Particle concentrations and effectiveness of free-standing air filters in bedrooms of children with asthma in Detroit, Michigan

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ARTICLE INFO

Article history:
Received 24 November 2010
Received in revised form
22 March 2011
Accepted 13 May 2011

Keywords:
Indoor environment
Free-standing HEPA air filters
Asthmatic children
Particulate matter
Exposures

1. Introduction

Airborne particulate matter (PM) is an environmental trigger of asthma [1–3] and has been linked to adverse health impacts including aggravation of respiratory conditions and premature death [4,5]. Often, attention focuses on the PM fraction that is small enough to enter deep into the respiratory tract, e.g., PM2.5 consisting of particles smaller than 2.5 μm dia [6,7]. Exposure to environmental tobacco smoke (ETS), to which a large fraction (60%) of asthmatic children in the U.S. is exposed [8], is associated with increased frequency and severity of asthma attacks, prolonged duration of symptoms, and decreased lung function [9,10]. Children in urban areas are especially exposed to elevated levels of allergens and indoor air pollutants, including PM2.5 [7].

Indoor environments dominate exposures of many pollutants, including PM, because most people spend the bulk of their time indoors, e.g., U.S. adults and children respectively are indoors 87 and 85% of the time [11]. Indoor PM concentrations are determined by both indoor emission sources, e.g., tobacco smoke, gas stoves, cooking, vacuuming, and outdoor (ambient) sources, e.g., suspended soils, pollen and traffic exhaust [12–14]. Ambient PM2.5 can easily penetrate building envelopes [17,18] and it represents an important component of indoor exposure [15]. ETS is an important source of PM as well as gaseous pollutants [9,16]. In addition to the types and strengths of indoor and outdoor sources [14,17], indoor concentrations are affected by building characteristics [17,18], air exchange rates (AER) [19], air mixing characteristics [20,21], heating/cooling system type [22], and the presence, if any, of PM filters [19,23–25].