

Clinical Commentary Review

Home Environmental Interventions for the Prevention or Control of Allergic and Respiratory Diseases: What Really Works

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Home health care workers interventions have been implemented in western countries to improve health status of patients with respiratory diseases especially asthma and allergic illnesses. Twenty-six controlled studies dealing with prevention and control of these diseases through home environmental interventions were reviewed. After a comprehensive description of the characteristics of these studies, the effectiveness of each intervention was then evaluated in terms of participants' compliance with the intervention program, improvement of quality of the indoor environment, and finally improvement of health outcomes, in detailed tables. Limitations and biases of the studies are also discussed. Overall, this review aims at giving a toolbox for home health care workers to target the most appropriate measures to improve health status of the patient depending on his and/or her environment and disease. Only a case-by-case approach with achievable measures will warrant the efficacy of home interventions. This review will also provide to the research community a tool to better identify targets to focus in future evaluation studies of home health care workers action. © 2016 American Academy of Allergy, Asthma & Immunology (*J Allergy Clin Immunol Pract* 2016;■:■-■)

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The prevalence of allergic and respiratory diseases such as asthma, chronic bronchitis, and rhinitis has increased considerably over the last 3 decades in industrialized western countries¹⁻⁴ and is now approximately 20%. The economic burden of these diseases is very high as it is estimated to cost \$23 billion in terms

of health care and indirect costs including lost work and lost school days in the United States.⁵

Atopic heredity, dietary factors, and exposure to environmental pollution are clearly identified as risk factors for these diseases.⁶⁻⁸ Among pollutants, the role of the indoor environment is of growing concern.⁹ First, people in modern societies spend a majority of time (approximately 90%) in indoor environments (home, workplace, school). Second, improved energy efficiency in modern homes with thermal insulation has resulted in confined indoor environments and thus higher exposure to contaminants. Third, there is some evidence that biological (mold, endotoxins, allergens from house dust mites, pets, cockroaches, rodents) and chemical contaminants (environmental tobacco smoke [ETS], nitrogen dioxide, formaldehyde, volatile organic compounds) have been associated with allergic and respiratory symptoms.^{7,10-19} Indoor temperature and relative humidity may also increase exposure levels to these contaminants.^{17,18}

Given the societal and economic costs of allergic and respiratory pathologies (medical care, lost productivity in the workplace, absenteeism from school and work),²⁰ changing the indoor environmental risk factors may offer an opportunity for prevention and control of such diseases.

Different initiatives based on home interventions have been implemented in western countries.^{21,22} To assess their effectiveness, we propose a review of intervention studies. We first provide a comprehensive description of the characteristics of these studies. The effectiveness of each intervention is then evaluated in terms of participants' compliance with the intervention program, improvement of quality of the indoor environment, and finally improvement of health outcomes. In conclusion, prospects for improvement are discussed, a toolbox for home health care workers is provided, and overall, this review highlights the need for further studies using a multifaceted approach to better understand the environmental determinants of these respiratory diseases.

METHODS

A systematic literature search was conducted using the Web of Science platform giving access to the Medline and Academic Search Complete databases, on articles published between 2004 and April 2015. The search was performed with the following keywords located in the abstract of the article: (environmental intervention OR home intervention) AND (indoor OR respiratory diseases OR allergic diseases OR asthma).

The inclusion criteria were peer-reviewed papers in the English language, dealing with prevention and control of allergic and

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Abbreviations used*ETS- Environmental tobacco smoke**HEPA- High-efficiency particulate air**MIEC- Medical indoor environment counselor**RCT- Randomized controlled trial*

respiratory diseases through home environmental interventions. This retrieved 2022 articles. Among them many papers were cited twice. Reading the summary, papers dealing with environmental intervention of counselors at home of respiratory disease affected people were selected. Papers dealing with interventions at home of people suffering from respiratory diseases not caused by environmental factors were excluded (rehabilitation of elderly patients after discharge from hospital, occupational asthma, chronic obstructive pneumo-bronchitis for example). Additional studies cited by the selected references were also included. Finally, 33 studies met the selection criteria. Among them, 7 were pre- and postintervention studies without control group and were excluded.²³⁻²⁹ Finally, 26 studies were considered in this review. For each article, the intervention protocol in homes was analyzed and categorized, as well as the results related to behavior change among participants, the impact of intervention on the home environment, and health outcomes.

