

Blue-Green Infrastructure and Cleaner Air: A Systematic Literature Review for the UK

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Abstract: Air pollution is a widespread problem that impacts both indoor and outdoor spaces, posing serious risks to human health and well-being. Both short-term and long-term exposure to air pollution have detrimental effects on human health and the climate, increasing the risk of cardiovascular disorders, respiratory illnesses, and global warming. Many cities throughout the world, including those in the UK, have explored the potential of blue-green infrastructure (BGI) as a strategy in addressing air quality. BGI is a nature-friendly strategy of working with green spaces - such as street trees, parks or gardens; and blue elements such as rivers, wetlands, canals or lakes to address climate change and environmental degradation while promoting the creation of resilient and liveable cities. However, BGI's efficacy varies depending on design, scale, and location; therefore, customised strategies are needed for various urban settings. According to this systematic review of the latest research (years 2015 to 2025) on BGI and air pollution; road-side trees, green walls, and wetlands as a blue infrastructure help in filtering outdoor pollutants. By reducing pollutant concentrations and fostering sustainable urban environments, green infrastructure may have a great potential to enhance outdoor air quality in comparison to indoor air quality. The systematic review also points out the need for policy frameworks to include evidence-based strategies into urban planning, ensuring that outdoor BGI is accessible, equitable, and effective in addressing air pollution and climate challenges. Trans-disciplinary research is necessary to optimise BGI deployment to develop future British cities that prioritise sustainability, clean air, and public health.

Keywords: air pollution mitigation, air quality, blue-green infrastructure, nature-based solutions

1. Introduction

Air pollution is currently the biggest environmental threat to public health in the United Kingdom (UK); between 28,000 to 36,000 people die each year in the UK because of poor air quality (Gov.UK, 2022). The life expectancy of every UK resident is reduced by seven to eight months on average every year due to air pollution (Brunt et al. 2016). Every year more than 1,100 cases of lung cancer are reported in the UK directly linked to air pollution, which is higher than in the United States of America (USA) and Canada (Gregory, 2025). Through improved air quality in metropolitan areas, the push for cities to use clean energy in their quest for Net Zero offers several advantages for human health and the environment. In many nations around the world, air pollution is a serious and life-threatening problem that endangers both the environment and public health (Al-Habaibeh et al. 2025). Construction companies are incorporating life cycle carbon assessment into their operations because of the global push to lower carbon emissions and lessen the environmental carbon footprint of the sector and its influence on climate change (Al-Habaibeh et al. 2026).

Air pollution can occur both indoors and outdoors. Fundamental factors influencing health and well-being include thermal comfort and indoor air quality, which are especially important in medical facilities where environmental factors directly impact staff performance and patient recovery rates (Rosli Razak et al. 2025).



A complex combination of gases, liquid droplets, and solid particles make up air pollution. It can originate through different combinations, resulting from a variety of places. This includes the burning of domestic fuels, industrial chimneys, traffic exhausts, power generation, open garbage burning, diesel engine smoke, road dust and many more. Among the air pollutants that are typically measured are particles with an aerodynamic diameter of 2.5 micrometres or less (PM 2.5) and 10 micrometres (PM 10), respectively, as well as Ozone (O₃), Nitrogen Dioxide (NO₂), Sulphur Dioxide (SO₂), and Carbon Monoxide (CO) (WHO, 2022). These air pollutants can have immediate and long-term negative health impacts, as can Volatile Organic Compounds (VOCs), which are gases released by some solids or liquids (WHO, 2022).

Many high-income countries have recently witnessed improvements in air quality, and the UK has likewise observed a similar trend, with ambient concentrations of NO₂, SO₂, PM10, and PM2.5 steadily decreasing (Osborne et al. 2021). The UK standard for PM10 is nearly three times higher than the World Health Organization (WHO) guidelines and the country's regulatory limit for PM2.5 is five times greater, both of which are unacceptable (Carrington, 2022; Gov.UK, 2022). This demonstrates a failure by the government to prioritize public health adequately. Aligning with the (WHO, 2022) guidelines would reduce the health burden of air pollution, protect vulnerable populations, and demonstrate a stronger commitment to environmental & global health standards. Globally, the climate and ecosystems of the planet are directly related to air quality (theconstructor, 2022).

Blue-green infrastructure policies, along with innovative ideas to decrease pollution, provide a win-win strategy for both climate and health as they lessen the burden of sickness linked to air pollution and contribute to, both, short and long-term mitigation of climate change (WHO, 2022).

