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Children living in areas with more street trees have lower prevalence of asthma

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Abstract

Background—The prevalence of childhood asthma in the USA increased by 50% from 1980 to 2000, with especially high prevalence in poor urban communities.

Methods—Data on the prevalence of asthma among children aged 4–5 years and on hospitalisations for asthma among children less than 15 years old were available for 42 health service catchment areas within New York City. Street tree counts were provided by the New York City Department of Parks and Recreation. The proximity to pollution sources, sociodemographic characteristics and population density for each area were also measured.

Results—Controlling for potential confounders, an increase in tree density of 1 standard deviation (SD, 343 trees/km^2) was associated with a lower prevalence of asthma (RR, 0.71 per SD of tree density; 95% CI, 0.64 to 0.79), but not with hospitalisations for asthma (RR, 0.89 per SD of tree density; 95% CI, 0.75 to 1.06).

Conclusions—Street trees were associated with a lower prevalence of early childhood asthma. This study does not permit inference that trees are causally related to asthma at the individual level. The PlaNYC sustainability initiative, which includes a commitment to plant one million trees by the year 2017, offers an opportunity for a large prospective evaluation.

An epidemic of childhood asthma has been documented around the world[1] and within the USA.[23] The exact cause of the increase remains elusive, but prevailing theories cite changes in the environment, indoors and outdoors, and changes in lifestyle as potential causes for the increase in the prevalence of asthma.[14–6] Racial, ethnic and socioeconomic disparities in asthma are substantial,[7–9] with an especially high prevalence of asthma in poor urban communities.[10–13] In the USA, a disproportionate part of the recent increase in the prevalence of asthma has been observed in the inner cities,[1314] which has contributed to its geographical variation. For example, early childhood prevalence of asthma is three times higher in the East Harlem area of New York City than in the adjacent but more affluent Upper East Side area.[15]

Street trees may explain geographic variation in the prevalence of asthma within urban environments. Trees may help prevent asthma, either by encouraging outdoor play or

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through an effect on local air quality. According to the “hygiene hypothesis”,[16,17] urban children exposed to few microbes early in life have an increased risk of developing asthma and atopy. Exposure to air pollution could also contribute to excess asthma in urban areas.[18–20] On the other hand, trees are a source of pollen and may exacerbate asthma among children with atopic asthma.[21]

We conducted an ecological study in New York City with the objective of describing the direction and magnitude of any association between street trees and childhood asthma.

METHODS

The unit of analysis is the United Hospital Fund (UHF) area, originally designed to represent hospital catchment areas and still used for health statistics reports. The 42 UHF areas range in size from 3 to 67 km^2.

The prevalence of asthma for 4-year-old and 5-year-old children was assessed by the New York City Department of Health (NYCDOH) through school screening in 1999.[15] Data on hospitalisations as a result of asthma among children younger than 15 were obtained from the NYCDOH for the year 1997.[15] Asthma cases or hospitalisations were divided by the number of age-eligible children living in each UHF area to give an approximate risk.

Data from the 1995 street tree census were provided by the New York Parks and Recreation Department. Census-takers counted street trees along each street segment. Street tree density is the total number of trees on street segments within the UHF divided by land area.

Census data from the year 2000 were used to calculate the percentage of residents below the federal poverty line, the percentage of African American residents, the percentage of Latino residents, and the population density for each UHF area. Population density was calculated as persons per square kilometre. These potential confounders may be related to tree placement decisions and unmeasured asthma risk factors.

We also measured proximity to pollution sources (toxic release inventory sites, stationary point sources and major truck routes) that have previously been associated with asthma in New York City.[19] Following the approach of Maantay,[19] we defined the areas exposed to each pollution source, then calculated the proportion of each UHF area that was exposed to one or more pollution sources.

Partial and simple Pearson correlation coefficients were calculated for each pair of independent variables. Poisson regression models with robust variance estimates were run in the software program Stata 9.2. Our multivariable models controlled for population density, demographic and socioeconomic characteristics (percentages of residents below the poverty line, of African American residents and of Latino residents) and proximity to pollution sources.

