

PRACTICAL MANAGEMENT STRATEGIES TO REDUCE EXPOSURE RISKS OF INDOOR AIR POLLUTANTS IN LIMITED RESOURCE HOUSEHOLDS

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Abstract

The goal of this research project was to test a teaching method that would encourage members of limited resource households to reduce their risks of exposure to indoor environmental toxins. The study focused on an educational approach for conveying the importance of healthy indoor air quality to those living in such households. This “Practical Management Strategies” project (PMS) had four components. The first was a summary of educational resources developed in this area for limited resource households. The second identified limits and gaps in these materials and developed new materials to fill these gaps. The third component was the implementation of a pilot program which both educated occupants about indoor environmental toxins and audited the presence of such toxins in their homes. The fourth component was a gauge of the effectiveness of this pilot program’s approach.

Introduction

Human health can be adversely affected by a multitude of conditions in our constructed environments. These elements emanate from materials and techniques used in the construction process, from activities within such spaces, and from connections to the external environment. These factors are of particular concern when examining indoor air quality because most people in the U.S. spend more than 21 hours of the day indoors (U.S. Environmental Protection Agency, 2001; Warsco, 1992), with some groups such as infants, the elderly, and infirm persons

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spending nearly all of their time indoors (Berry, 1991). A number of conditions contribute to typically higher levels of indoor pollutants than corresponding levels outdoors (U.S. Environmental Protection Agency, 1993).

Numerous studies have documented the incidences of indoor air pollution and its negative impacts on children, especially with respect to lead, pesticides, radon, and asthma triggers (Roberts & Dickey, 1995). For physiological and behavioral reasons, children are at higher risk than adults for both exposure to environmental toxicants and for adverse health effects from those toxicants (Goldman, 1995; Staes, Balk, Ford, Passantino, & Torrice, 1994). Children are more highly exposed to environmental pollutants than adults because they breathe more air per pound of body weight and chew or suck on toys and hands that have been in contact with pollutants (U.S. Environmental Protection Agency, 2001). There is a great need for widely implemented programs that reduce risks of exposure to these pollutants (Goldman, 1995); and these risk reduction efforts should include a focus on children and limited resource households.

The Problem Faced by Limited Resource Households

Members of limited resource households are disproportionately affected by indoor air pollutants. Chi and Laquatra (1990) observed that homes in rural areas of New York State with high levels of radon gas were more likely to be inhabited by low-income families than by those with resources adequate enough to discover and alleviate the problem. Factors that contributed to this situation included the relative age of these homes and the high number of structural deficiencies therein, including cracks in foundations and basement floors. Homes occupied by higher-income households were in better overall condition with fewer radon pathways. This disproportionate exposure was also observed for low-income households with regard to lead contamination (Farr & Dolbeare, 1996).

Evans and Kantrowitz (2002) made a compelling case for the need to further investigate the health problems that may be related to indoor pollutants in limited resource households. They identified poor housing as a contributing factor in exposure to toxins and to a general inability for members of these households to achieve optimal health. They examined multiple environmental risk factors and presented an overview of evidence demonstrating relationships between socio-economic status, exposure to environmental pollutants, and health.

These factors of socio-economic status, substandard housing, and poor health are linked, though their connections have not been thoroughly studied according to Evans and Kantrowitz (2002). They noted that existing studies of the effects of environmental hazards have been more focused on ethnicity than on income levels. These authors suggested that the overall health effect of multiple environmental pollutants may be significantly underestimated because the majority of existing

research examines pollutant factors in isolation from one another. They concluded that simultaneous exposure to multiple risk factors could partially explain the statistical gradient between socio-economic status and health, and they indicated a need for educational efforts and policy initiatives aimed at improving the quality of life within low-income households.

Risks Associated with Indoor Pollutants

Other pollutants related to house age and foundation problems are asbestos and biological contaminants. Asbestos, which is linked to different types of cancer (U.S. Environmental Protection Agency, 1994), was used in insulation and other building materials until the 1970s. Structurally deficient house foundations, other building envelope deficiencies, and leaking pipes can allow excess moisture to accumulate in homes and contribute to the growth of mold, mildew, and other biological contaminants that are associated with rhinitis, asthma, pharyngitis, conjunctivitis, and other illnesses (U.S. Environmental Protection Agency, 1994).