A systematic literature review of the latest literature on air pollution and BGI has been conducted. Evidence from across the academic literature sources relating to air pollution, with a particular focus on the UK and other high-income countries have been reviewed. The systematic review aims to provide an overview of the current evidence on the topic of impacts of BGI on air quality levels. This would guide in identifying the needs for policy making and also to identify the knowledge gaps to direct further research in designing future UK cities, which should be sustainable, healthy, and resilient.

2. Methods

2.1. Scope and Search Strategy

Online literature searches were conducted to identify studies that had measured the relationship between BGI or more broadly green-blue-grey infrastructures (GBGI), and air pollution in both outdoor and indoor environments. The review was limited to peer-reviewed studies published in English between 2015 and 2025, each source was included based on predefined eligibility criteria. Research undertaken in high-income countries was conducted, as the aim was to find studies that were pertinent to the UK setting regarding the level of urbanisation, industrialisation, and the main sources of air pollution. According to the (WorldBank, 2024) country classifications, high-income nations were identified.

Of the various GBGI, see *Table 1* as classified by (Kumar et al. 2024), the study concentrates only on selected typologies, not including any gardens or hybrid green infrastructure (GI). The thematic focus of this review evolves around the linear features: street trees and hedges; along with constructed GI: green walls and green roofs. Combinations of trees-hedges and trees-shrubs mixes are also considered, and the blue infrastructure includes rivers, wetlands, and lakes. All other GBGI typologies are not part of this study as there are no or limited studies available on them; this includes: footpaths, railway corridors, roof gardens, pergolas, heritage gardens, nursery gardens, parklets, pocket parks, school yards, sport fields, golf courses, shared open spaces, sparsely vegetated land, cemeteries, allotments, permeable paving's, permeable parking, attenuation ponds, flood control channels, rain gardens, bio-swales, outdoor swimming pools, canals, ponds, reservoirs, estuary, sea, balconies, private gardens, and shared common garden areas. In addition to the chosen GBGI, indoor plants impact on the overall indoor air quality are also studied.

Table 1. GBGI classification for which relevant data is available; based on (Kumar et al. 2024).

Linear features	Street trees	Parks	Public parks	
	Hedges		Zoological garden	
	Cycle track		Botanical garden	
	Road verge		Amenity areas	Playgrounds
	Riparian woodland		Mixed	Trees & hedges
Constructed GI	Green walls	Trees & shrubs		
Green roofs	Grass & trees			
Non-sealed urban areas	Grasslands	Other public space	Adopted public spaces	

	Shrub lands	Waterbodies	City farms
	Woodlands		Rivers
	Arable agriculture		Wetlands
	Lakes		

Relevant key words, phrases, and synonyms were identified to develop a search string. The key words used were air pollution, air quality, green infrastructure, near road, blue infrastructure, indoor air pollution. The pollutant types investigated for outdoor settings are ultrafine particle number concentration, PM1, PM2.5, PM10, PM15, nitrogen oxides (NO_x), SO₂, O₃, and black carbon (BC), whereas for indoor environments, the pollutants considered are carbon dioxide (CO₂), PM, and VoC's. A systematic review of the scientific literature by identifying articles was conducted between February and March 2025. Searches were conducted across major scholarly databases, including Science Direct (Elsevier), Springer Link, Nature, SAGE, Taylor & Francis, Frontiers, and Multidisciplinary Digital Publishing Institute (MDPI). In addition, relevant articles already known to the authors were also included. All search results were aggregated and subjected to a structured screening and appraisal stage.

The quality of each reference in this study was assessed using modified standards from accepted systematic literature review guidelines. The authors have examined whether the study design was appropriate, research aims were clear, the procedures were adequately explained, the sample size was adequate, the methods for measuring pollutant levels were reliable, and the statistical analysis was strong.

2.2. Screening and appraisal

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach was followed for the systematic literature review. The review is structured around the aim and the selection of appropriate databases, with clear criteria for inclusion and exclusion. The records identified for the literature review were 106 in total. The countries of research are indicated in *Figure 1* where the final selected 52 research articles, papers, and web pages to be included in the qualitative synthesis are: UK (26), United States of America (8), Sweden (4), Poland (4), Italy (2), Australia (1), Switzerland (1), France (1), Czechia (1), Finland (1), Denmark (1), Germany (1), and Spain (1). *Figure 2* presents the screening and appraisal process using PRISMA framework.

