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Breathing easier: indoor air quality education program.

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Breathing Easier: Indoor Air Quality Education Program

by

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Abstract

Background: Exposure to indoor air pollutants increases the risk for poor health outcomes and health disparities among vulnerable groups such as children. The purpose of this evidence-based project was to implement an indoor air quality program that would: 1) improve caregiver awareness of indoor and outdoor environmental health exposures and 2) increase the intention to reduce exposures to indoor household pollutants. The target population included caregivers of preschool children, ages 3 to 5 years, who currently attend the Ohio Valley Education Cooperative.

Methods: This project used a pre and post test study design that included two, virtual-learning modules that reviewed content and discuss action steps for the following: 1) testing for radon and carbon monoxide, 2) reducing allergen triggers, 3) preventing moisture and mold in the home, and 4) controlling both secondhand smoke and pesticide exposure.

Results: Data analysis included descriptive statistics related to age, gender, and housing status. The Wilcoxon Signed-Ranks Test (WSRT) was used as a nonparametric test to determine any significant difference between the pre and post test findings. In session one, a statistically significant difference was found with higher post test scores for the following categories related to awareness: overall indoor air quality, mold, and radon. Statistical significance was found for the following categories related to caregiver intention: overall indoor air quality, mold, radon, and carbon monoxide. In session two, statistical significance was found for the following categories related to awareness: overall indoor air quality, mold, radon, secondhand smoke, and pesticide exposure. Statistical significance was found for the following categories related to caregiver intention: overall indoor air quality, mold, radon, carbon monoxide, and pesticide exposure.

Discussion: Improving awareness of factors that influence indoor air and intention of caregivers to implement action steps to reduce exposure to pollutants requires a multifaceted strategy that addresses the home environment and caregiver involvement.

Keywords: indoor air quality, caregiver, home environmental health, allergen triggers, mold, radon, carbon monoxide, secondhand smoke, pesticides

Indoor Air Quality Education Program

Problem Description

Air pollution poses a serious threat to respiratory health (American Lung Association, 2019). The World Health Organization (WHO; 2019) estimates that 3.8 million deaths occur globally each year related specifically to indoor air pollution. The air indoors can contain increased levels of moisture, dust, and other air pollutants causing symptoms such as coughing, wheezing, or shortness of breath. In fact, the Environmental Protection Agency (EPA) estimates the quality of indoor air to be between 2 and 10 times poorer than outdoor air quality in the same location (2018). Poor air quality can contribute to the development of respiratory infections, lung cancer, and chronic lung disease. It is estimated that Americans spend about 90% of their time indoors (Klepeis et al., 2001); therefore, indoor air quality has a substantial impact on systemic health and quality of life.

Indoor air pollution often results from a combination of biological, chemical, and structural factors that contribute to the environment (Massawe et al., 2013). Biologic pollutants may include but are not limited to bacteria, molds, pet dander, dust mites, pollen, etc. Additionally, chemical pollutants in the home environment may include, but are not limited to, radon, carbon monoxide, pesticides, personal care products, store-bought cleaning products, air fresheners, and environmental secondhand smoke. According to Massawe et al. (2013), varying combinations of these factors can lead to poor indoor air quality and are commonly known sources of environmental triggers that can impact chronic respiratory disease, such as asthma.

Health problems can occur as a result of both short and long term exposure to indoor and outdoor air pollution. Indoor air quality can be associated with the outdoor environment, its air quality, and pollution; therefore, addressing outdoor air quality by reducing pollutants is crucial to improved air quality overall (American Lung Association, 2019). The impact of pollutants such as pesticides can cause systemic health effects that can lead to repeated hospital visits (Massawe et al., 2013). For example, Trueblood, Shipp, Daikwon, Ross, and Cizmas (2016) found a prevalence of pesticide-related hospitalizations among children and teenagers to be 2.1 per 100,000 population compared to 0.0 per 100,000 for those not exposed to pesticides. As a result, simple strategies such as reducing agricultural sources of emission can reduce unhealthy air outdoors (American Lung Association, 2019).

Concentrated urban areas are most frequently associated with air pollution concerns. However, rural areas suffer from indoor air pollution as well as outdoor air pollution (Majra, 2011). In fact, indoor concentrations of pesticides may be greater in rural areas related to frequent and continuous use of agricultural products (California EPA, 2005). Overall, environmental triggers can exist in both indoor and outdoor spaces; therefore, it is necessary to identify exposures in all communities and in individual households that can contribute to disease severity.