Lead, which is related to a variety of disorders and is particularly dangerous to children (U.S. Environmental Protection Agency, 1995), can be a common component of house dust (Ott & Roberts, 1998). While lead poisoning through ingestion has received substantial attention, airborne lead is an often overlooked source of exposure (U.S. Environmental Protection Agency, 1994). In homes painted before 1978, lead paint was commonly used on double-hung windows, which shed the paint as dust when the sashes rub against each other (New York State Department of Health, 1994). In addition to these problems, exposure to carbon monoxide, nitrogen dioxides, and other combustion pollutants is common in homes and other built environments where older heating systems are improperly maintained, or where un-vented combustion-based space heaters are used (Greiner, 1997).

Risks of exposure to indoor environmental toxicants are known, and numerous educational initiatives are currently underway to inform individuals, families, and communities about ways to reduce these risks. *Home*A*Syst* and *Healthy Indoor Air for America's Homes* are two examples of national programs that have mobilized the Cooperative Extension Service to successfully collaborate with state and county health departments, private organizations like the American Lung Association, and others in local community awareness programs. While impacts of these programs have been substantial, institutional barriers continually hinder efforts to effectively reach limited resource households on a widespread basis.

There are federal programs such as the U.S. Department of Housing and Urban Development's *Healthy Homes* program that provide funding for organized efforts aimed at improving indoor environments in the homes of low-income households. However, only limited funds from these programs are provided competitively to groups and organizations. *Healthy Homes* depends on year-to-year

appropriations in order to remain in existence. A comprehensive policy to address this issue in a more uniform way is essential before limited resource households can acquire knowledge and the resources required to reduce their risk of exposure to indoor environmental toxins.

It is important to note that publications developed by the U.S. Environmental Protection Agency (EPA), the U.S. Department of Housing and Urban Development (HUD), and the Cooperative Extension Service which describe mitigation efforts for indoor environmental toxicants are unlikely to be implemented by limited resource households whose priorities are likely to focus on rent and food payments (U.S. Department of Housing and Urban Development, 1998; U.S. Environmental Protection Agency, 1993; University of Wisconsin, 2000). This unfortunate situation exists because testing and remediation protocols that are typically advised for lead, asbestos, and radon can be costly, despite the fact that measures can be taken (short of full-scale remediation) which will substantially *reduce* exposure risks.

In the case of lead, a continuing problem exists with high blood lead levels in low-income children. The EPA (2001, p. 9) reported: "Minority status, income status, and age of housing have all been shown to correlate with elevated blood lead in children." Similarly, indoor exposure to environmental tobacco smoke (ETS) causes between 150,000 and 300,000 respiratory tract infections in children and infants annually and has been implicated in sudden infant death syndrome in 1,900 to 2,700 cases per year in the U.S. (U.S. Environmental Protection Agency, 2001). Equally disturbing statistics exist for carbon monoxide poisoning from indoor combustion sources, asthma cases from indoor biological contaminants, and cancer deaths from radon and other pollutants (U.S. Environmental Protection Agency, 2003).

While full mitigation may be infeasible at times, other methods can be implemented that at least reduce the risk of indoor environmental toxicant exposure. For example, vegetation obstacles can be planted between a home and lead-contaminated soil to prevent children from playing in the soil. Homes can be ventilated for longer than normal periods to reduce radon exposure through dilution. Barriers can be placed over lead-painted walls to a height that will reduce a child's exposure. Similar strategies may be applicable for friable asbestos.

Catalog and Review of Materials Collected from States

A series of requests was sent to state health departments and state Extension housing specialists throughout the country. These requests generated an abundance of resource materials that related directly to recognizing and correcting potential sources of indoor pollutants. The appendixes containing information on these resource materials are available for review on the HERA Web site (www.housingeducators.org). Many of these publications originated with federal agencies and several were made available through corporate sponsorships.

Literature addressing lead exposure was among the most popular received, with many publications offering advice on exposure prevention and treatment. *The Virginia Partnership for Lead Poisoning Prevention Education* sponsored a Family Education Project with Virginia Cooperative Extension (Parrott, 2001). The training manual for this project included many items meant for direct distribution to households, as well as articles and links to more information as the training continues to be implemented in the field.

