management"; "air pollution" AND "wind corridor"; "air pollution" AND "vegetation"; "air pollution" AND "barrier"; "air pollution" AND "wind corridor"; and "air pollution" AND "regulation."

Results

Land Use and Urban Planning

In the early 1960s, urban planning had been recognized as a critical measure to control air pollution [14]. Many studies have since highlighted the importance of assessing air pollution when making urban planning decisions (i.e., [15]). Land use planning covers public policy interventions that order and regulate land use in an efficient, sustainable, and ethical manner. Land use planning is sometimes used interchangeably with urban planning [16]. Numerous studies have investigated the impact of land use planning on air pollution in different areas, including Africa ([17–19]), Australia ([20]), Brazil ([21]), Canada ([22]), Chile ([23]), China ([24–26]), Greece ([27]), Hong Kong ([28, 29]), Italia ([30]), Kazakhstan ([31]), Mexico ([32–34]), Paris ([35]), Sweden ([36, 37]), Taiwan ([38–40]), Rome ([41]), the United Kingdom ([42]), and the United States([43]). Land use regression, which has been comprehensively reviewed by researchers, is the primary method employed for analyzing the impact of land use on air pollution levels [44]. However, big data or machine learning-based methods are increasingly receiving attention. The research that examined the role of urban planning in addressing air pollution problems was comprehensively reviewed, highlighting the key findings and methodologies employed in the field [12]. It was found that the interrelationships between air quality and the intensity and spatial distribution of human activity need to be identified more precisely so that feasible policies that positively influence air quality through planning actions can be determined. The approaches that can be used to control air pollution in land use or urban planning include appropriate urban growth strategies, balancing communities and subregions, low-density development, and regional open space patterns (Environmental Protection Agency [45]).

Appropriate Urban Growth Strategies

When selecting appropriate regional growth strategies, planners should focus on air pollution dispersion efficiency and reducing travel. For instance, a recent study combined land use regression and an air dispersion model to estimate pollution exposure [46]. A nonlinear land use regression-based machine learning algorithm was developed to model and predict spatial–temporal patterns of air pollution in urban zones [47]. The proposed framework was shown to effectively model the NO_2 pollutant in the urban zone of Geneva.

Balanced Communities and Subregions

In urban or land use planning, it is important to create subregions that have a balanced supply of required functionalities to reduce travel, which in turn mitigates air pollution. In addition, it is also important to implement appropriate zoning planning, as this can also reduce air pollution. For instance, spatial statistical techniques were applied to examine and explain the air pollution levels in urban areas of Cigli (Izmir) [48]. The results indicated that the presence of the industrial zone, the form of fossil fuels used in heating, and topography are the critical determinants of air pollution. A framework was constructed to explore the method of air pollution control in urban planning in China [49]. The concluded guiding suggestions were adhered to a sustainable development strategy, adopting scientific and technological remediation methods in existing high environmental pollution areas, optimizing the industrial structure to control the source of atmospheric pollutants, planning ecological zones, and estimating the atmospheric environmental capacity so that the industrial layout can meet the environmental self-purification ability. The impact of land use types on children's respiratory health was studied, and it was found that traffic-related land use types, sports facilities, and commercial land adjacent to homes have negative effects on children's respiratory symptoms. However, the presence of schools in the neighborhood has positive effects [50].

Low-Density Development

To reduce air pollution, low-density development can be important, as pollutant concentrations can be lower as population density decreases. Land use density and residential density's impact on air pollution and health issues have been increasingly investigated in the literature (i.e., [51, 52]). A study of European cities points out that dense and fragmented cities have the highest PM_{10} and SO_2 concentrations; nondense and continuous cities seem to have the best air quality [53]. Another study shows denser cities have higher mortality costs [54].

Regional Open Space Patterns

Implementing thoughtful spatial planning across urban regions represents an impactful pollution reduction strategy. By designing interconnected green space and open buffer zones surrounding key emission sources, planners can better separate industrial facilities and waste sites from residential areas. Prioritizing liveable neighborhoods shielded from contamination promotes healthier habitats [55]. Such comprehensive regional planning also enables interconnected open space networks. Preserving these broader ecosystems maintains the natural filters trees and vegetation provide against air pollutants while enhancing communities' access to recreation and the mental health benefits of green environments. One systematic review points out that greenness and dementia are inversely associated at intermediate exposure levels but not at high levels [56]. Another review shows that green space can reduce air pollution, ensure the healthy development of children, and promote lifelong health [57]. Ultimately, forward-thinking regional land use policies that integrate separation buffers, ecosystem protections, and nature access offer a multi-pronged approach to managing pollution's most harmful impacts on populations. The potential then emerges for urban development and vital wildlife domains to coexist through sharing the regional landscape. Furthermore, in recent years, the concept of environmental function zoning has been proposed to consider environmental planning and management [49]. The health-related impacts of urban green space (UGS) were quantified and mapped, and it was concluded that the redesign of UGS can be beneficial for human health [58]. Low-density development with more green space generally has better air quality and the potential to be health-promoting in multiple dimensions[59].