Problem Data

Indoor air pollution is one of the leading causes of disease and premature death in the world (WHO, 2019). Noncommunicable diseases linked to poor indoor air quality can include stroke, ischemic heart disease, chronic obstructive pulmonary disease, and lung cancer. Major contributing pollutants to poor respiratory health include exposure to radon and carbon monoxide. Radon is the third leading cause of lung cancer resulting in approximately 21,000 lung cancer deaths per year (EPA, 2019). Of the 21,000 radon-related lung cancer deaths, approximately 2,900 occurred in are non-smoking individuals (EPA, 2019). Carbon monoxide poisoning contributes to 430 annual deaths and 50,000 emergency room visits each year (CDC, 2019).

Exposure to air pollutants increases risk for poor health outcomes for vulnerable populations. In particular, poor indoor air quality can be harmful to children (Cincinelli et al., 2017). Children generally are more susceptible to respiratory infections compared to adults and, therefore, poor air quality related to air pollution can have a significant impact on child health. Currently, half of all pneumonia deaths worldwide are in children under 5 years of age and are associated with indoor air pollution (WHO, 2019). Increased mortality in infants and young children is also associated with air pollutants (American Lung Association, 2019). In fact, air pollutants account for almost 1 in 10 deaths in children under five years of age (WHO, 2018). Understanding the association of poor air quality with increased health risks is essential for motivating health behavior change to improve respiratory health in all children.

Rationale for Intervening

An important avenue for improving the home environment is to provide education and awareness of action steps to reduce exposure to indoor air pollutants (WHO, 2019). Children's environmental health risks can be positively impacted by home environmental assessments coupled with home health education to caregivers. Environmental health education shared during early childhood has the potential to help reduce or eliminate environmental exposures and, thus, positively impact childhood risk associated with respiratory illness over their lifetime (Huntington-Moskos et al., 2016). A growing body of evidence stresses the need for home environmental education to impact health outcomes of chronic asthma (American Lung Association, 2019). The Expert Panel of the National Asthma Education Program (NAEPP) recommends multifaceted allergen education for effectively reducing exposures to environmental triggers (National Heart, Lung, and Blood Institute, 2007). Education for caregivers, including parents, siblings, grandparents, or others family members living in the home is an essential component to building environmental health in the home.

Respiratory illnesses such as asthma can have a direct impact on academic performance in schools due to increased absenteeism. In children, school absenteeism can contribute to anxiety, poor self-image, and poor academic performance (Crocker et al., 2011). Children have recorded millions of missed school days across the U.S. related to frequent visits to the emergency room and hospitalizations from asthma and other respiratory illnesses (Massawe et al., 2013). In addition, children’s immediate caregivers are also impacted both financially and emotionally as their own attendance at work or other activities may suffer. The average annual medical cost of asthma is nearly $3,200 per child (American Thoracic Society, 2018). A healthy home environment, which addresses the reduction of environmental exposures, can substantially impact both the health and well-being of the child, the caregiver and the entire family as a whole.

Purpose and Specific Aims

The purpose of this Doctor of Nursing Practice (DNP) evidence-based education project was to implement an indoor air quality education program that would: 1) improve caregiver awareness of indoor and outdoor environmental health exposures and 2) reduce exposures to indoor household pollutants. The specific aims for this DNP project were as follows:

Aim 1: Assess caregiver awareness of factors that influence indoor air quality related to radon and carbon monoxide levels, allergen triggers such as mold and secondhand smoke, and pesticide exposure after the implementation of a two-session educational program.

Aim 2: Assess the intention of caregivers to implement action steps to reduce exposure to indoor pollutants.

Conceptual Framework

The Self-Efficacy Theory served as a guide for this educational program, as human behavior change is a central concept to this theory. Self-efficacy highlights an individual's judgment of his or her own capabilities (Bandura et al., 1977). Perceived self-efficacy can be affected by behavioral settings, use of knowledge or skills, and the effort of an individual. As cognitive influence plays a major role in reaching desired effects, personal self-efficacy can influence how goals, tasks, and challenges are approached (Bandura, 2000).