The Oregon Health Division responded with a series of publications aimed at improving indoor air quality. Topics included radon, environmental tobacco smoke, mold and mildew, carbon monoxide, and infectious waste disposal. Oregon was one of the few states to include information about pest control and problems associated with pesticide use. This suggests that there may be a need to focus more educational efforts toward this topic as the evaluation of existing materials progresses.

The Connecticut Department of Public Health also sent a variety of publications designed for general distribution. Of interest is a comprehensive and well-designed checklist developed in cooperation with the EPA for use by the homeowner to identify problems. Suggestions to correct the problems are presented as well as sources for more information and a chart outlining health risks. This publication is an excellent model for use by educators, health department workers, real estate agents, and consumers.

The educational modules used for the Practical Management Strategies (PMS) project were developed by Cornell University staff. This material included information on asbestos, carbon monoxide, excess moisture, and radon. The educational module on lead was adopted from the *Healthy Homes, Healthy Kids Lead Program* (Minnesota Department of Health [MDH], 1998) which was developed by MDH with funding from the EPA and HUD. The information contained in the Minnesota publication was presented with minimal text in order to reach a low-literacy audience, and with numerous photographs, so that the most crucial information was conveyed *visually*. This fit the criteria developed for the PMS materials.

Identifying Requirements for Educational Materials and Development Processes

From the above literature that was received, a list of curricula and presentation outlines on the topic of indoor pollutants was assembled based on type of pollutant. Most importantly, these educational materials were examined in order to assess which presentation methods would be most suitable and effective for this particular project. The materials from the MDH (1998) stood out the most, providing an excellent model for a low-tech, thorough, yet portable presentation delivery method. This was a flip chart, using 8½ x 11-inch pages in landscape format. This method

displayed basic text and graphics to the viewer, and was configured to provide additional basic notes and speaking points to the educator.

In addition to the above assessment on presentation methods, Extension educators from several counties across New York State were consulted. Family and Consumer Sciences educators with experience in leading the Expanded Food and Nutrition Education Program (EFNEP) were targeted. Because the EFNEP program served as a model for the PMS project, the Extension educators were felt to be knowledgeable advisors for the development of informational materials for limited resource households. To select these educators, we first spoke with Cornell University faculty who provide statewide leadership for EFNEP who then provided us with names of all EFNEP educators. We contacted those who had dual responsibilities for program delivery in EFNEP and housing-related issues. We had telephone conversations with four such educators.

There were three basic recommendations that appeared most frequently in the educator consultations:

- Educational materials should be *simple and concise*.
- Presentation materials should identify each indoor pollutant and state where it originates, how it can negatively affect health, and strategies to prevent exposure.
- Graphics should be extensively used to present multiple points and to make the educational presentation more interesting and engaging.

These educators reviewed a draft of the materials for a critical review. Following that, the presentation was modified for use in the field.

Research Design of the Experiment

The research portion of the project was conducted on two groups of low-income residents: an experimental group and a control group. For the first wave of the project, the experimental group received an in-home visit by a peer educator. This visit consisted of three components. The first was a verbal survey about household demographic characteristics, health status regarding allergies and asthma, knowledge of health risks associated with indoor air pollutants, and practical measures to reduce these risks. The second component was a visual and oral presentation that described ways to recognize indoor environmental toxins and measures that can be implemented to minimize exposure risks. The third component was a toxin audit of the homes, where the peer educator inspected the living space with the occupants while also measuring and assessing the presence of radon, carbon monoxide, mold, lead, and asbestos. The control group received no in-house visit from a peer educator; these occupants only were provided the first component, the verbal survey that was identical to the experimental group's survey. This was conducted by phone rather than face-to-face.

The second wave of the experiment was conducted three weeks later, and only by phone for both the experimental and control groups. The survey questions for both were identical to those asked in the first wave: knowledge of health risks associated with indoor air pollutants and practical measures to reduce these risks. This second wave of surveys was performed in order to evaluate the educational efficacy of the in-home peer educator visit and to determine how much knowledge of the subject was retained by the occupants over a period of time.