Transportation Planning and Traffic Management

Traditional transportation planning includes trip generation, trip distribution, modal split and trip assignment [60]. The first three steps model the transportation demand side, while the final step represents the transportation supply side. The unified framework accommodates both transportation demand and supply when executed with full feedback. The goal of urban transportation planning is to solve traffic congestion, improve traffic safety, and reduce environmental pollution [61]. The following approaches in transportation planning for controlling air pollution: (1) multimodal planning, which decreases highway travel through expanded transit usage; (2) improved highway location and network configuration, which proposes that a planning framework should consider pollutant concentrations. However, conventional travel forecasts should be equipped with methodologies that can translate traffic estimates into pollutant concentrations; (3) compatible highway/land use relationships, indicating that the regulation of joint corridor development and land uses adjacent to the right of way can reduce pollution impact [45].

Though past planning decisions may be set in stone, the fluid potential of traffic management strategies offers a constructive path forward to transform rigid urban infrastructures into healthier spaces that sustain both current and future generations.- There are multiple traffic management strategies that can mitigate the impact of air pollution. For instance, speed reduction, carsharing, congestion pricing, low emission zones, and speed-guided Intelligent Transportation Systems (ITS) are imperative strategies analyzed in past studies. Speed bumps have been used to slow down traffic to protect pedestrians. However, the deceleration and acceleration of vehicles can increase air pollution. Particulate concentrations near the trapezium-shaped pedestrian crossings increased by 55.7% and near the plastic circular speed bumps increased by 58.6%, respectively [62]. Another example is applying electronic toll collection to replace manual toll collection in Taiwan's highways, which not only helps alleviate traffic congestion but also reduces ultrafine particles by over 50% [63]. We critically overview the related research as follows.

Speed Reduction

Speed reduction is considered an effective strategy to reduce emissions. The impact of speed limit intervention on air pollution in Amsterdam was assessed, and a significant reduction in PM_{10} and PM_1 was found as a result of reducing the speed limit at an urban ring highway [64]. A study conducted in Switzerland investigated the impact of the maximum speed limit on emissions and found that nitrogen oxide (NOx) emissions can be reduced by 4% [65]. Another study, which focused on the speed limit introduced in the Netherlands to improve air quality, concluded that emission reduction by speed management is in the range of 5–30% for NOx and 5–25% for PM_{10} [66]. The effect of the maximum speed limit and variable speed policies on reducing air pollution in Barcelona was analyzed in a separate study [67]. The results showed that the variable speed policy alleviated NOx and PM_{10} concentrations better than the maximum speed limit policy. Another study showed that the implementation of the 30 km/h in Luassane, Switzerland, yields health benefits in terms of reducing road crashes and noise pollution [68]. From the global results, although speed reduction can generally help reduce air pollution, its impact on air pollution depends on various factors, such as location, type of roadway, and traffic volume.

Carsharing

Carsharing provides users access to shared vehicles to reduce the need for private vehicle ownership. It has been proven to be an effective policy for reducing roadway traffic and has been adopted in many large cities around the world (i.e., San Francisco, California [69]). In a 10-year retrospective examining North America's carsharing programs, it was calculated that carsharing policies have reduced vehicle kilometers traveled (VKT) by 44% [70]. Similarly, a reduction in VKT by 27% in North America due to carsharing programs was revealed through a large-scale survey [71]. Rising fuel costs and increased environmental awareness have facilitated greater adoption of car sharing. However, the effect depends heavily on shared mobility acceptance [72].

Congestion Pricing

Congestion pricing has been considered a powerful tool for managing congestion and improving traffic flow. It levies tolls on roadways to reduce peak-period vehicle trips by encouraging people to shift to more efficient modes such as transit [73]. It can also effectively reduce emissions caused by traffic. For instance, a study on the impact of congestion pricing in Stockholm reported 15%, 8.5%, and 13% reductions in road use, NOx, and PM_{10}, respectively [74].