According to Bandura (1994), an individual's thoughts are developed from mastery experience, seeing similar people manage tasks successfully, vicarious experience, modeling of others, verbal persuasion or encouragement, and physiological indicators from emotions. A strong self-efficacy enhances one's accomplishment and personal well-being. Learning is a holistic approach to acquiring new knowledge through our environment and individual experience. Factual knowledge alone will not result in a proficient performance (Bandura, 2000); learning results from thinking, feeling, perceiving, and behaving. All components of this model were utilized to develop and implement a productive learning environment. Figure 1 illustrates Bandura's Self-Efficacy Theory.

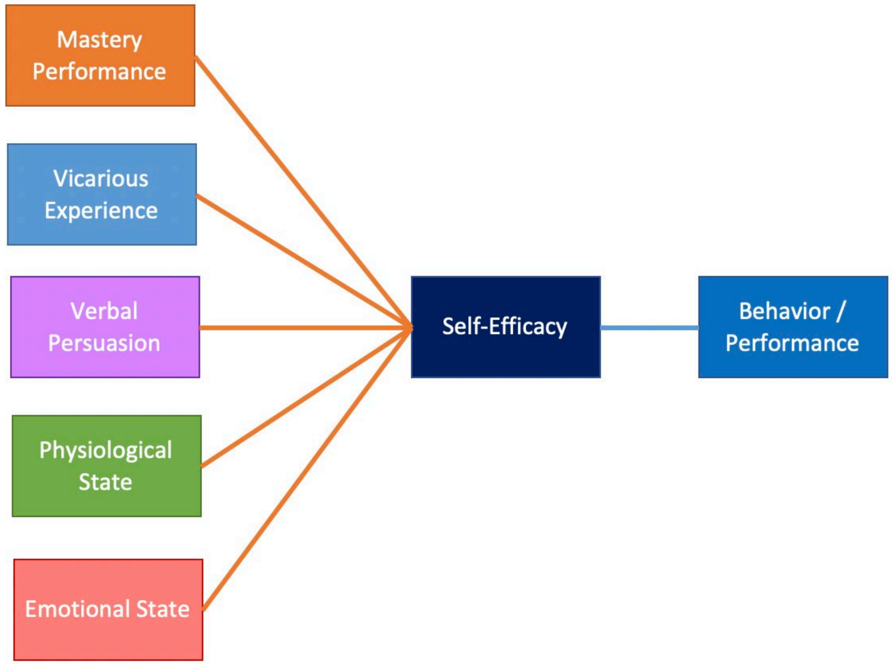

Figure 1. Self-Efficacy Theory. This figure was adapted from Bandura, 1997.

This DNP project was implemented to improve the awareness of caregivers regarding indoor and outdoor environmental triggers. With the guidance provided by the Self-Efficacy framework, this project used various educational tools to support a variety of learning styles, including visual aids, and active learning strategies. According to Bandura, the individual must achieve a success to increase self-efficacy (Bandura et al., 1977). Caregivers gained this experience with the new challenge of creating a healthy home environment. The vicarious experience, within the context of this project, referred to the observation of others successfully performing ways to impact the home environment. If the caregiver had not been exposed to previous home health education, this experience was likely to have a greater impact (Bandura, 2000). Bandura also highlights verbal encouragement, an aspect of the theory, for which empirical support was provided (Bandura et al., 1977). Lastly, as the physiological stress of creating a healthy home environment may have affected the individual's self-efficacy, the educational materials were presented to encourage a variety of action steps and differing levels of engagement to tailor to each individual's own confidence level and readiness to engage in trigger exposure reduction.

Target Population

The target population included caregivers of preschool children, ages 3 to 5 years, who currently attend Ohio Valley Education Cooperative (OVEC). A caregiver was identified as one who lives in the same home and assists in the management and care of the child. The most common racial or ethnic group living in Shelby County, KY is White/Caucasian (*n*=36.8k; 80.3%), followed by Hispanic (*n*=4.17k; 9.0%), Black (*n*=3.1k; 6.8%), and other (*n*=1.73k; 3.8%) (Data USA, 2017). Households in Shelby County, KY have a median annual income of approximately $63,171 (Data USA, 2017).

Setting

This evidence-based project was conducted through OVEC, which serves a rural population and is located in Shelbyville, KY. This community is located 33.1 miles from the nearest large city of Louisville, KY. The workforce in Shelby County, KY has 3.21 times higher than expected residents working as Farming, Fishing, and Forestry Occupations than surrounding counties (Data USA, 2017).