Test of Materials, Field Survey Technique, and Sampling

The pilot project was developed in Albany County, New York. All work in the county was undertaken during late winter and early spring of 2002. The sample of limited resource households was drawn from participants in the Healthy Homes of Albany County Program (HHAC) and the Home Energy Assistance Program (HEAP). HHAC utilized Extension's partnership with the county weatherization program and HEAP to recruit limited resource households. Income eligibility screenings were performed through links between these two programs. The income eligibility requirements of these programs are the same and are based on federal income guidelines used to identify limited resource households.

Homeowner lists provided through these two programs were assembled, and the residents were contacted by telephone. This effort generated only a few home visits. A second home recruitment strategy was then undertaken by forming a connection with municipal programs for senior citizens. This resulted in a very fruitful partnership. Peer educators were recruited and a one-day training session was held. The training materials were developed and presented by Extension staff affiliated with HHAC. With the cooperation of only two senior citizen programs, HHAC quickly had the 50 homes required for the project. Homeowner incentives were offered in the form of gift certificates.

This selection method precluded the use of a clear experimental frame for the analysis but met the goals of testing the material and presentation strategy for the study. In order to explore the data gathered, the statistical analysis controlled for the demographic variations between the experimental group (home visit) and the control group (contacted for the telephone survey only). This difference in the groups may be useful in developing a wider program effort.

The implementation of the field study required several steps. Researchers at Cornell University provided the survey instrument used in the home visit. They also developed some portions of the educational materials. Extension staff in Albany County developed a project introduction for the flip chart and additional material for the fact sheets. This listed state and county contacts, certified and licensed testing labs and remediation companies, and Internet resource sites.

Peer educators were recruited from the senior citizen population of the county and had excellent technical credentials. The peer educators provided valuable

input and insights in the development of the education material, including the site visit forms and the home inspection protocol. Peer educator training included a full-day session and multiple-team home visits. This training was completed before the peer educators scheduled experimental home visits.

Demographics and Other Sample Characteristics of Interest

Both groups contained 50 subjects. The experimental group was composed of nearly 80% retired persons, 68% were female, 50% were widowed, 83% were Caucasian, and 60% lived alone. Nearly all had incomes under \$25,000. The control group was much more normally distributed across age, occupational status, and income, although 76% were also female; 22% were retired with 28% working full-time and 18% working part-time. Only 20% of these households contained one resident. While 38% of the sample had incomes below \$25,000, the others fell along a range up to \$75,000. Eighty-seven percent reported being Caucasian. Educational levels were roughly the same with slightly more college graduates among the control group respondents. In the control group, 68% of occupants identified allergy complaints in the household, 30% involving children up to 18 years of age. This compared to 52% in the experimental group with only 2% involving a child.

Experimental Results

The responses given by the experimental and control groups were analyzed by comparing the means of the relevant variables. The mean responses were used to measure any difference associated with time (Wave One and Wave Two) and any difference associated with training provided to the experimental group. The associated statistical technique, the *t* test, was summarized by Tashakkori and Teddlie (1998) as independent sets of observations for comparison between experimental and control subjects. A *t* test for non-independent samples (the repeated measures for both groups) was used for the results presented in Table 1.

The control group received no information regarding identification or control of indoor pollutants. The experimental group was provided with the educational experiences described earlier. Testing compared the mean responses of Wave One and Wave Two for the two groups. A typical null hypothesis among group responses (i.e., a comparison of the Wave One responses of the experimental group with the Wave Two responses of the experimental group) was that the mean response to a concern about radon did not change after training was provided. A typical null hypothesis between the control and experimental groups would be that the mean response of the control group compared to the mean response of the experimental group did not vary from Wave One to Wave Two. SPSS was used to carry out the analysis using the *t* test routines to compare results both within and among the groups.

Table 1 displays the results of paired t tests from responses in Wave One and Wave Two by households in the experimental group to statements about indoor environmental contaminants. Statements were presented and respondents scored each from 1 to 5, with 1 meaning “strongly disagree” and 5 meaning “strongly agree.”