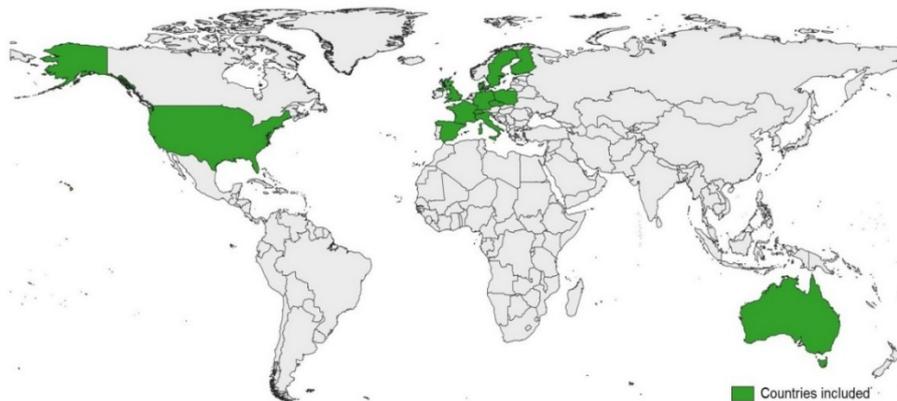


Figure 1. Countries included in the qualitative synthesis.

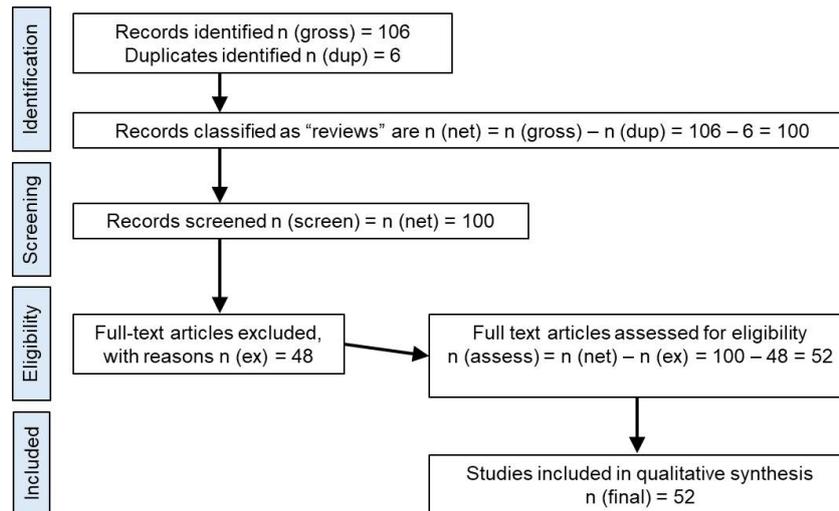


Figure 2. Screening and appraisal process using PRISMA framework.

The exclusion criteria defined for rejecting papers during the screening process was:

- Country of research different from what was intended for the study.
- GI covered in general and not specific to the vegetation species.
- The results for road-side vegetation were not quantified to understand the percentage reduction in pollutants.
- Any published papers that are outside of the date criteria.
- The pollutant types were different than required to study. e.g., lead, cadmium, nickel, and zinc.

3. Results

The results of the 52 studies that were identified as part of the qualitative synthesis are summarised in this section. It is divided into four sections according to the theme:

- Urban trees and shrubs or hedges close to roads.
- Building exterior design – green walls or vertical screens, and green roofs.
- Blue infrastructure or green and blue infrastructure.
- Indoor plants including green walls or vertical screens.

3.1. Urban trees and shrubs or hedges close to roads

Figure 3 presents an example of urban trees and shrubs or hedges close to roads. Based on the results of the searches conducted across majorly databases, roadside vegetation species shortlisted are: beech, cedar, conifers, English yew, lime, London plane, maple, oak, olive, pine, Salix (willow), silver birch, and western red cedar. The shrubs or hedges selected are: deciduous hedge, European box, holly, hawthorn, Silvergrass, and yew.

High pollution reduction efficiency was shown by species such as beech, English yew, lime, and pines, especially for fine PM. Other trees such as cedars achieved 50% reduction in PM10 and PM2.5 (Janhäll, 2015), while olive trees showed up to 87.6% reduction (Wróblewska and Jeong, 2021). Pollution reduction values varied among research findings. Species such as maple and London plane demonstrated moderate but noticeable impacts. Since they affect overall efficacy, qualitative factors including leaf features (size and texture), seasonal fluctuations, and Biogenic Volatile Organic Compounds (BVOC) emissions are also covered in addition to the quantitative findings. **Table 2** summarizes the pollutant categories, plant species, and associated removal efficiencies.

Table 2. Urban trees close to roads.