Statement of Intervention

A multifaceted educational intervention with a variety of materials assembled into a toolkit was utilized for this project. The educational intervention reviewed content and discussed action steps for the following: 1) testing for radon and carbon monoxide, 2) reducing allergen triggers, 3) preventing moisture and mold in the home, and 4) controlling both secondhand smoke and pesticide exposure.

Ethics

This DNP project and protocol was submitted to the University of Louisville Institutional Review Board (IRB) for ethics review and was approved as a non-human subjects quality improvement project. In addition, the project was approved through the agency approval process within Ohio Valley Education Cooperative. This project had a focus of using current evidence for project implementation to improve educational awareness related to reducing harmful indoor and outdoor environmental exposures.

Synthesis of Literature

Although air pollution is often perceived as bothersome, exposure to hazardous pollutants in our air can be life threatening, particularly for vulnerable populations such as children. Certain types of mold can cause adverse effects such as an allergic reaction or immune response in children. A child's decline in respiratory health may be associated with visible mold present in the home resulting from excessive moisture (CDC, 2009; Polyzois et al., 2016). Controlling moisture is critical in educational abatement strategies such as increasing ventilation or removing and cleaning mold contaminated materials (CDC, 2009; Cincinelli et al., 2017; Polyzois et al., 2016). Managing air pollution, through proper identification of indoor environmental triggers, can support the reduction of respiratory symptoms in children. Providing an avenue for parents to obtain this information may serve to improve respiratory health in children. This DNP evidence-based education project incorporated the following environmental health topics: mold, radon, secondhand smoke, carbon monoxide, and pesticides.

Radon is a colorless, odorless gas that can have a significant impact on indoor air quality and respiratory health. Residential exposure to radon is associated with lung cancer (Cincinelli et al., 2017). However, despite this known risk there is minimal public awareness for the exposure of radon (Butler et al., 2018; Siza et al., 2018). Therefore, it is strongly suggested that a more extensive radon screening program and systemic approach is necessary along with education of test kit utilization (Butler et al., 2018; Cincinelli et al., 2017). Along with radon, environmental secondhand smoke is another major contributor to indoor air pollution, particularly in tobacco growing states (American Lung Association, 2012). Many children are exposed to secondhand smoke in indoor spaces via air ducts, walls, floors, and crawl spaces (Butler et al., 2018). Secondhand smoke can be especially harmful to children as their lungs are still developing. Along with secondhand smoke, carbon monoxide is a product of combustion (CDC, 2009). Although testing for different air pollutants, Butler et al. (2018) and Schwartz et al. (2010) effectively utilized kits to identify secondhand smoke, radon, and/or carbon monoxide with study participants. Home air quality can be improved with the promotion and education of home testing information and test materials. Test kits were also more likely to be used if participants received them with education versus education alone (Butler et al., 2018; Schwartz et al., 2010). Education related to indoor air quality is an important resource for parents who wish to positively impact future respiratory health risk of their children (Huntington-Moskos et al., 2016).

Rural communities experience health disparities related to environmental exposures, particularly when considering their exposure to pesticides that irritate the respiratory system. Primarily in the summer months, numerous crops are grown using pesticides and children in these rural communities are more susceptible to adverse effects related to respiratory distress (Raherison et al., 2018). When analyzing radii of 50m, 100m, and 500m around children's homes there were an average of 16, 22, and 50 known respiratory-distressing pesticides found, respectively (Bukalasa et al., 2017). Overall, exposure to pesticides can lead to health disparities specific to respiratory health in children.

Procedures

Project Design

This evidence-based education project used a pre-test and post-test study design in a preschool setting to evaluate caregiver awareness of indoor and outdoor environmental health exposures and intention to reduce exposure to pollutants.

Intervention

This project had the intent of implementing two, 45-minute educational in-person sessions that focused on factors that contributed to indoor air quality. However, due to COVID-19 precautions, the program was adapted in the form of two, virtual-learning modules to provide enhanced safety to participants. The Head Start staff released each educational session virtually via secure email and through OVEC's social media page for caregivers to access for completion. Each module provided options for both visual and auditory learning. The first session began with an overview of content expectations and instructions for operating the module virtually, along with an introduction of the DNP candidate. The pre-test was linked in the module at the start of the session via SurveyMonkey (www.surveymonkey.com; San Mateo, CA). This 12-item pre-test had no other identifiable data other than a participant ID number. A brief overview of the importance of the indoor air quality education program to child health was delivered to all participants. The session included an introductory activity for healthy indoor environment incorporating educational materials from the Science Take-Out "A Healthy Home?" community environmental health (CEH) kit (2019). More specifically, the module contained information from fact sheets for carbon monoxide, radon, and mold, along with activity engagement questions. The participants were able to return previous slides as they answered the questions and explored ways to reduce exposure to each of these pollutants. At the conclusion of the session, a post-test was linked to the module for those who participated in the project to evaluate the initial indoor air quality education program. The session ended with a brief overview of the plan for the second educational session and an invitation to attend for all participants.