The first statement related to a common misconception about house tightening: “Energy conservation causes indoor air pollution.” The response corresponding to the material presented by the peer educator was “strongly disagree.” During the educational intervention, peer educators stressed the value of house tightening measures coupled with controlled mechanical ventilation as a method to improve indoor air quality. The mean response in Wave Two (2.30) moved in the direction of the correct response and was significant ($t = 2.49, p = .017$). The second statement addressed another common misconception about indoor air quality—that it is difficult to improve this aspect of an indoor environment. The statement was phrased as: “It is easy to improve the quality of air inside the home.” The mean response in Wave One was 3.64. While the response improved in Wave Two (3.62), the improvement was not statistically significant ($t = .10, p = .922$).

Table 1. Results from Indoor Air Quality Experiment ($N = 50$)

Experimental Group: Wave 1 vs. Wave 2 Paired Samples					
Statement	n	t	df	p	M
1. Energy conserving measures cause indoor pollution	43	2.49	42	.017	2.88 2.30
2. Easy to improve the quality of the air inside the home	42	.10	41	.922	3.64 3.62
3. Radon problems can be solved by opening the window	44	.83	42	.411	2.72 2.91
4. Allergies and asthma can be controlled by home maintenance	44	1.22	43	.229	3.91 4.11
5. Maintenance of appliances can reduce CO	44	3.17	43	.003	3.91 4.36
6. Damp wiping floors and window sills minimizes exposure to lead	42	.24	41	.814	3.48 3.43
7. Drinking water immediately from the tap cuts down lead exposure	43	1.86	42	.700	2.30 2.77
8. Controlling moisture controls mold	44	4.60	43	.000	3.93 4.57
9. Asbestos should be left alone	40	.78	39	.454	3.82 4.06

Note: Five point scale: 1 = strongly disagree to 5 = strongly agree

Statement three involved an understanding of radon gas in the home. Respondents once again showed an increase in understanding that ventilation can reduce the presence of the gas but the difference in mean responses was not statistically significant ($t = .83, p = .411$). A similar result was obtained for statement four regarding the control of allergies and asthma through home maintenance ($t = 1.22, p = .229$). This may indicate a need for further information about these conditions both for the peer educator and for the household. A statistically significant result ($t = 3.17, p = .003$) was demonstrated for the topic of statement five. The mean response of the survey respondents indicated an increase in knowledge regarding the role of appliance maintenance in the reduction of carbon monoxide in the home.

Both statements six and seven showed no statistical difference in mean responses yet indicated some increase in knowledge. The effectiveness of damp wiping surfaces to control lead exposure showed a decrease in agreement ($t = .24, p = .814$) while immediate use of tap water as a method of decreasing lead exposure showed more agreement ($t = 1.86, p = .700$). For the topic area of mold control as described in statement eight, respondents showed a statistically significant increase in agreement with the statement that moisture control reduces mold ($t = 4.60, p = .000$). The final statement asked about knowledge of asbestos as a hazard. Once again there was a difference in the responses between Wave One and Wave Two ($t = .78, p = .454$) but not one that was statistically significant.

Field Study Assessment and Recommendations

There were several statistical limitations to this research. First, as mentioned above, a large portion of the issue with indoor environmental toxins in low-income housing focuses on a concern for homes that are occupied in part by children. Yet the only successful means of scheduling enough in-home peer educator visits was through senior citizen municipal programs, to the extent that 80% of the experimental group were homes of retirees. The research, then, is not benefiting a significant proportion of our intended target audience. Furthermore, the difference in average ages between the experimental group and control group (e.g., 80% retirees in the former category versus 22% in the latter), may be a factor in comparing the memory retention of the subject matter when comparing the two waves of surveys that were three weeks apart. That is, senior citizens may retain less of the information from the in-home visit than younger occupants.

At the end of the pilot effort, feedback was received from the Extension educator in charge of the project and from the peer educators. The general consensus was that the educational presentation needed to be shorter. While this is a valid concern, it was unclear just how abbreviated the educational presentation could become and still be effective at conveying the necessary information that individuals would need to reduce their exposures to indoor pollutants.