Vegetation species	Pollutant type	Results	References
Beech	PM	High potential to reduce PM levels.	(Oulehle et al. 2024)
Cedar	PM10 and PM2.5	~50% reduction.	(Janhäll, 2015)
Conifers	PM	~40% reduction.	(Janhäll, 2015)

		Highly effective.	(Hashad et al. 2023; Pleijel et al. 2022; Tong et al. 2016; Tiwari and Kumar 2022)
English Yew	PM	High efficiency.	(Barwise et al. 2024)
		Highest capacity during winter season.	(He et al. 2020)
Lime	PM10 and O ₃	High efficiency.	(Kofel et al. 2024; Manzini et al. 2023)
London plane	PM	6.4% reduction.	(Wróblewska and Jeong, 2021)
		10.67% reduction.	(Selmi et al. 2016)
Maple	BC	12 to 22% reduction.	(Janhäll, 2015)
	-	Emit low concentrations of BVOCs.	(DEFRA, 2018)
Oak	BC	12 to 22% reduction.	(Janhäll, 2015)
	PM10 and PM2.5	~50% reduction.	(Janhäll, 2015)
Olive	PM	87.6% reduction.	(Wróblewska and Jeong, 2021)
Pine	PM	High efficiency.	(Chojnacka-Ożga and Ożga, 2021; Kończak et al. 2024)
	-	Emit low concentrations of BVOCs. Low tolerance for air pollutants.	(DEFRA, 2018) (Yang et al. 2015)
Salix (willow)	-	Emit high concentrations of BVOCs.	(Karlsson et al. 2020)
Silver birch	-	Emit low concentrations of BVOCs.	(DEFRA, 2018)
Vegetation barriers in general	CO	23.6-56.1% reduction.	(Lin et al. 2016)
	PM	10-20% reduction in the first 200m from road.	(Tong et al. 2016)
		15-21% reduction.	(Abhijith and Kumar, 2019)
		Waxy leaves are better than hairy leaves.	(Perini et al. 2017)
		High efficiency.	(Jones et al. 2019; Kathryn Brown and Dr. Ana Mijic, 2019; Redondo-Bermúdez et al. 2022)
		Urban trees are more complex to study and are subjected to variability in weather, climate and other environmental conditions.	(Washbourne, 2016)
Trees with smaller leaves are more effective.	(Choe et al. 2020)		
Western Red Cedar	PM2.5 and PM1	~ 46% and 26% reduction respectively.	(Maher et al. 2022)
	PM10	~ 23% reduction.	(Sheikh et al. 2023)

Depending on PM sizes, hedges including holly and deciduous shrubs exhibited PM reductions of 18% to over 76% (Donateo et al. 2021; Janhäll, 2015; Abhijith et al. 2017), as indicated in **Table 3**. Factors like wind speed and plant height affected hedge efficiency, with the biggest reductions in PM levels seen nearer to the ground (Donateo et al. 2021; Santiago et al. 2019), (Kumar et al. 2022). Furthermore, species-specific traits were important; for instance, Silvergrass was found to be effective in reducing overall PM levels (Kiersten Rankel, 2024). Smaller size European box plants demonstrated higher PM efficiency (Tomson et al. 2021). *Figure 4* presents the available and quantifiable data of average PM reduction, by urban trees, shrubs or hedges close to roads, based on **Tables 2** and **3**.



Figure 3. Photos of an urban tree and hedges close to Beeston Ln in Nottingham, UK.

Table 3. Shrubs or hedges close to roads.

Vegetation species	Pollutant type	Results	References
Deciduous hedge	PM10, PM2.5 and PM1	35%, 44%, and 52% reduction respectively.	(Donateo et al. 2021)
European box	PM10, PM2.5 and PM1	The smaller the size, the higher the quantity captured.	(Tomson et al. 2021)
Hedges in general	PM and Black carbon	Influenced by wind conditions and did not follow the volumes of on-road traffic flows.	(Kumar et al. 2022)
		Reduce concentration close to the ground only, and not at higher heights.	(Donateo et al. 2021; Santiago et al. 2019)
		PM density, which made up 66%, 29%, and 5% of all deposited particles, respectively, followed the pattern PM1>PM1-.2.5> PM2-5-10.	(Abhijith and Kumar 2020)
Holly	PM15	18% reduction.	(Janhäll, 2015)
	PM	58.3 to 76.1% reduction.	(Abhijith et al. 2017)
Hawthorn	PM15	27% reduction.	(Janhäll, 2015)
	PM10	34% reduction.	(Abhijith et al. 2017)
Silvergrass	PM	High efficiency.	(Kiersten Rankel, 2024)
Yew	PM15	3% reduction.	(Janhäll, 2015)
	PM	17 to 20.5% reduction.	(Abhijith et al. 2017)