Emissions Regulation

Emission regulations (e.g., Tier 3 in the USA and Euro 6 rules in the EU) are becoming stricter worldwide, and these regulations have contributed significantly to the reduction of traffic emissions worldwide despite the increase in traffic population [75]. In addition, low-emission zones (LEZs) are areas that restrict more polluting vehicles from entering [76]. A study on the impact of LEZs in Germany indicated that slight but statistically significant reductions in NO2, NO, and NOx concentrations were associated with the implementation of these zones [76]. Another study, which reviewed the effectiveness of approximately 200 LEZs established in 12 EU countries in improving urban air quality, concluded that there have been mixed results [77]. However, the ultra-LEZs in London reported 23%, 7% and 3% reductions in NOx, $PM_{2.5}$ and CO_2 emissions, respectively [78]. The primary issue is that how the effectiveness is measured may mask the subtle effects of LEZs, and it is not easy to isolate and accurately determine the effects of LEZs. Traffic emission regulations in Texas, USA, have also reduced the infant health risks associated with maternal residences near highways [79]. Another study in Tokyo, Japan, shows that diesel emission regulation reduces air pollution and infant mortality [80]. A long-term study in Beijing, China, also indicates emission regulations reducing traffic-related $PM_{2.5}$ and NO_2 can significantly lower premature death in different age groups [81].

Intelligent Transportation Systems (ITSs) and Autonomous Vehicles (AVs)

ITS is a system that uses advanced technologies to improve the efficiency, safety, and sustainability of transportation systems. It can also be used to alleviate air pollution. For instance, it was indicated that the usage of the speed guided-ITS (SG-ITS) significantly reduces fuel consumption and pollutant emissions. Specifically, the implementation of the SG-ITS was found to significantly reduce the total vehicular exhaust emissions of NOx, CO, Total Hydrocarbon (THC), and Particulate Matter (PM) in Beijing by 15.9%, 20.5%, 23.9%, and 22.5%, respectively [82]AVs have significant environmental impacts. However, related studies focus on emissions and regard them as the main topic, while other dimensions have been ignored.

Urban Ventilation

Through the urbanization process, cities are expanding, traffic volume and building heights are increasing, and street canyons (i.e., urban roads that have buildings on both sides) are becoming deeper. Street canyons and building configurations affect the dispersion and dilution of air pollutants [83]. Densely distributed tall buildings can reduce wind speed and hinder the dispersion of air pollution [84]. The construction of urban ventilation corridors has shown mixed results in pollution reduction, as shown in Table 1. Some studies show that urban ventilation corridors can worsen the air quality in urban areas, while other studies show that urban ventilation corridors can improve the air quality. Thus, the design of the urban ventilation corridor is especially important, as one study points out that the air pollution level will increase if there is no exit for the urban ventilation corridor [85]. Special focus should be placed on understanding the effect of surface roughness, urban ventilation corridor space planning and management [86].

Physical Barriers

Physical barriers such as sound walls, trees, and shrubs can be used for air pollution migration methods (Table 1). Vegetation characteristics such as leaf area index (LAI), leaf area density (LAD), and surface roughness may affect the particle collection efficiency [91, 92]. Ultrafine particle concentration reduction from 37–79% was seen when using barriers [89, 90, 93]. In general, denser vegetation with a LAD higher than 3 or 5 m^2/m^3 is required to reduce downwind particulate matter concentration [94, 95]. Furthermore, vegetation should be placed near the pollution source [96].

Table 1 The effects of different migration strategies on air pollution reduction

Migration strategies	location	Results	References
Low-density development	Europe	Nondense and continuous cities seem to have the best air quality	[53]
Car sharing	San Francisco, California and North America	Car sharing policies have reduced roadway traffic	[69, 70]
Emission Regulation	Europe and USA	Emission regulations have contributed greatly to the reduction of traffic emissions	[75]
ITSs and AVs	Beijing, China	ITS can be used to alleviate air pollution	[82]
Urban ventilation corridor	Xi'an, China	Urban ventilation corridor worsens the air quality in central urban areas	[62]
Urban ventilation corridor	Beijing, China	Urban ventilation corridor can reduce the $PM_{2.5}$ concentration by 11.7%	[87]
Urban ventilation corridor	Heifi, China	Urban ventilation corridor can reduce the $PM_{2.5}$ concentration	[88]
Sound walls	Raleigh, USA	Sound walls can reduce	[89]
Vegetation	Chapel Hill and Mebane, USA	Vegetation barrier can reduce UFPs by 37.7–63.6%	[90]

Recently, a study showed that low-cost, impermeable solid structures (LISSs) can help reduce near-roadway air pollution [97]. Physical barriers can help reduce air pollution and noise; this can help improve hearing condition and mental health, lower adverse cardiovascular illness, and decrease mortality in nearby roadway communities [98–100].

Conclusions and Future Research Needs

This review has examined the broad range of developments, concerns, and considerations around utilizing urban planning strategies to mitigate air pollution exposures. The research demonstrates urban planning's pivotal role in pollution control. Key findings indicate that land use policies balancing development and open space, transportation planning expanding sustainable mobility modes, strategic infrastructure design factors and emission regulations fundamentally shape pollution patterns and exposure risks.