The second educational session began with an overview of content expectations and instructions for operating the module virtually, along with an introduction of the DNP candidate. A pre-test was embedded in the module for the participants to be complete. This 18-item test had no other identifiable data other than a participant ID number. This educational intervention included a module focused on the content of a reproducible toolkit with key action-steps for improving indoor air quality. Due to the COVID-19 pandemic and the inability to have in-person sessions, this toolkit was not distributed to participants. However, one sample toolkit was given to the OVEC to use for future programs. The module encompassed specific content for environmental secondhand smoke and pesticide exposure, setting up both a radon and carbon monoxide test kit, tips for reducing allergen triggers including a discussion regarding the use of a mattress and pillow allergen cover, and a cost analysis of household items to create a healthy indoor environment. The educational intervention was evaluated using a second post-test (18-items) at the conclusion of the session. The session concluded after thanking the participants for their attendance. For those who elected to participate, an anonymous raffle for five radon test kits provided at no cost by the Environmental Management Branch of the Kentucky Cabinet for Health and Family Services was completed.

Participants

Sample characteristics were identical for both session one and two. Majority of the data came from single family homes (*n*=19; 95.0%) followed by mobile homes (*n*=1; 5.0%) as illustrated in Table 1. Females (*n*=15; 75.0%) accounted for three times as many participants as males (*n*=5; 25.0%); see Table 1. As shown in Table 2, the indoor air quality education program included caregivers ages 23 to 63 (*n*=20). Participants were encouraged to complete each educational session virtually by the family service staff with OVEC Head Start.

Table 1

Sample Characteristics

Characteristic	Frequency	Percent
Mobile Home	1	5
Single Family Home	19	95
Total	20	100
Male	5	25
Female	15	75
Total	20	100

Table 2

Sociodemographic Characteristics

Variable	N	Mean	SD	Minimum	Maximum	Range
Age	20	43.8	11.8	23.0	63.0	40.0

Data Collection

All data were collected virtually by the DNP candidate via SurveyMonkey during both session one and two. HIPPA procedures were followed; participant confidentiality and anonymity were maintained. Data was stored on an encrypted flash drive.

Measurement Instrument

In educational session one, demographic data was collected for age, gender, and housing. A 12-item Likert-scale was developed to measure both caregiver awareness and intention to implement healthy homes strategies to improve indoor air quality and exposure to mold, radon, and carbon monoxide. This Likert-scale was adapted from several preexisting scales including the Homeowner Indoor Air Quality Opinion Survey and Field Testing Protocol Development, *HealthStyles* Survey, Household Secondhand Smoke Exposure Questionnaire, Knowledge, Attitudes, and Preventative Efforts to Avoid SHS Exposure Scale, and Lead and Healthy Homes EHA Questionnaires (NAHB Research Center, Inc., 2006; King et al., 2011; Gharaibeh et al., 2011; Mankikar et al., 2016). The scale was validated through expert opinion and a 10-person validation. Answers were recorded using a 5-point scale, from strongly disagree to strongly agree with a higher score demonstrating a high level of caregiver awareness or intent to implement healthy home strategies.

Similarly, demographic data for age, gender, and housing was also collected in educational session two. An 18-item Likert-scale was developed to measure caregiver knowledge and intention to implement healthy homes strategies to improve indoor air quality and exposure to mold, radon, carbon monoxide, secondhand smoke, and pesticide exposure. This Likert-scale was adapted from several preexisting scales including the Homeowner Indoor Air Quality Opinion Survey and Field Testing Protocol Development, *HealthStyles* Survey, Household

Secondhand Smoke Exposure Questionnaire, Knowledge, Attitudes, and Preventative Efforts to Avoid SHS Exposure Scale, and Lead and Healthy Homes EHA Questionnaires (NAHB Research Center, Inc., 2006; King et al., 2011; Gharaibeh et al., 2011; Mankikar et al., 2016). The scale was validated through expert opinion and a 10-person validation. Answers were recorded using a 5-point scale, from strongly disagree to strongly agree from strongly disagree to strongly agree with a higher score demonstrating a high level of caregiver awareness or intent to implement healthy home strategies.