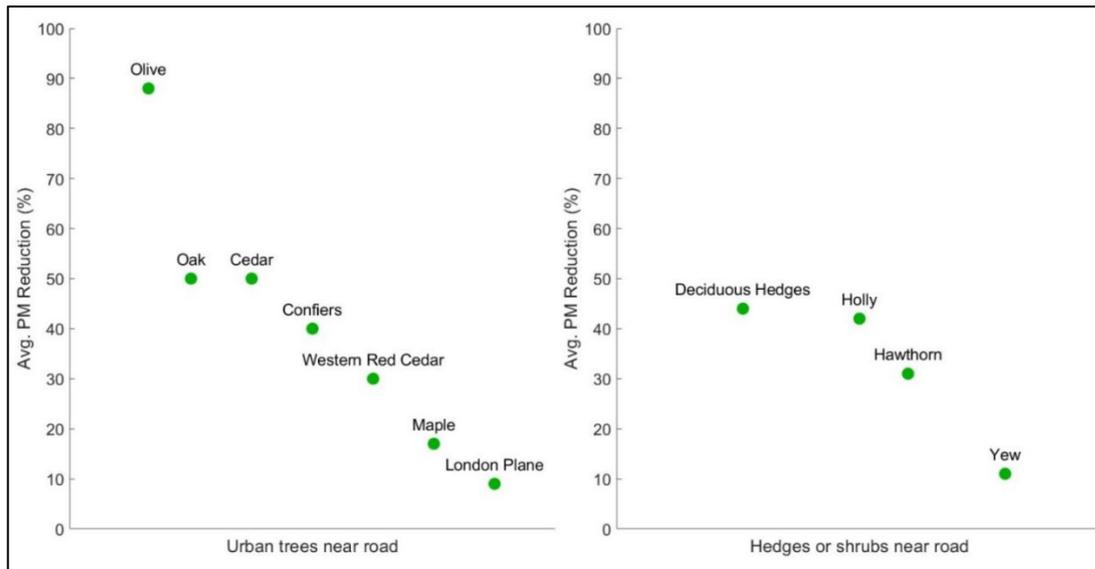


Figure 4. Available and quantifiable data of average PM reduction, by urban trees, shrubs or hedges close to roads; based on [Tables 2](#) and [3](#).

3.2. Building exterior design— green walls or vertical screens, and green roofs

The phrase ‘green wall’ refers to any type of vegetated wall surface and is also known as green vertical systems, bio walls or vertical gardens. Green walls, see [Figure 5](#), can be categorized into living walls and green facades. Whereas green screens in comparison are an upcoming concept, for example, the usage of climber vegetation which grows on a steel or plastic mesh. Green roofs, [Figure 5](#), are typically defined for building roofs that are entirely or partially covered by vegetation.

Other names for green roofs include eco-roofs, living roofs, or roof gardens. There are three different types: extensive (less than 15cm growth media depth), intensive (height from 0.2 to 1.2 meters), and semi-intensive which occupies less than or equal to 25% of the area of an extensive green roof, with a moderately deep growing substrate ([Tomson et al. 2021](#)). The species studied are bay tree, engineered green wall, English ivy, sword fern or Boston fern for green walls and white stonecrop, red fescue, and creeping bent grass for green roofs, see [Table 4](#) and [Table 5](#).



Figure 5. Photos of green wall and green screen from Carnaby Street in London, UK and roof garden at Boots library in Nottingham Trent University, Nottingham, UK respectively.

Table 4. Building exterior design – green walls or vertical screens.

Vegetation species	Pollutant type	Results	References
Bay tree	PM10 and O ₃	More effective pollutant removers.	(Tomson et al. 2021)
CityTree – innovatively engineered green wall (Mosses)	PM2.5, PM1, ultrafine particle number concentration, and BC.	15-20%, 11-13%, 38%, and 17% reduction respectively.	(Donateo et al. 2021)
English Ivy	PM	They have the potential to trap PM all year round and can restore their PM-capture capacity following rainfall.	(Tomson et al. 2021)
Sword fern or Boston fern	PM	92.46% reduction.	(Wróblewska and Jeong, 2021)
Vegetation barriers	PM	Increase in width results in greater concentration results.	(Donateo et al. 2021)

Table 5. Building exterior design – green roofs.