Specifically, the literature establishes low-density growth approaches, balanced sub-regional land use mixes, residential buffers from contamination sources, and interconnected green networks as constructive spatial planning techniques. Transportation strategies like speed reduction zones, car-sharing programs, congestion pricing, vehicle technology advancements, and intelligent systems also provide congestion and emission relief. However, physical interventions like vegetation barriers and ventilation corridors produce mixed pollution outcomes, highlighting the need for careful parameterization and simulation during planning.

Moreover, increasingly stringent vehicle emission standards and low emission zones offer regulatory backstops, though localized effects remain uncertain. As cities continue expanding, a multi-faceted policy portfolio can channel growth toward sustainable forms meeting economic needs while safeguarding public health. An integrated planning vision incorporating clean energy transitions, active transport facilitation, congestion mitigation, development impact control, and social equity promotes liveable urban areas for current and future generations.

This review compiles evidence supporting urban planning's diverse mechanisms to curb pollution. While further research can continue refining the understanding of precise local relationships, the foundation clearly establishes proactive planning as invaluable for improving environmental quality amidst the proliferation of urban regions worldwide.

However, as efforts continue toward reducing urban air pollution, accelerating the shift to clean energy sources like wind and solar must remain a priority. This transition should emphasize powering electric vehicles via renewable energy to maximize emissions reductions. The underestimated potential of battery electric vehicles to reduce emissions [101]. Additionally, advancing technology developments that alleviate traffic congestion can offer novel avenues to curb pollution. Further research and focus must remain on the interconnected strategies listed below for clean energy adoption, congestion mitigation, pollution control, and ultimately, enhanced sustainability and climate resilience in urban areas.

Environmental Justice

Environmental justice (EJ) in urban or land use planning has become increasingly noted by recent studies[102, 103]. Air pollution was one of the major issues investigated according to a recent EJ review [104]. The field of environmental justice currently faces several critical research gaps that demand further scholarly attention and detailed analysis. These gaps in the existing literature underscore the necessity for a more nuanced and comprehensive understanding of the complex interrelationships between transportation, equity, and environmental justice. The following points elucidate the primary areas requiring additional research:

- An in-depth examination of the distributional consequences of transportation investments and the formulation of innovative methodologies to evaluate and address transportation equity issues is imperative.
- The connection between transportation-related air pollution and health inequities among racial-ethnic minorities and economically disadvantaged populations warrants thorough examination.
- Researchers should direct their attention to the social and political aspects of transportation equity, encompassing the influence of public participation, governance, and decision-making processes.
- The distributive, procedural, and interactional aspects of transportation justice necessitate further exploration in conjunction with the development of new theoretical and methodological approaches to tackle equity concerns in urban transportation.
- Addressing the lack of research pertaining to the incorporation of environmental justice considerations in transportation planning is of utmost importance, emphasizing the need for additional studies on best practices, performance measures, and evaluation methods.

Novel Research Methodologies

The rapid development of computing power has made artificial intelligence (AI)-based methods (i.e., machine learning, reinforcement learning) more feasible in analysing the impact of urban and land use planning on air pollution. Future research can explore more appropriate methodologies to come up with more suitable planning decisions.

Carbon Footprint

It is important to accurately estimate carbon footprint to formulate effective urban planning that can reduce air pollution. For instance, it is well known that electric vehicles (EVs) can reduce air pollution. However, the pollution produced when generating electricity should also be considered when evaluating EVs' environmental impact, as adopting EVs shifts the pollution generation to power plants. In this regard, land use and urban planning can be even more pivotal in reducing air pollution.

Precise Evaluation Tools

Although land-use regression (LUR) is widely used in many relevant studies, it may not be directly applicable to all urban areas, as the areas of interest can differ significantly. Therefore, it is suggested to integrate LUR with other validation statistics ([105]) to enhance its effectiveness.

Field Studies

More field studies are needed, and the following points require further attention:

- Investigating the effect of air pollution dispersion from multiple parameters (e.g., urban ventilation corridor, sound barrier, vegetation, building height and setback, and transportation planning) and its health effects.
- More field studies in low- and middle- countries suffering from urban air pollution.

Epidemiology Studies

More epidemiological studies on air pollution reduction and health outcomes are needed, especially in developing countries with air pollution problems. The following points require further attention:

- Assessing the air pollution reduction methods and health effect outcomes.
- Finding the health effects, such as chronic obstructive pulmonary diseases (COPD) and stroke, from long-term exposure to traffic emissions, especially UFPs and VOCs in different parts of the world.
- Understand individual susceptibility to air pollutants; suspectable factors may include vulnerable populations (children, pregnant women, and elders), health and smoking status.