Regarding the order of the three components of the in-home visit, the peer educators were instructed to conduct the audit first, and then use the information gained to determine which part of the educational presentation to focus on. This method was reasonably successful, allowing the educator to tailor the presentation to the specific needs of the occupants. For example, if a home had no combustion appliances, that section of the educational program could be skipped, allowing the educator to spend more time in educating the occupants about the pollutants that were positively identified. However, since the peer educators were placing radon test kits at the time of their visits, it was not known if the home had high radon levels until three to four weeks after the visit. Therefore, the educators always covered the educational information on radon, even though radon presence may not have been indicated later by the test kits. Having results of the radon test kit in advance would have shortened the length of the presentation for some occupants.

In future projects, separating the audit from the educational presentation may be a better strategy than the procedure followed in this experiment. On the first visit, the peer educator could give some basic background information on common indoor air pollutants and the health effects associated with exposure to them. The house audit could be performed with the occupant participating in the audit to see if any of the pollutants just discussed were present. Tests could be placed, samples taken, and then the first visit ending with the understanding that the peer educator would call again when test results were back. In the second visit the peer educator would concentrate on how to reduce exposure to the pollutants identified in the dwelling. In addition, if very high levels of pollutants were discovered, the peer educator could work with the home occupant to find public programs/support to mitigate pollutant levels.

Conclusions and Implications

This study demonstrated that peer educators can effectively convey information to limited resource households regarding health risks from indoor environmental pollutants and practical measures that can be taken to minimize those risks. Whether increased knowledge of these risks leads to risk-reduction behaviors is an area that needs further study. Peer education with a focus on blood lead levels (BLL) in children has had a mixed record of success. Lanphear, Eberly, and Howard (2000) reported on an intervention involving families with children between 6 and 24 months of age. Trained dust control advisors informed these families about lead poisoning prevention and cleaning techniques to reduce dust lead levels. The families were also provided with premium cleaning equipment and supplies. Blood samples taken from children at 48 months of age in the experimental group and a control group showed no significant differences in BLL resulting from the educational intervention. However, the authors did not provide information on who the dust control advisors were.

Rhoads et al (1999) demonstrated that a combined approach of maternal education and assistance with cleaning was effective in reducing BLL in children. In that study, 56 mothers in the experimental group attended classes on lead that were taught by a study staff member and received house cleaning services provided by study staffers recruited from the community. Because of the small sample size, however, the authors could not conclude that the maternal education alone was the significant BLL reduction factor, but that such education in conjunction with house cleaning is. Jordan, Yust, Robison, Hannan, and Deinard (2003) showed that intensive educational sessions provided by same-ethnicity peer educators reduced BLL in children by 34%.

Kegler and Malcoe (2004) trained lay health advisors, recruited from a Native American community, to teach families in their social networks about sources of lead exposure and lead poisoning prevention strategies over the course of two years. BLLs were measured in the intervention population and in a comparison Caucasian population, and both showed significant decreases even though the intervention population showed greater awareness levels of lead poisoning. Further research on the effectiveness of peer education in reducing exposure risks from multiple indoor environmental toxins is necessary.

As a public policy issue, the disproportionate exposure to such indoor environmental toxins by limited resource households should be recognized for the costs imposed on society. Fisk (2000) demonstrated that indoor environmental improvements in the U.S. would reduce health care costs and improve human productivity substantially. He estimated savings of between \$6 to \$14 billion from reductions in respiratory disease and \$1 to \$4 billion from decreases in allergies and asthma. Other social costs to consider are those imposed by intelligence losses and behavioral problems from lead exposure. These costs justify a policy intervention to correct a social inequity.

Resources collected from this study can be found on the Housing Education and Research Association Web site:

www.housingeducators.org

Educators ~ Housing Topics A to Z

Indoor Air Quality Resources

Resources from state health departments, Extension, and EPA/HUD are listed in appendixes:

- A. Indoor Air Quality
 - B. Mold & Moisture Problems
 - C. Lead Poisoning
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References