Type or species	Pollutant type	Results	References
Extensive green roofs are less effective than intensive green roofs	SO ₂ and NO _x PM10 and PM2.5	Levels decreased. Values increased.	(Tomson et al. 2021)
White stonecrop, Red fescue, and Creeping bent-grass	PM	Red fescue was most effective followed by creeping bent-grass, and then white stonecrop.	(Wróblewska and Jeong, 2021)

3.3. Blue infrastructure or green and blue infrastructure

Species growing in blue-infrastructure, **Figure 6**, included for the review are common reed, soft-stem bulrush or river club-rush, iris or flag, European ash, purple loosestrife, and sycamore maple. The contribution of riparian or wetland vegetation, blue infrastructure, and their relation to PM reduction was considered. Wetlands plants such as common reed, soft-stem bulrush, and iris showed a great capacity for trapping both fine and coarse particles (Wróblewska and Jeong, 2021), as summarized in Table 6.

On the other hand, species like purple loosestrife showed poor particle removal effectiveness (Wróblewska and Jeong, 2021). According to (Kumar et al. 2024), rivers had no measurable effect on PM levels, although wetlands and lakes showed minimal effect, lowering PM levels by 1% to 3% respectively. The European ash and sycamore maple as shown in **Figure 7** are two tree species that grow close to waterbodies, demonstrated more significant decreases in PM, up to 86% and 10% respectively (Selmi et al. 2016).



Figure 6. Photos of blue-green infrastructure from Hammersmith Park, London.

Table 6. Blue infrastructure or green and blue infrastructure.

Type	Pollutant type	Results	References
Common reed, Soft-stem bulrush or river club-rush and Iris or flag	Fine and coarse particles	High potential.	(Wróblewska and Jeong, 2021)
European ash	PM	~86% reduction.	(Selmi et al. 2016)
Purple Loosestrife	Fine and coarse particles	Low efficiency.	(Wróblewska and Jeong, 2021)
River, wetland and lake	a. PM1 b. PM2.5 c. PM10	a. No effect. b. Rivers have no effect, whereas wetlands and lakes reduce the levels by 1% and 3 % respectively. c. Rivers and lakes have no effect, whereas wetlands reduce the levels by 1%.	(Kumar et al. 2024)
Sycamore maple	PM	~10% reduction.	(Selmi et al. 2016)

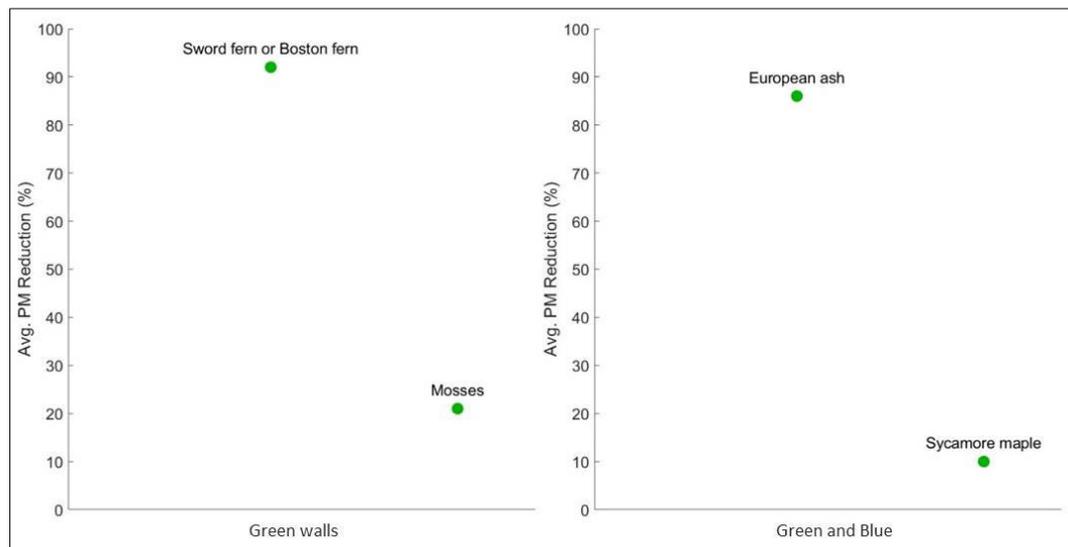


Figure 7. Available and quantifiable data of average PM reduction, by green walls or vertical screens and green and blue infrastructure; based on Tables 4 and 6.