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Data Availability No datasets were generated during the current study.

Declarations

Conflict of Interest The authors declare no competing interests.

Human and Animal Rights This article does not contain any studies with human or animal subjects performed by the authors.

References

1. The World Bank, Urban Development. 2023.
2. Sicard P, et al. Trends in urban air pollution over the last two decades: A global perspective. Sci Total Environ. 2023;858:160064.
3. Rowangould GM. A census of the US near-roadway population: Public health and environmental justice considerations. Transp Res Part D: Transp Environ. 2013;25:59–67.
4. Lelieveld J, et al. The contribution of outdoor air pollution sources to premature mortality on a global scale. Nature. 2015;525(7569):367–71.
5. Chen H, et al. Living near major roads and the incidence of dementia, Parkinson's disease, and multiple sclerosis: a population-based cohort study. The Lancet. 2017;389(10070):718–26.
6. Boogaard H, et al. Long-term exposure to traffic-related air pollution and non-accidental mortality: A systematic review and meta-analysis. Environ Int. 2023;176:107916.
7. HEI, Systematic Review and Meta-analysis of Selected Health Effects of Long-Term Exposure to Traffic-Related Air pollution. 2023.
8. Carter SA, et al. In utero exposure to near-roadway air pollution and autism spectrum disorder in children. Environ Int. 2022;158:106898.
9. Kim JS, et al. Longitudinal associations of in utero and early life near-roadway air pollution with trajectories of childhood body mass index. Environ Health. 2018;17(1):64.
10. Schikowski T, Huls A. Air Pollution and Skin Aging. Curr Environ Health Rep. 2020;7(1):58–64.
11. Glazener A, Khreis H. Transforming Our Cities: Best Practices Towards Clean Air and Active Transportation. Curr Environ Health Rep. 2019;6(1):22–37.
12. Kurtzweg JA. Urban Planning and Air Pollution Control - Review of Selected Recent Research. J Am Inst Plann. 1973;39(2):82–92.
13. Gross M. Computer-Simulation in Urban-Planning and Air-Pollution Control. J Environ Syst. 1981;11(3):257–69.
14. Schreibeis L, Domke HR, Grove JJ. Air-Pollution Control in Urban-Planning. American Journal of Public Health and the Nations Health. 1961;51(2):174-+.
15. Azarov V, Barikaeva N, Solovyeva T. Monitoring of Fine Particulate Air Pollution as a Factor in Urban Planning Decisions. 2nd International Conference on Industrial Engineering (Icie-2016). 2016;150:2001–2007.
16. Baker M. Encyclopedia of quality of life and well-being research. 2014, New York: Springer. 12 volumes.
17. Abera A et al. Air Pollution Measurements and Land-Use Regression in Urban Sub-Saharan Africa Using Low-Cost Sensors-Possibilities and Pitfalls. Atmosphere. 2020;11(12).
18. Tularam H et al. A hybrid air pollution/land use regression model for predicting air pollution concentrations in Durban, South Africa. Environ Pollut. 2021;274.
19. Tularam H et al. Harbor and Intra-City Drivers of Air Pollution: Findings from a Land Use Regression Model, Durban, South Africa. International Journal of Environmental Research and Public Health. 2020;17(15).
20. Knibbs LD, et al. A national satellite-based land-use regression model for air pollution exposure assessment in Australia. Environ Res. 2014;135:204–11.
21. Cobelo I et al. The impact of wildfires on air pollution and health across land use categories in Brazil over a 16-year period. Environmental Research. 2023;224.
22. Johnson M, et al. Comparison of Remote Sensing, Land-use Regression, and Fixed-site Monitoring Approaches for Estimating Exposure to Ambient Air Pollution Within a Canadian Population-based Study of Respiratory and Cardiovascular Health. Epidemiology. 2011;22(1):S139–S139.
23. Romero H, et al. Rapid urban growth, land-use changes and air pollution in Santiago Chile. Atmos Environ. 1999;33(24–25):4039–47.
24. Zhao JJ et al. The Influence of Land Intensive Use and Urbanization to Air Pollution: Evidence from China. 2017 3rd International Conference on Energy, Environment and Materials Science (Eems 2017). 2017;94.
25. Sun W. et al. Study on Land-use Changes and Their Impacts on Air Pollution in Chengdu. Atmosphere. 2020;11(1).
26. Chen YF et al. Mapping the emission of air pollution sources based on land-use classification: A case study of Shengzhou, China. Land Use Policy. 2022;117.
27. Fameli KM, et al. Effect of the Land Use Change Characteristics on the Air Pollution Patterns above the Greater Athens Area (Gaa) after 2004. Global NEST J. 2013;15(2):169–77.
28. Lee M, et al. Land use regression modelling of air pollution in high density high rise cities: A case study in Hong Kong. Sci Total Environ. 2017;592:306–15.
29. Tang R, et al. Integrating travel behavior with land use regression to estimate dynamic air pollution exposure in Hong Kong. Environ Int. 2018;113:100–8.
30. Gaeta A, et al. Development of nitrogen dioxide and volatile organic compounds land use regression models to estimate air pollution exposure near an Italian airport. Atmos Environ. 2016;131:254–62.
31. Shvets O, Gyorok G. Possible Implications for Land-Use Planning Mechanisms when Considering the Results of Monitoring and Modelling Air Pollution by Industry and Transport on the Example of Kazakhstan Cities. Acta Polytechnica Hungarica. 2023;20(4):7–26.
32. Jazcilevich AD, Garcia AR, Ruiz-Suarez LG. A modeling study of air pollution modulation through land-use change in the Valley of Mexico. Atmos Environ. 2002;36(14):2297–307.
33. Son Y, et al. Land use regression models to assess air pollution exposure in Mexico City using finer spatial and temporal input parameters. Sci Total Environ. 2018;639:40–8.
34. Hinojosa-Balino I, Infante-Vazquez O, Vallejo M. Distribution of $PM_{2.5}$ Air Pollution in Mexico City: Spatial Analysis with Land-Use Regression Model. Appl Sci-Basel. 2019;9(14).
35. Aziz A, Anjum GA. Sensitizing Land Uses to Control Motor Vehicular Air Pollution: a Case Study of Lahore in Connection with Paris. Environ Model Assess. 2016;21(3):419–35.
36. Habermann M, Billger M, Haeger-Eugensson M. Land use regression as method to model air pollution. Previous results for Gothenburg/Sweden. Toward Integrated Modelling of Urban Systems. 2015;115:21–28.
37. Korek M, et al. Can dispersion modeling of air pollution be improved by land-use regression? An example from Stockholm, Sweden. J Eposure Sci Environ Epidemiol. 2017;27(6):575–81.
38 Wu CF, et al. Modeling horizontal and vertical variation in intraurban exposure to $PM_{2.5}$ concentrations and compositions. Environ Res. 2014;133:96–102.
39. Li H-C, et al. Assessment of different route choice on commuters' exposure to air pollution in Taipei Taiwan. Environ Sci Pollut Res. 2017;24(3):3163–71.
40. Wong PY et al. Using a land use regression model with machine learning to estimate ground level $PM_{2.5}$. Environmental Pollution. 2021;277.
41. Rosenlund M, et al. Comparison of regression models with land-use and emissions data to predict the spatial distribution