- Berry, M. (1991). Assessing the risks of indoor air. In J. Laquatra & S. Zaslou (Eds.), *Indoor air quality in homes: Synthesizing the issues and educating consumers* (pp. 17-21). Champaign, IL: Building Research Council-Small Homes Council.
- Chi, P. S. K., & Laquatra, J. (1990). Energy efficiency and radon risks in residential housing. *Energy, 15*(2), 81-89.
- Evans, G. W., & Kantrowitz, E. (2002). Socioeconomic status and health: The potential role of environmental risk exposure. *Annual Review of Public Health, 23*, 303-331.
- Farr, N., & Dolbeare, C. N. (1996). Childhood lead poisoning: Solving a health and housing problem. *Cityscape: A Journal of Policy Development and Research, 2*(3), 167-181.
- Fisk, W. J. (2000). Health and productivity gains from better indoor environments and their relationship with building energy efficiency. *Annual Review of Energy and the Environment, 25*, 537-566.
- Goldman, L. R. (1995). Case studies of environmental risks to children. *The Future of Children, 5*(2), 27-33.
- Greiner, T. H. (1997). The case of the CO leak: Solving the mysteries of carbon monoxide exposures. *Home Energy, 14*(6), 21-28.
- Jordan, C., Yust, B. L., Robison, L. L., Hannan, P., & Deinard, A. S. (2003). A randomized trial of education to prevent lead burden in children at high risk for lead exposure: Efficacy as measured by blood lead monitoring. *Environmental Health Perspectives, 111*(16), 1947-1951.
- Kegler, M. C., & Malcoe, L. H. (2004). Results from a lay health advisor intervention to prevent lead poisoning among rural Native American Children. *American Journal of Public Health, 94*(10), 1730-1735.
- Lanphear, B. P., Eberly, S., & Howard, C. R. (2000). Long term effect of dust control on blood lead concentrations. *Pediatrics, 106*(4), 48-51.
- Minnesota Department of Health. (1998). *Healthy homes, healthy kids lead program* (IC#141-0735). St. Paul, MN: Minnesota Department of Health.
- New York State Department of Health. (1994). *A technical manual on lead*. Albany, NY: New York State Department of Health.
- Ott, W. R., & Roberts, J. W. (1998). Everyday exposure to toxic pollutants. *Scientific American, 278*(2), 86-91.

- Parrott, K. (2001). *Virginia partnership for lead poisoning prevention education, family education project* (Training Manual). Blacksburg, VA: Virginia Cooperative Extension.
- Rhoads, G. G., Ettinger, A. S., Weisel, C. P., Buckley, T. J., Goldman, K. D., Adgate, J., & Lioy, P. J. (1999). The effect of dust lead control on blood lead in toddlers: A randomized trial. *Pediatrics, 103*(3), 551-555.
- Roberts, J. W., & Dickey, P. (1995). Exposure of children to pollutants in house dust and indoor air. *Reviews of Environmental Contamination and Toxicology, 143*, 59-79.
- Staes, C., Balk, S., Ford, K., Passantino, R. J., & Torrice, A. (1994). Environmental factors to consider when designing and maintaining a child's day-care environment. *Pediatrics, 94*(6), 1048-1050.
- Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches* (Applied Social Research Methods Series, 46). London: Sage Publications.
- U.S. Department of Housing and Urban Development. (1998). *Danger in the home* (HUD-1740-H). Washington, DC: U.S. Department of Housing and Urban Development.
- U.S. Environmental Protection Agency. (1993). *The inside story: A guide to indoor air quality* (EPA-402-K-93-007). Washington, DC: U.S. Environmental Protection Agency, Office of Air and Radiation.
- U.S. Environmental Protection Agency. (1994). *Indoor air pollution: An introduction for health professionals*. Washington, DC: U.S. Environmental Protection Agency, Indoor Air Division.
- U.S. Environmental Protection Agency. (1995). *Protect your family from lead in your home* (EPA747-K-94-001). Washington, DC: U.S. Environmental Protection Agency.
- U.S. Environmental Protection Agency. (2001). *Healthy buildings, healthy people: A vision for the 21st century* (Office of Air and Radiation [6609J] 402-K-01-003). Retrieved from www.epa.gov/iaq/hbhp/section_1.pdf
- U.S. Environmental Protection Agency. (2003). *An introduction to indoor air quality*. Retrieved from www.epa.gov/iaq/ia-intro.html
- University of Wisconsin. (2000). *Help yourself to a healthy home*. Madison, WI: Healthy Homes Partnership.
- Warsco, K. (1992). Explaining housing-related illness: A decade of analysis of emerging paradigms. *Housing and Society, 19*(3), 49-62.