RESULTS

Street tree density was high in the most densely populated areas and in areas with less poverty, and was negatively correlated with the two measures of asthma burden (table 1). Higher street tree density was associated with a lower prevalence of childhood asthma even after adjustment for potential confounders (including sociodemographic characteristics, population density and proximity to pollution sources), but the association between street trees and hospitalisations as a result of asthma was no longer significant after adjustment.

Unadjusted estimates suggest that an increase in tree density of 1 standard deviation (SD, 343 trees/km^2) would be associated with a 24% lower prevalence of asthma (relative risk (RR), 0.76 per SD of tree density; 95% CI, 0.67 to 0.91) and a 26% lower risk of hospitalisation as a result of asthma (RR, 0.74 per SD of tree density; 95% CI, 0.62 to 0.87). After adjustment for potential confounders, we estimate that the same increase in street tree density would be associated with a 29% lower early childhood prevalence of asthma (RR, 0.71 per SD of tree density; 95% CI, 0.64 to 0.79). The association between tree density and hospitalisations as a result of asthma was not significant after adjustment (RR, 0.89 per SD of tree density; 95% CI, 0.75 to 1.06).

DISCUSSION

Areas with more street trees experienced a lower prevalence of early childhood asthma. This association was stronger after adjusting for potential confounders such as population density and proximity to sources of air pollution. The inverse association of street trees with hospitalisations for childhood asthma became non-significant following adjustment for the same potential confounders.

Our cross-sectional and ecological study does not permit inference that trees are causally related to the prevalence of childhood asthma at the individual level. These observational data may be subject to residual confounding or confounding by unmeasured characteristics. Previous studies of tree density and childhood asthma have not been published to our knowledge, and our results need to be replicated by others. Future studies may be more robust if they are able to measure and control for characteristics of the home environment, such as the presence of allergens.

A natural experiment could demonstrate whether abundant street trees caused the lower prevalence of asthma observed in densely planted areas. The PlaNYC sustainability initiative (www.nyc.gov/html/planyc2030) includes a commitment to plant one million trees in New York City by the year 2017 and offers an opportunity for a large prospective evaluation. Staged tree planting by area could help identify the effects of increased tree density on childhood asthma.

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What is already known on this subject

Poor urban areas in the USA experience an especially high prevalence of childhood asthma. Although temporal patterns in air quality or pollen counts have been associated with exacerbations of asthma, the geographical variation in the prevalence of asthma within cities has not been adequately explained.

What this study adds

Our findings, while not conclusive, suggest that street trees may play a role in preventing early childhood asthma. These data did not support an association between street trees and hospitalisations owing to childhood asthma. Future work to prospectively evaluate a major tree planting intervention will allow stronger inference as to the effects of nearby trees on the prevalence of childhood asthma.

Table 1

Correlations among area characteristics, early childhood prevalence of asthma, and hospitalisations as a result of childhood asthma in New York City

	Street tree density	Population density	Percentage in poverty	Percentage black	Percentage Latino	Percentage near pollution source	Prevalence of asthma	Hospitalisations as a result of asthma
Street tree density		0.81***	−0.49**	0.18	0.08	−0.05	−0.66***	0.32
Population density	0.50***		0.40*	−0.21	−0.17	0.34*	0.65***	−0.29
Percentage in poverty	−0.54***	0.21		0.38*	0.54***	0.18	−0.27	0.25
Percentage black	−0.23	−0.02	0.40**		−0.52***	−0.22	0.19	0.35*
Percentage Latino	−0.52***	0.12	0.78***	0.11		−0.03	0.28	0.14
Percentage near pollution source	0.14	0.57***	0.38*	−0.04	0.29		−0.19	0.26
Prevalence of asthma	−0.54***	0.26	0.73***	0.44**	0.70***	0.26		0.58***
Hospitalisations as a result of asthma	−0.39*	0.23	0.75***	0.56***	0.65***	0.34*	0.83***	

Partial correlation coefficients, shown above the diagonal, are adjusted for all other area characteristics shown; simple Pearson correlation coefficients are shown below the diagonal; characteristics and childhood asthma were assessed for 42 areas throughout New York City between 1995 and 2000.

* $p \le 0.05$;

** $p \le 0.01$;

*** $p \le 0.001$.