of traffic-related air pollution in Rome. J Eposure Sci Environ Epidemiol. 2008;18(2):192–9.

42. Namdeo A, et al. Land-use, transport and vehicle technology futures: An air pollution assessment of policy combinations for the Cambridge Sub-Region of the UK. Cities. 2019;89:296–307.
43. Kirwa K, et al. Fine-Scale Air Pollution Models for Epidemiologic Research: Insights From Approaches Developed in the Multi-ethnic Study of Atherosclerosis and Air Pollution (MESA Air). Curr Environ Health Rep. 2021;8(2):113–26.
44. Hoek G, et al. A review of land-use regression models to assess spatial variation of outdoor air pollution. Atmos Environ. 2008;42(33):7561–78.
45. EPA, A Guide for Reducing Air Pollution Through Urban Planning. 1973, Environmental Protection Agency.
46. Molter A, et al. Modelling air pollution for epidemiologic research - Part I: A novel approach combining land use regression and air dispersion. Sci Total Environ. 2010;408(23):5862–9.
47. Champendal A, Kanevski M, Huguenot PE. Air Pollution Mapping Using Nonlinear Land Use Regression Models. Comput Sci Appl - Iccsa 2014, Pt Iii, 2014;8581:682-+.
48. Ozcan NS, Cubukcu KM. Examination of the Relationship between Urban Air Pollution and Urban Planning Decisions in Cigli Case, Izmir (Turkey). Environ Behav Proc J. 2016;1(2):178–87.
49. Jiang T, Wei LN, Bai L. Construction of the Framework for Exploring the Method of Air Pollution Control in Urban Planning. 2020 International Conference on Energy. Environ Bioeng (Iceeb 2020). 2020;185.
50. Zou ML et al. Frequent occurrence of respiratory symptoms in children is associated with exposure to air pollution, land use types, and parental mental health in the Greater Taipei area. Environ Res. 2022;206.
51. Lai KY et al. Associations of Urban Built Environment with Cardiovascular Risks and Mortality: a Systematic Review. J Urban Health Bull New York Acad Med. 2023.
52. Singh N, Dey S, Knibbs LD. Spatio-temporal patterns of tropospheric NO2 over India during 2005–2019. Atmos Pollut Res. 2023;14(3).
53. Cárdenas Rodríguez M, Dupont-Courtade L, Oueslati W. Air pollution and urban structure linkages: Evidence from European cities. Renew Sustain Energy Rev. 2016;53:1–9.
54. Carozzi F, Roth S. Dirty density: Air quality and the density of American cities. J Environ Econ Manage. 2023;118.
55. Giles-Corti B, et al. City planning and population health: a global challenge. The Lancet. 2016;388(10062):2912–24.
56. Zagnoli F, et al. Is Greenness Associated with Dementia? A Systematic Review and Dose-Response Meta-analysis. Curr Environ Health Rep. 2022;9(4):574–90.
57. Roche IV, et al. The Health-Related and Learning Performance Effects of Air Pollution and Other Urban-Related Environmental Factors on School-Age Children and Adolescents-A Scoping Review of Systematic Reviews. Curr Environ Health Rep. 2024;11(2):300–16.
58. Oosterbroek B et al. Assessment of green space benefits and burdens for urban health with spatial modeling. Urban Forest Urban Green. 2023;86.
59. Hankey S, Marshall JD. Urban Form, Air Pollution, and Health. Curr Environ Health Rep. 2017;4(4):491–503.
60. Lin DY, et al. Integration of Activity-Based Modeling and Dynamic Traffic Assignment. Transp Res Rec. 2008;2076:52–61.
61. Boltze M, Anh Tuan V. Approaches to Achieve Sustainability in Traffic Management. Procedia Eng. 2016;142:204–211.
62. Baltrėnas H, Janusevicius T, Chlebnikovas A. Research into the Impact of Speed Bumps on Particulate Matter Air Pollution. Measurement. 2016;100.
