Abstract

Association Between Bedroom Particulate Matter Filtration and Changes in Airway Pathophysiology in Children With Asthma

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Importance

Fine particles (particulate matter 2.5 μm [$PM_{2.5}$]), a ubiquitous air pollutant can deposit in the small airways that play a vital role in asthma. It appears to be unknown whether the use of a $PM_{2.5}$ filtration device can improve small airway physiology and respiratory inflammation in children with asthma.

Objective

To discover what pathophysiological changes in the small airway are associated with a $PM_{2.5}$-removing device in the bedrooms with asthma.

Design, Setting, and Participants

Children with mild or moderate asthma were enrolled in this double-blind, crossover study. The participants used a true filtration device and a shame filtration device in their bedrooms in a random order for 2 weeks each with a 2-week washout interval. The study was conducted in a suburb of Shanghai, China, during a low-ozone season.

Exposures

Ozone and $PM_{2.5}$ were measured inside bedrooms and outside a window.

Main Outcomes and Measures

Impulse oscillometry, spirometry, and fractional exhaled nitric oxide were measured at the beginning and the end of each intervention. Peak expiratory flow was measured twice daily.

Results

Forty-three children (5-13 years old; 26 boys [60%]) participated. Outdoor 24-hour mean $PM_{2.5}$ concentrations were moderately high, ranging fro, 28.6 to 69.8 μg/m^3 (median, 53 μg/m^3). During true filtration, bedroom $PM_{2.5}$ concentrations were a mean (SD) of 63.4% (35.9%) lower than during shame filtration. Compared with sham filtration, true filtration was significantly associated with improved airway mechanics, reflected in 24.4% (95% CI, 11.8%-37.1%) reduction in total airway resistance, a 43.5% (95% CI, 13.7%-73.3%) reduction in small airway resistance, a 22.2% (95% CI, 2.2%-42.2%) reduction in resonant frequency, and a 73.1% (95% CI, 0.3%-145.8%) increase in airway reactance. True filtration was associated with significant improvements in fractional exhaled nitric oxide (a 27.6% [95% CI, 8.9%-42.4%] reduction) and peak expiratory flow (a 1.6% [95% CI, 0.8%-2.5%] increase). These improvements were signification associated with bedroom $PM_{2.5}$ reduction. Improvements in small airway function were nonsignificant (8.4% [95% CI, -1.4% to 18.3%]) in all participants but significant (13.2% [95% CI, 1.2%-25.1%]) in participants without eosinophilic airway inflammation at baseline. No improvements were observed for forced vital capacity, forced expiratory volume during the first second, and the ration of these in all participants or subgroups.

Conclusions and Relevance

Per these results, indoor $PM_{2.5}$ filtration can be a practical method to improve the air flow in an asthmatic lung through improved airway mechanics and function as well as reduced inflammation. This warrants a clinical trial to confirm.

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