3.4. Indoor plants including green walls or vertical screens

Species such as creeping fig, parlour plant, and philodendron, primarily accumulate carbon without significantly lowering ambient concentrations. Species such as areca palm and peace lily have demonstrated the ability to decrease CO₂ and increase the humidity levels (Bandehali et al. 2021), as summarized in Table 7. Snake plant is effective in improving the quality of the air in the night as it is observed to convert CO₂ into O₂ at night (eltafans, 2019).

Research highlights that, environmental elements including temperature, light availability, and plant density have a significant impact on plant efficacy (Tian et al. 2023; Gubb, 2020). Several evaluations, however, question the efficacy of potted plants in general, contending that they have limited effect on indoor air quality in comparison to mechanical options such as HEPA filters (Cummings and Waring 2020; ALU 2024; Romano, 2022). The MopFan is a novel air purification device – a system that incorporates cutting-edge filtering technologies such as photocatalytic oxidation, high-efficiency particulate air filters, as well as bio-aerogel materials, which are primarily intended to reduce gaseous pollutants (Tapia-Brito and Riffat 2025). Indoor plants, as in Figure 8, may nevertheless provide indirect advantages, such as higher humidity, fewer airborne micro-organisms, and enhanced occupant well-being, despite the drawbacks (Berger et al. 2022; Berger, 2023).

Table 7. Indoor plants including green walls or vertical screens.

Vegetation species	Pollutant type	Results	References
Areca palm	CO ₂	Decreases CO ₂ levels.	(Bandehali et al. 2021)
	-	Release moisture into the air.	(White, 2024)
Creeping fig	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
Dragon plant or lemon lime or corn plant	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
English Ivy and Devil's Ivy	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
Florida beauty	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
Indoor green walls or vertical screens	VOC, PM and CO ₂	By absorbing VOC and PM, green wall is quite good in improving air quality; however, it has not proved very successful at absorbing CO ₂ . In a dry environment, green wall is a good choice since it raises the relative humidity.	(Bandehali et al. 2021)
Indoor plants in general	VOC & PM	One plant per square foot of floor space required to make any substantial difference.	(Delgoda, 2022)
		External elements such as light and temperature, as well as interior elements such as leaf area and cuticle wax, can have a big impact on the effectiveness.	(Tian et al. 2023)
		HEPA filters are more effective than indoor plants.	(Romano, 2022)
		Potted plants do not improve indoor air quality.	(Cummings and Waring 2020; ALU 2024)
	-	Can benefit the health and well-being of building occupants.	(Berger et al. 2022; Berger, 2023)
	-	Light can play a vital role on efficiency.	(Gubb et al. 2018)
	-	A large number of plants and additional lighting (at around 22,200 lux) are needed for detectable CO ₂ reduction at the room scale.	(Gubb, 2020)
	PM _{2.5}	PM _{2.5} levels peak in between 7pm and 10pm in the UK.	(Dyson, 2022)
Never-never plant	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
Parlour plant	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
Peace lily	CO ₂	Decreases CO ₂ levels.	(Bandehali et al. 2021)
	-	Increases moisture levels.	(Liz Baessler 2022)
	-	Reduces airborne microbes and mold spores.	(Andrew White 2024)
Philodendron	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
Purple spider plant	CO ₂	Accumulates carbon.	(Bandehali et al. 2021)
Snake plant	CO ₂	Convert large amounts to O ₂ at night.	(eltafans, 2019)

Spider plant	PM	Accumulation of PM at a high level on surface of leaf.	(Bandehali et al. 2021)
	-	Release moisture into the air.	(White, 2024)
Weeping fig	CO ₂	Decreases CO ₂ levels.	(Bandehali et al. 2021)

Targeted selection and placement of plant species is crucial since the research supports the idea that vegetation is not always successful and that its efficacy varies depending on species attribute, pollutant type, location, and environmental circumstances. This gives designers, legislators, and urban planners important chances to purposefully include vegetation into high-exposure locations including residences, school zones, public transportation corridors, and roadside areas. Particularly for lowering PM and VOC levels close to pedestrian zones, vertical greening systems and hedges provide a workable option in highly populated areas with limited ground space. Even though they might not be able to completely replace mechanical filters indoors, plants can still be a useful addition, particularly when used extensively and with proper lighting, humidity control, and air circulation.



Figure 8. Photos of indoor plants at Nottingham Trent University City Campus, Nottingham, UK.

Prioritizing high-priority, pollutant-specific species in high-risk areas, utilizing a layered strategy that incorporates trees, shrubs, and hedges to optimize pollutant capture is recommended (Ravindra et al. 2026). Incorporating green infrastructure into building design, and encouraging indoor plant use in residences, workplaces, educational institutions, and healthcare facilities where occupant well-being and air quality is crucial, are some of the initial recommendations.