RESULTS**Study characteristics**

The studies reviewed are presented in [Table I](#). They pursued 2 types of objectives. Some intervention programs aimed at preventing the development of allergic and respiratory symptoms (mainly asthma) (primary prevention) among infants qualified as high risk,^{30,33,36,37} that is, with at least 1 parent suffering from atopy, allergic diseases, or asthma. Pregnant women were enrolled to begin the prevention program prenatally ([Table I](#)). The other programs aimed at preventing exacerbation of allergic and respiratory symptoms in patients who were sensitized to allergens or diagnosed with asthma (secondary prevention). The majority of patients enrolled in those intervention programs were children.^{39,40} Adgate et al,³⁸ Francis et al,⁴³ Krieger et al,⁴⁸ and Luczynska et al⁴⁹ targeted an adult population, whereas others did not set age criteria for inclusion^{41,44} ([Table I](#)).

Most of the studies were randomized controlled trials (RCT), where participants were assigned either to an intervention group receiving one or more intensive home-based interventions or to a reference group ([Table I](#)). This reference group received either no intervention^{37,41,48,53} or an intervention with standard information on risk factors and some limited resources,^{36,45} or placebo avoidance measures (sham air cleaners, ineffective bedding covers).^{43,49,52} The studies of Carter et al³⁹ and Corver et al³³ were implemented with both a placebo group and a control group who received no intervention. Bryant-Stephens and Li²⁰ carried out a 3-armed RCT, with an intervention group, a control group, and a case-matched control group who received neither intervention nor follow-up home visits. To conduct these intervention programs, the great majority of participants were selected via hospital databases or via physicians. The most frequent inclusion criteria were diagnosed asthma, a recent visit to an emergency department or hospitalization for asthma, and a positive skin test to one or more indoor allergens. The number of participants ranged from 20⁵² to 3312.⁴⁴

The length of the studies was highly variable according to their purpose. Prospective prenatally randomized cohort studies began before birth and continued up to 12 months for Schönberger et al³⁷ and up to 8 years for Arshad et al.³⁰ The duration of exacerbation prevention programs ranged from at least 3 months between the first home-based intervention and the last follow-up visit,³⁰ to 24 months.⁴⁰ A 12-month study is the most frequent case.

Home interventions can be grouped into 3 categories: education-based methods, physical methods, and a combination of both. The education-based approach alone aimed at helping the patients and their families to adopt behaviors to obtain healthy home environments. On the basis of a baseline home survey (visual inspection, dust and/or air sampling) and a preliminary health evaluation (questionnaire, prick test, blood sampling, spirometry), participants were taught about avoidance measures for the risk factors identified.⁴¹ Physical methods consisted in providing the participants with equipment and supplies necessary to perform comprehensive environmental remediation (bedding covers, vacuum cleaner with high-efficiency particulate air [HEPA] filter, air purifier, intensive cleaning, pest control, ie, miticide, bait traps, professional eradication of mice, and cockroaches).^{33,43,44,48,49,52,53} For most studies, multiple risk factors were targeted. Exposure to house dust mites was studied in almost all cases. In one-half of the studies, triggers such as pet or cockroach allergens were investigated. The presence of rodents was assessed in approximately 30% of the studies. In one-third of the home interventions, investigation related to signs of mold was carried out. Except for ETS, efforts to reduce exposure to chemical contaminants (volatile organic compounds, particulate matter) were less frequent in comparison with attention paid to biological contaminants.

The number of home interventions ranged from 1 to 9 per home, with a maximum number of 17 visits in the study published by Parker et al.⁵¹ But a single intervention program remained the most frequent situation. When it was mentioned, home visits were carried out by persons trained in the clinical aspects of asthma and other respiratory diseases, asthma triggers, and avoidance measures. Some counselors were also educated about social learning theory.^{42,46,51} Several of the counselors enrolled were "Community Health Workers" who shared the same ethnic, linguistic, and cultural origins as the participants.^{46,48,51}

To assess the effectiveness of home environmental interventions for the prevention or control of allergic and respiratory diseases, follow-up surveys were conducted in the weeks and months after the end of the intervention program. This consisted in collecting data about the home environment and the health status of the participants over this period, by means of home visits and/or phone calls ([Table I](#)).

Compliance of participants

The use of bedding covers ([Table II](#)) was clearly the most commonly used measure in the intervention groups and in a significant manner compared with the control group, with rates of application up to 96%.³¹ It should be noted that the bedding covers were given free of charge to the occupants in the vast majority of cases. It can be supposed that if the bedding covers were not free of charge, the compliance would have not been so high.³⁷ Postma et al²² showed that participant compliance was clearly related to the supply of resources. de Blay et al⁴¹ mentioned that compliance depends on socioeconomic status

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