

Urban trees and asthma: a call for epidemiological research

Air pollution is now the greatest environmental cause of premature death, and more than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed WHO limits. Likewise, prevalence of asthma—which has been linked to poor air quality—has been increasing in many countries over the past few decades. In both scholarly literature and popular media, one strategy to address these seemingly interconnected problems has received increasing attention, namely, urban greening and tree planting in particular. This attention is reflected in recent issues of *The Lancet Respiratory Medicine*.^{1,2}

Yet, an interdisciplinary review of peer reviewed literature that we conducted with colleagues from epidemiology, atmospheric science, plant science, urban ecology, environmental engineering, and landscape planning finds no scientific consensus to support this strategy.³ There are inconsistencies within models, between models, among empirical studies, and between model and empirical studies. Moreover, urban trees can, in many cases, reduce air quality and increase asthma through pollen production and synergistic interactions between pollen and air pollution; emitting biogenic volatile organic compounds that contribute to ozone formation; and concentrating air pollution by reducing air flow in urban streets flanked by buildings where people walk, bike, and drive.

The cause of asthma is very complex and includes a range of environmental, genetic, and demographic factors. There are also substantial differences in how scientific disciplines approach the topic of urban trees, air quality, and asthma. Natural science generally uses models, laboratory studies, and field studies to assess biophysical processes linking urban trees with air pollution;

and in some instances, layered modelling is used to project estimates of asthma morbidity and mortality.^{4,5} But respiratory health benefits derived from such studies are rarely supported by epidemiological research, which highlights links with pollen, not air pollution. Importantly, most public health studies in our review find adverse associations between urban trees and asthma.

Some observational studies do find links between green space and reduced respiratory disease, but they do not, to the best of our knowledge, identify air pollution reduction as the mechanism. One exception includes a study by Alcock and colleagues,⁶ which correlated reductions in asthma hospitalisation with air pollution reduction via urban trees. However, other studies show no protective effect of urban trees on asthma morbidity via air pollution reduction.^{7,8} Another study posits that asthma reductions may be explained by greater and more diverse microbial exposure in vegetated spaces.⁹ It is also conceivable that urban flora may reduce asthma by decreasing stress—a risk factor for asthma, and one of the most consistently identified benefits that people derive from spending time in or near greenspaces.

All of this raises the pressing question: if urban trees are a promising means to decrease asthma and respiratory disease by reducing air pollution levels, why is there such a dearth of public health scholarship and empirical evidence showing this relationship?

The substantial differences in how epidemiology and natural science study and draw conclusions relating to air quality and urban vegetation exhibit disciplinary crosstalk—poor communication, unconscious misunderstandings, and inconsistent use of terms, literature, and findings between disciplines. In the case at hand, disciplinary crosstalk is exacerbated by the ascendancy of so-called ecosystem services as the dominant conceptual frame for depicting, studying, and valuing vegetation in cities. Ecosystem

services refers to the benefits people derive from ecosystem functions; human health has been described as the central aspect of these services. Yet, public health scholarship is still not integrated in ecosystem services literature, and this is particularly noteworthy in a subfield focusing on urban ecosystem services (figure 1).

In light of the aforementioned gaps, we are issuing a call for epidemiological research on urban trees, air quality, and respiratory health to inform landscape and urban planning. This supports similar calls for interdisciplinary research on the human health effects of spending time in or near greenspaces,¹⁰ and it also addresses a policy issued by the American Public Health Association.¹¹ entitled, “Improving Health and Wellness through Access to Nature.”

We are in no way suggesting that trees should not be planted in cities. Trees are essential for people-friendly streets (figure 2), and urban flora provides numerous benefits to wildlife and human health and wellbeing that are unrelated to air quality. Indeed, urban greening may be essential for future generations, the vast majority of whom will live in cities and may not have much contact with flora. But we do not believe that there is sufficient evidence to support citywide tree planting as a strategy to improve respiratory health via air quality improvement. Recommending this in

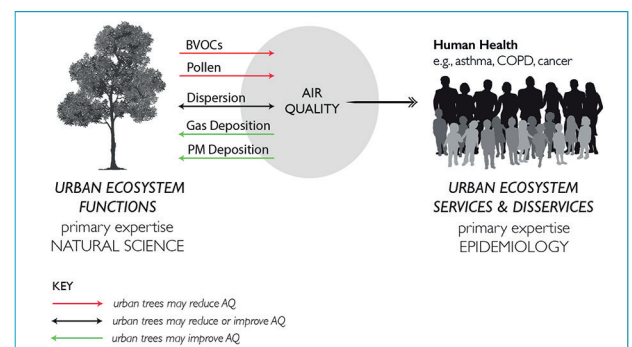


Figure 1: Relationship between urban ecosystem functions, urban ecosystem services and disservices, and disciplinary expertise pertaining to air quality and human health (reproduced from Eisenman et al,³ by permission of Elsevier) BVOCs=biogenic volatile organic compounds.



Figure 2: Las Ramblas in Barcelona, Spain, lined with Planetrees (*Platanus x acerifolia*)

scientific and popular literature risks obfuscating rather than illuminating public policy on a health issue such as asthma that affects millions of

people worldwide. It could also detract from the most important strategy to improve air quality—reducing air pollution emissions at their source.

We declare no competing interests.

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- 1 Soyiri IN, Alcock I. Green spaces could reduce asthma admissions. *Lancet Respir Med* 2018; **6**: e1.
- 2 van Dorn A. Urban planning and respiratory health. *Lancet Respir Med* 2017; **5**: 781–82.
- 3 Eisenman TS, Churkina G, Jariwala SP, et al. Urban trees, air quality, and asthma: an interdisciplinary review. *Landsc Urban Plan* 2019; **187**: 47–59.
- 4 Nowak DJ, Hirabayashi S, Bodine A, Hoehn R. Modeled PM_{2.5} removal by trees in ten US cities and associated health effects. *Environ Pollut* 2013; **178**: 395–402.

- 5 Rao M, George LA, Rosenstiel TN, Shandas V, Dinno A. Assessing the relationship among urban trees, nitrogen dioxide, and respiratory health. *Environ Pollut* 2014; **194**: 96–104.
- 6 Alcock I, White M, Cherrie M, et al. Land cover and air pollution are associated with asthma hospitalisations: a cross-sectional study. *Environ Int* 2017; **109**: 29–41.
- 7 Lovasi GS, O'Neil-Dunne JP, Lu JW, et al. Urban tree canopy and asthma, wheeze, rhinitis, and allergic sensitization to tree pollen in a New York City birth cohort. *Environ Health Perspect* 2013; **121**: 494–500.
- 8 Toh J, Shum M, De Vos G, et al. Association between asthma-related emergency department visits, tree pollen, pollution and humidity in the Bronx, 2001–2008. *J Allergy Clin Immunol* 2014; **133**: AB13.
- 9 Donovan GH, Gatzliolis D, Longley I, Douwes J. Vegetation diversity protects against childhood asthma: results from a large New Zealand birth cohort. *Nat Plants* 2018; **4**: 358–64.
- 10 Sullivan WC, Frumkin H, Jackson RJ, Chang C-Y. Gaia meets Asclepius: creating healthy places. *Landsc Urban Plan* 2014; **127**: 182–84.
- 11 American Public Health Association. Improving health and wellness through access to nature. Nov 5, 2013. <https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2014/07/08/09/18/improving-health-and-wellness-through-access-to-nature> (accessed April 29, 2019).