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The feasibility of an air purifier and secondhand smoke education intervention in homes of inner city pregnant women and infants living with a smoker

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A R T I C L E I N F O

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A B S T R A C T

Objectives: Secondhand smoke (SHS) and other air pollutants adversely affect the health of pregnant women and infants. A feasibility study aimed at reducing air pollution in homes of pregnant women or infants living with a smoker was completed.

Methods: In collaboration with the Baltimore City Health Department, women ≥ 18 years of age and either pregnant nonsmokers, or post-partum (any smoking status) with an infant age 0–12 months were recruited. Homes had at least one smoker. Intervention included two air purifiers and secondhand smoke education. Outcomes included feasibility, change in fine particulate matter ($PM_{2.5}$), air nicotine, and salivary cotinine pre- and post-intervention.

Results: Fifty women were enrolled (mean age 27 years, 92% African American, 71% single, 94% Medicaid eligible, 34% reported smoking) and 86% completed the study. Of the 50 women, 32 had infants and 18 were pregnant at time of enrollment. Post- intervention, 70% of participants reported smokers were less likely to smoke indoors, and 77% had at least one air purifier turned on at the final visit. Participant satisfaction was high (91%) and 98% would recommend air purifiers. Indoor $PM_{2.5}$ was significantly decreased ($P < 0.001$). Salivary cotinine was significantly decreased for non-smoking women ($P < 0.01$) but not infants, and no significant change in air nicotine occurred ($P = 0.6$).

Conclusions: Air purifiers with SHS education is a feasible intervention in homes of women and infants. These data demonstrate reduction in indoor $PM_{2.5}$ and salivary cotinine in non-smoking adults. Air purifiers are not an alternative for smoking cessation and a home/ car smoking ban. Smoking cessation should be strongly encouraged for all pregnant women, and nonsmoking mothers with infants should be counseled to completely avoid SHS exposure. This study provides support for a future intervention evaluating clinical endpoints.

1. Introduction

Secondhand tobacco smoke (SHS) and other air pollutants adversely affect the health of pregnant women and infants. According to the Surgeon General, SHS exposure is linked to low birth weight, sudden infant death syndrome, and early childhood respiratory diseases (U.S. Department of Health and Human Services, 2006). Indoor air can be contaminated by various compounds including gases (carbon monoxide, radon and volatile organic chemicals), gas/vapors and particulates from environmental tobacco smoke (ETS), biological contaminants (mold and bacteria), and particulate matter. Particulate matter is suspended in air and originates from indoor (dust, mold, bacteria, tobacco

Abbreviations: SHS, secondhand smoke; $PM_{2.5}$, fine particulate matter; EPA, Environmental Protection Agency; BCHD, Baltimore City Health Department; WIC, Women, Infants, and Children; LOD, limit of detection; WHO, World Health Organization

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smoke, gas cooking, wood burning fireplaces, cleaning activities) as well as outdoor sources (pollen, combustion from motor vehicles and power plants) (Diette et al., 2008). Particle size determines the location of deposition in the respiratory tract. While particles < 10 µm in diameter (PM_{10}) can be inhaled, fine particles < 2.5 µm ($PM_{2.5}$) reach the alveoli leading to health problems (Diette et al., 2008). ETS contains more than 4000 chemicals, many of which are known or suspected toxic or carcinogenic agents. ETS is a major source of indoor air pollution and 40% of U.S. children are exposed at home where they spend a majority of their time (Centers for Disease Control and Prevention, 2016).

Over the past decade, The Johns Hopkins Center for Childhood Asthma in the Urban Environment has documented that indoor air pollution in inner city Baltimore homes is significantly higher than simultaneously measured ambient and suburban home concentrations, and levels often exceed the annual limits for ambient pollution exposure set by the U.S. Environmental Protection Agency (EPA) (McCormack et al., 2008; Simons et al., 2007).

Education and counseling interventions to reduce SHS exposure have demonstrated varying success (Baxi et al., 2014), and trials utilizing indoor air purifiers have demonstrated their feasibility and sustained effectiveness in reduction of indoor air pollution in homes of children with asthma (Batterman et al., 2012; Du et al., 2011; Eggleston et al., 2005; Lanphear et al., 2011; Butz et al., 2011). Studies evaluating the health effects of air purifiers have shown that they may be beneficial in children with asthma (Eggleston et al., 2005; Lanphear et al., 2011; Butz et al., 2011) but the feasibility of these interventions in the homes of pregnant women and infants without chronic respiratory illnesses is unknown. Establishing feasibility in this population is important prior to conducting a trial since an intervention aimed at prevention requires individuals to be motivated in the absence of illness (Institute of Medicine, 2001). Additionally, there are known barriers to recruitment and retention in our target population of low income minority women (El-Khorazaty et al., 2007).