Results

Session One Results

Twenty caregivers completed session one pre and post-tests for the evidence-based project (*n*=20). The Statistical Package for the Social Sciences (SPSS) version 26 was utilized for computerized analysis of the data. The 12-item Likert-scale measured both caregiver awareness and intention to implement healthy homes strategies within the following categories: overall indoor air quality, mold, radon, and carbon monoxide. Each category comprised two questions related to caregiver awareness and one question related to intention to implement healthy homes strategies. Results are illustrated in Table 3 below.

Table 3

Session One Results

Category	Pre-test M (SD)	Post-test M (SD)	Z	P
IAQ Awareness	7.950 (1.932)	9.550 (1.050)	-3.111	0.002
IAQ Intention	3.900 (0.718)	4.550 (0.605)	-2.739	0.006
Mold Awareness	8.550 (1.191)	9.500 (0.761)	-2.812	0.005
Mold Intention	4.100 (0.718)	4.700 (0.571)	-2.972	0.003
Radon Awareness	6.300 (1.976)	7.650 (1.387)	-2.13	0.033
Radon Intention	3.370 (0.831)	4.000 (0.649)	-2.235	0.025
CO Awareness	8.000 (1.747)	9.000 (1.589)	-1.779	0.075
CO Intention	3.450 (1.191)	4.050 (0.605)	-2.364	0.018

Caregiver awareness was assessed by measuring current understanding of factors that influence indoor air quality related to radon and carbon monoxide levels, allergen triggers such as mold and secondhand smoke, and pesticide exposure. A Wilcoxon Signed-Ranks Test (WSRT) indicated the mean post-test ranks were statistically significantly higher than the pre-test ranks for the following categories related to caregiver awareness: overall indoor air quality ($Z = -3.111$, $p = 0.002$), mold ($Z = -2.812$, $p = 0.005$), and radon ($Z = -2.130$, $p = 0.033$). Inversely, the WSRT specified the mean post-test ranks for carbon monoxide (CO) awareness were not statistically significantly higher than the pre-test ranks ($Z = -1.779$, $p = 0.075$).

Caregiver intention was assessed by measuring individual willingness to implement action steps to reduce exposure to indoor pollutants. Similarly, the WSRT specified the mean post-test ranks were statistically significantly higher than the pre-test ranks for the following categories related to intention: overall indoor air quality ($Z = -2.739$, $p = 0.006$), mold ($Z = -2.972$, $p = 0.003$), radon ($Z = -2.235$, $p = 0.025$), and CO ($Z = -2.364$, $p = 0.018$).

Session Two Results

Similarly, twenty caregivers completed session two pre and post-tests for the evidence-based project (*n*=20). The 18-item Likert-scale measured both caregiver awareness and intention to implement healthy homes strategies within the following categories: overall indoor air quality, mold, radon, carbon monoxide, secondhand smoke, and pesticide exposure. Each category comprised two questions related to caregiver awareness and one question related to intention to implement healthy homes strategies. Results are portrayed in Table 4 below.

Table 4

Session Two Results

Category	Pre-test M (SD)	Post-test M (SD)	Z	P
IAQ Awareness	7.350 (1.663)	9.600 (0.995)	-3.307	< 0.001
IAQ Intention	3.000 (1.214)	4.750 (0.550)	-3.419	< 0.001
Mold Awareness	7.850 (1.182)	9.650 (0.745)	-3.418	< 0.001
Mold Intention	3.470 (0.697)	4.650 (0.671)	-3.306	< 0.001
Radon Awareness	5.300 (1.750)	8.900 (1.553)	-3.622	< 0.001
Radon Intention	2.900 (1.119)	4.650 (0.587)	-3.429	< 0.001
CO Awareness	6.000 (2.362)	9.500 (0.889)	-3.418	< 0.001
CO Intention	3.370 (0.597)	4.550 (0.686)	-3.357	< 0.001
SHS Awareness	6.050 (2.46)	9.400 (1.314)	-3.254	< 0.001
SHS Intention	4.050 (0.605)	4.400 (0.821)	-1.807	0.071
Pest Awareness	6.300 (1.625)	9.400 (0.883)	-3.574	< 0.001
Pest Intention	3.150 (0.587)	4.550 (0.759)	-3.573	< 0.001