63. Lin M-Y, et al. Effect of Implementing Electronic Toll Collection in Reducing Highway Particulate Matter Pollution. Environ Sci Technol. 2020;54(15):9210–6.
64. Dijkema MBA, et al. Air quality effects of an urban highway speed limit reduction. Atmos Environ. 2008;42(40):9098–105.
65. Keller J, et al. The impact of reducing the maximum speed limit on motorways in Switzerland to 80 km h(-1) on emissions and peak ozone. Environ Model Softw. 2008;23(3):322–32.
66. Keuken MP, et al. Reduced NOx and PM_{10} emissions on urban motorways in The Netherlands by 80 km/h speed management. Sci Total Environ. 2010;408(12):2517–26.
67. Bel G, et al. The environmental effects of changing speed limits: A quantile regression approach. Transport Res Part D-Trans Environ. 2015;36:76–85.
68. Rossi IA et al. Estimating the health benefits associated with a speed limit reduction to thirty kilometres per hour: A health impact assessment of noise and road traffic crashes for the Swiss city of Lausanne. Environ Intl. 2020;145.
69. Cervero R, Tsai YS. City CarShare in San francisco, California - Second-year travel demand and car ownership impacts. Transit Plann Dev Manage Perform Market Fare Policy Capacity Qual Serv. 2004;1887:117–27.
70. Shaheen SA, Cohen AP, Chung MS. North American Carsharing 10-Year Retrospective. Transp Res Rec. 2009;2110:35–44.
71. Martin E, Shaheen S. The Impact of Carsharing on Public Transit and Non-Motorized Travel: An Exploration of North American Carsharing Survey Data. Energies. 2011;4(11):2094–114.
72. Prieto M, Baltas G, Stan V. Car sharing adoption intention in urban areas: What are the key sociodemographic drivers? Transport Res Part A: Policy Practice. 2017;101:218–27.
73. Lin DY, Unnikrishnan A, Waller ST. A Dual Variable Approximation Based Heuristic for Dynamic Congestion Pricing. Netw Spat Econ. 2011;11(2):271–93.
74. Johansson C, Burman L, Forsberg B. The effects of congestions tax on air quality and health. Atmos Environ. 2009;43(31):4843–54.
75. Wallington TJ, et al. Vehicle Emissions and Urban Air Quality: 60 Years of Progress. Atmosphere. 2022;13(5):650.
76. Morfeld P, Groneberg DA, Spallek MF. Effectiveness of Low Emission Zones: Large Scale Analysis of Changes in Environmental NO2, NO and NOx Concentrations in 17 German Cities. Plos One. 2014;9(8).
77. Holman C, Harrison RM, Querol X. Review of the efficacy of low emission zones to improve urban air quality in European cities. Atmos Environ. 2015;111:161–9.
78. London Tf. Inner London ultra low emission zone-one year report. 2023.
79. Willis MD, et al. Assessing the effectiveness of vehicle emission regulations on improving perinatal health: a population-based accountability study. Int J Epidemiol. 2020;49(6):1781–91.
80. Kang C, Ota M, Ushijima K. Benefits of diesel emission regulations: Evidence from the World's largest low emission zone. J Environ Econ Manage. 2024;125.
81. Wu XF et al. Long-term characterization of roadside air pollutants in urban Beijing and associated public health implications. Environ Res. 2022;212.
82. Yang ZW et al. Speed-guided intelligent transportation system helps achieve low-carbon and green traffic: Evidence from real-world measurements. J Clean Prod. 2020;268.
83. Voordeckers D, et al. Guidelines for passive control of traffic-related air pollution in street canyons: An overview for urban planning. Landsc Urban Plan. 2021;207:103980.