A pilot study was conducted to evaluate the feasibility of deploying air purifiers in the homes of pregnant women or infants who live with a smoker. Feasibility was assessed via willingness of women to enroll, participant retention, observed use of the air purifiers, report of smoking behaviors, and satisfaction with the intervention. Secondary objectives included measurement of the change in $PM_{2.5}$, air nicotine, and salivary cotinine from baseline to the fourth week of continuous air purifier use. We hypothesized that the intervention would prove feasible in the identified population, and that four weeks of air purifier use combined with SHS education would lead to significant reduction in indoor air pollution ($PM_{2.5}$, air nicotine) as well as salivary cotinine in pregnant women and infants.

2. Methods

2.1. Study design (Fig. 1)

A single arm, unmasked clinical trial was conducted to evaluate the feasibility and effectiveness of a combined air purifier and SHS education intervention. Participants had four home visits scheduled during the five-week study period. Environmental monitoring occurred at baseline and during the fourth week of air purifier use. Two air purifiers were placed in each home (adult/ infant bedroom and the living area) after baseline air monitoring was completed and participants were encouraged to keep air purifiers on during the remainder of the study. Saliva samples were obtained from adult and infant participants during the second and final home visit (pre- and post- intervention) for cotinine analysis as a biomarker of SHS exposure. The Johns Hopkins Medical Institutional Review Board approved the study, and all participants provided written informed consent before beginning the study (Fig. 1).

2.2. Study participants

Women were referred from one of the Baltimore City programs providing services for women and children who are low income and/or at risk for poor birth outcomes or they were directly recruited from local Women, Infants, and Children offices (WIC). Participants were eligible if they met the following criteria: (1) Female ≥ 18 years of age and pregnant at time of enrollment (by report) and a non-smoker (by report) *or* mother/ infant dyad: mother ≥ 18 years and infant 0–12 months (mother could be a smoker or nonsmoker by report); (2) Participant in a Baltimore City program; (3) Reported smoker in the home (either mother participant or another household member). Participants were excluded based on the following: (1) Pregnant woman reported being a smoker herself; (2) Post-partum or pregnant woman unwilling or unable to participate; (3) Non-English speaking; (4) Planned to move out of the Baltimore area in the next 6 months; (5) Transitional housing; (6) No electricity in the home.

2.3. Intervention

Each participant received two air purifiers that provided 1500 square feet of coverage each (HealthMate™ Standard). Air purifiers were donated by Austin Air® (Buffalo, NY). The HEPA air purifier works by removing large particles (dust, hair, and dander) that are suspended in the air, then medium particles such as mold and pollen, are filtered. A carbon filter can remove chemicals, gases, and odors. Finally, the

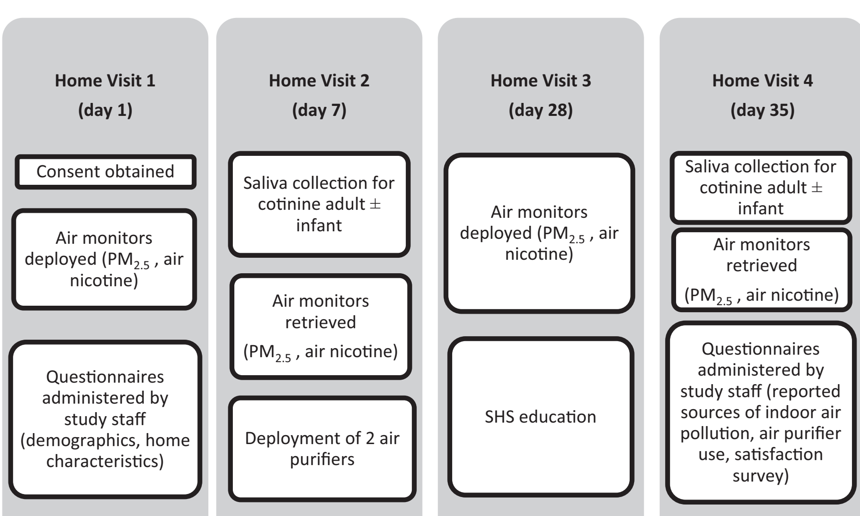

Fig. 1. Study design.