4. Gap in Knowledge in Literature and Conclusion

By methodologically examining and synthesising data on the effects of specific BGI typologies on both indoor and outdoor air quality in the UK, the study has addressed its aim. The study offers a comprehensive understanding of which BGI types are most beneficial, under what circumstances, and with what limitations, by critically evaluating 52 high quality studies. The results provides practical information for urban planners, policymakers, and designers seeking evidence-based strategies to incorporate BGI into building design and urban design for air quality enhancement.

This paper presented a systematic literature study to gain knowledge on the positive impacts of BGI on air quality, considering specific scenarios, mainly roadside vegetation, constructed GI, indoor plants, and vegetation in waterbodies. The weather patterns, wind directions, wind speed, time, and season are not considered in all studies. Several studies do not account for the size or age of the species, number of plants or trees, and sources of pollution. Not all studies on vegetation near roads consider the time evolution of number and type of vehicles in each lane, velocity of each vehicle, and expected emission factors. Nevertheless, a few studies consider the distance from the road. The size of the constructed GI, indoor plants, and BI are not covered by most studies.

The results suggest that road-side GI has a great ability to reduce pollutant levels, providing tangible benefits for outdoor air quality. This provides an opportunity to study in detail the GI, in addition to BI, and their relation to air quality along roads and building surroundings, especially residences. It is crucial to study residences as people generally spend most of their time at home, and especially indoors. Future

research should explore the combined efforts of GI and BI in residential areas, quantify indoor air quality improvements, and provide evidence-based building and urban design guidance for urban planning policies.

The air from roads surrounding houses may have direct or indirect influence on the indoor air quality. Since, indoor plants or green walls are found not to be highly successful in enhancing indoor air quality; the way forward would be to understand how BGI can influence air quality along roads and around houses, by choosing suitable locations. Conifers are highly effective because of their dense, fine-textured canopies, high leaf index, and year-round foliage. This calls for a unique opportunity to explore the use of conifer species along roads and around residences. Male trees of eastern red cedar are to be avoided as they are highly allergenic. From primitive clay pot methods to sophisticated hybrid cooling systems, evaporative cooling has been an essential passive thermal regulation strategy for millennia in various civilizations (CUCE 2025). These results are especially relevant in urban areas with high pollution levels where planting relevant vegetation species in combination with BI can be often used to improve outdoor air quality. Pines have a high efficiency in PM_{2.5} removal and low BVOC emissions, but their tolerance for air pollutants is low, and must be avoided. Mosquitoes and insects may be limited by creating water features with steep edges and reduced emergent vegetation. Likewise, preserving a strip of undisturbed vegetation around a water body may limit algal growth, but could also serve as an attractive habitat for rats and other rodents, raising health concerns.

The results of this research are supported by several recent case studies that highlight how BGI may be operationalised in real-world building design and urban planning. (Rosli Razak et al. 2025) demonstrated how machine learning-driven predictive models are applied for indoor air quality monitoring. Exploring the application of artificial intelligence and machine learning for outdoor BGI monitoring would enable city councils to make dynamic adjustments to vegetation management in response to pollution trends. Similarly, evaporative cooling systems and green roofs together are an efficient dual strategy for enhancing thermal comfort and reducing PM concentrations during urban heat episodes, according to (CUCE 2025). The use of hybrid green wall system featuring assisted mechanical ventilation capturing PM and NO_x levels could be explored. These examples highlight the importance of multi-functional BGI for UK policymakers, not just as an air quality metric but also for its co-benefits in public health and climate resilience.

Embedding such evidence into Local Development Plans and Clean Air Strategies, particularly when combined with real-time monitoring and cross-sector cooperation between public health departments, environmental agencies, and urban planners. Decisions should be made based on site characteristics, common public health issues, and community interests by carefully weighing potential risks and trade-offs. BGI projects should not be halted or scaled back as there is a growing understanding of the possible risks associated with urban BGI. Rather, it is possible to guarantee that BGI may improve overall health and well-being by integrating public awareness and interventions into urban planning at the very beginning, to develop future British cities.

Author contributions

Conceptualisation: Nikhil Ravindra. Methodology: Nikhil Ravindra, Amin Al-Habaibeh, Francesco Luke Siena. Investigation: Nikhil Ravindra. Writing – original draft preparation: Nikhil Ravindra. Writing – review and editing: Amin Al-Habaibeh, Francesco Luke Siena. All authors have read and approved the final manuscript.

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Conflict of Interest Statement

The authors have no competing interests to declare.

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