Caregiver awareness was assessed by measuring current understanding of factors that influence indoor air quality related to radon and carbon monoxide levels, allergen triggers such as mold and secondhand smoke, and pesticide exposure. A Wilcoxon Signed-Ranks Test (WSRT) suggested the mean post-test ranks were statistically significantly higher than the pre-test ranks for the following categories related to caregiver awareness: overall indoor air quality ($Z = -3.307$, $p < 0.001$), mold ($Z = -3.418$, $p < 0.001$), radon ($Z = -3.622$, $p < 0.001$), carbon monoxide (CO) ($Z = -3.418$, $p < 0.001$), second-hand smoke ($Z = -3.254$, $p < 0.001$), and pesticide exposure ($Z = -3.574$, $p < 0.001$).

Caregiver intention was assessed by measuring individual willingness to implement action steps to reduce exposure to indoor pollutants. Similarly, the WSRT specified the mean post-test ranks were statistically significantly higher than the pre-test ranks for the following categories related to intention: overall indoor air quality ($Z = -3.419$, $p < 0.001$), mold ($Z = -3.306$, $p < 0.001$), radon ($Z = -3.429$, $p < 0.001$), CO ($Z = -3.357$, $p < 0.001$), and pesticide exposure ($Z = -3.573$, $p < 0.001$). Inversely, the WSRT stipulated the mean post-test ranks for intention to reduce exposure to second-hand smoke were not statistically significantly higher than the pre-test ranks ($Z = -1.807$, $p = 0.071$).

Discussion

Interpretation

This evidence-based program examined the effect of indoor air quality education on caregiver awareness of home environmental triggers and intention to reduce exposure to those triggers. The caregiver's trend toward improved awareness and increased intention to act to reduce home environmental exposures is promising. Therefore, the results suggest effective home management including building awareness of potential air pollutants and how to implement trigger reduction strategies.

In session one, the validated 12-item Likert-scale showed improvements in caregiver awareness and intention to implement healthy homes strategies for the following categories: overall indoor air quality, mold, radon, and carbon monoxide (CO). CO awareness was the sole category without a statistically significant improvement, even though scores improved from pre to post test. Historically, CO awareness is nationally recognized and promoted through many state and local governments, and home safety organizations. In fact, the month of January has been declared "National CO Awareness Month" by First Alert, one of the nation's leading CO detector distributors (2018). Therefore, the combination of public service announcements and previous educational exposures may have contributed to the absence of statistical significance related to CO awareness.

In session two, the validated 18-item Likert-scale showed improvements in caregiver awareness and intention to implement healthy homes strategies for the following categories: overall indoor air quality, mold, radon, carbon monoxide, secondhand smoke, and pesticide exposure. Although intention to reduce exposure to secondhand smoke scores improved from pre to post-test, this was not statistically significant. As Shelby County is the fifth leading producer of burley tobacco in the state of Kentucky, the residential culture may have supported the resistance to implement secondhand smoke reduction strategies (United States Department of Agriculture, 2018).

With this educational program, the Likert scale would suggest that caregivers were more informed and likely to implement changes in their home. Improving awareness of factors that influence indoor air and intention of caregivers to implement action steps to reduce exposure to pollutants requires a multifaceted strategy that addresses the home environment and caregiver involvement. Through this educational intervention, caregivers gained awareness about indoor triggers and recognized effective methods for improving the home environment to minimize these triggers. This educational program can be utilized to collaborate with caregivers to set goals for improving the home environment.

Limitations

Several limitations existed in this evidence-based project. This DNP project was implemented in one area of the state of Kentucky; therefore, limiting its generalizability to other areas of the state or nation. Other factors contributing to limited generalizability included an overall small sample size and homogenous sample of women who lived in a single-family home. A further limitation included reporting bias, as caregivers may have embellished their intention to reduce home environmental triggers at program completion to avoid not meeting perceived expectations.

Due to the novel coronavirus, unforeseen government shutdowns required this project to implement virtually. This limited the potential for further caregiver understanding via question and answers. This limitation was time dependent and may not affect future implementation strategies.