84. Zhang Y, Gu Z. Air quality by urban design. Nat Geosci. 2013;6(7):506–506.
85. Barnes MJ, et al. Spatially-varying surface roughness and ground-level air quality in an operational dispersion model. Environ Pollut. 2014;185:44–51.
86. Wang W, et al. Identifying urban ventilation corridors through quantitative analysis of ventilation potential and wind characteristics. Build Environ. 2022;214:108943.
87. Zheng ZF et al. Urban ventilation planning and its associated benefits based on numerical experiments: A case study in beijing, China. Build Environ. 2022;222.
88. Fang Y, Zhao L. Assessing the environmental benefits of urban ventilation corridors: A case study in Hefei China. Build Environ. 2022;212:108810.
89. Hagler GSW, et al. Field investigation of roadside vegetative and structural barrier impact on near-road ultrafine particle concentrations under a variety of wind conditions. Sci Total Environ. 2012;419:7–15.
90. Lin M-Y, et al. The effects of vegetation barriers on near-road ultrafine particle number and carbon monoxide concentrations. Sci Total Environ. 2016;553:372–9.
91. Huang C-W, et al. The Effects of Leaf Area Density Variation on the Particle Collection Efficiency in the Size Range of Ultrafine Particles (UFP). Environ Sci Technol. 2013;47(20):11607–15.
92. Barwise Y, Kumar P. Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection. Npj Climate Atmos Sci. 2020;3(1).
93. Wang H, et al. Efficient Removal of Ultrafine Particles from Diesel Exhaust by Selected Tree Species: Implications for Roadside Planting for Improving the Quality of Urban Air. Environ Sci Technol. 2019;53(12):6906–16.
94. Deshmukh P, et al. The effects of roadside vegetation characteristics on local, near-road air quality. Air Qual Atmos Health. 2019;12(3):259–70.
95. Neft I, et al. Simulations of aerosol filtration by vegetation: Validation of existing models with available lab data and application to near-roadway scenario. Aerosol Sci Technol. 2016;50(9):937–46.
96. Janhall S. Review on urban vegetation and particle air pollution - Deposition and dispersion. Atmos Environ. 2015;105:130–7.
97. Hashad K et al. Enhancing the local air quality benefits of roadside green infrastructure using low-cost, impermeable, solid structures (LISS). Sci Total Environ. 2020;717.
98. James P, et al. A Review of the Health Benefits of Greenness. Curr Epidemiol Rep. 2015;2(2):131–42.
99. James P, et al. Exposure to Greenness and Mortality in a Nationwide Prospective Cohort Study of Women. Environ Health Perspect. 2016;124(9):1344–52.
100. Baldauf R. Roadside vegetation design characteristics that can improve local, near-road air quality. Transp Res Part D: Transp Environ. 2017;52:354–61.
101. Hoekstra A. The Underestimated Potential of Battery Electric Vehicles to Reduce Emissions. Joule. 2019;3(6):1412–4.
102. Duthie J, Cervenka K, Waller ST. Environmental Justice Analysis: Challenges for Metropolitan Transportation Planning. Transp Res Rec. 2007;2013(1):8–12.
103. Duthie J, Waller ST. Incorporating Environmental Justice Measures into Equilibrium-Based Network Design. Transp Res Rec. 2008;2089(1):58–65.
104. Casey JA et al. Methods in Public Health Environmental Justice Research: a Scoping Review from 2018 to 2021. Curr Environ Health Rep. 2023.
105. He BHQ, Heal MR, Reis S. Land-Use Regression Modelling of Intra-Urban Air Pollution Variation in China: Current Status and Future Needs. Atmosphere. 2018;9(4).