Feasibility and Sustainability

The findings suggest that this project implemented a feasible strategy for caregivers to transition the home to a healthy environment. The indoor air quality education was presented in a manner that encouraged participants to plan out action steps and budget for materials if needed. The budget included a cost analysis for household items that could be implemented in the home to impact indoor air quality. The indoor air quality education program also included a variety of materials tailored to different learning styles including visual aids, and active learning strategies. The teaching strategy for this education project was developed to adapt to multiple audiences.

Sustainability was promoted through the engagement of stakeholders within the DNP project. Organizational leaders and school administrators were supportive of the DNP project and the program operations. The main coordinator of the project was the health manager for

OVEC Head Start. Throughout project implementation, communication was constant with the health manager, as the original plan for the project had to be revised. The health manager was included during the creation of each virtual learning session and the decision for how the media was to be shared to caregivers of children enrolled within the Head Start. The family service staff with OVEC then conducted the release of the virtual educational sessions.

The materials utilized in the indoor air quality education program were public health resources and, therefore, are available to guide implementation for future indoor air quality education programs. A complete sample of each toolkit from both session one and two were given to the agency. This handover of materials will serve to support sustainability was promoted, as the Science Take-Out CEH kit and sample educational toolkit are each easily reproduceable for integration into any future an educational programming (Science Take-Out, 2019). The indoor air quality program itself can be replicated in a variety of educational settings such as the classroom or the clinic for future implications in practice. Successful approaches for implementing an indoor air quality education program virtually will need to consider family's technological access including the presence of a home computer, access to computer in community or access to smart phone.

Summary

Exposure to indoor air pollutants can be harmful; however, prevention is possible and exposure can be controlled. Indoor and outdoor air pollution poses a risk to the pediatric population, as small particles exist in the air creating environmental triggers that affect lung function and respiratory health. Although patients may not be allergic to these triggers, their airways can become sensitive and inflamed. A wide range of indoor pollutants, including radon, carbon monoxide, pesticides, mold, and environmental secondhand smoke, present as risks for respiratory illnesses. Recognizing these triggers is crucial for prevention (American Lung Association, 2019). The indoor environment can be modified to either reduce or eliminate air pollutants. Successful long-term management for improved respiratory health requires the sustained control of environmental factors or irritants that contribute to chronic respiratory symptoms.

Healthcare providers must advocate for creating a healthy indoor home environment. With current literature highlighting the success of home health education, the evidence-based educational intervention delivered an indoor air quality education program that focused on the indoor home environment to address respiratory health in children (CDC, 2009; Cincinelli et al., 2017; Polyzois et al., 2016). In the future, healthcare providers can collaborate with the caregivers of preschool aged children to replicate the efforts for their own communities with the long-term goal of reducing exposure to environmental triggers and improving respiratory health for children and their families.

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Appendix A: Session One Lesson Plan

Daily Lesson Plan

Teacher: Sara Kuner
Subject: Session One
Lesson Date: February 2020

CCSS/CLGs/SC Assessment Limits/Standards: *(What are the skills being taught? Which standards are being specifically addressed in this lesson?)* 1) Improve caregiver awareness of environmental health 2) Reduce exposure to pollutants	**Agenda:** *(What is the snapshot of my class flow?)* Review Radon, Carbon Monoxide, and Mold as a common environmental health concern in the home.
Lesson Objective: *(What will my students KNOW by the end of the lesson? What will they DO to learn it?)* Assess caregiver awareness of factors that influence indoor air quality related to radon, carbon monoxide, and mold. Assess the intention of caregivers to implement action steps to reduce exposure to indoor pollutants.	

TIME	INSTRUCTIONAL SEQUENCE	FORMATIVE ASSESSMENT Note: A variety of formative assessments should be used at key points throughout the lesson.
5 min	**Get started/Drill/Do Now:** *(What meaningful activity will students complete as soon as they enter the classroom?)* • Introduction to DNP Student	
5 min	**Assessment Prior to Educational Intervention:** *(How will I know if students have achieved today's objective?)* • Administration of Pre-test	Assess basic knowledge of indoor air quality
20 min	**Whole Group Instruction:** *(Focus lessons [explicit teaching/modeling, strategy demonstration, activate prior knowledge], shared reading, shared writing, discussion, writing process.)* • Review fact sheets for mold, carbon monoxide, radon • Complete A Healthy Home? Mold, Carbon Monoxide, and Radon activity, completed in pairs	
5 min	**Group Practice/Small Group Instruction:** (teacher-facilitated group discussion, student or teacher-led collaboration, student conferencing, re-teaching or intervention, writing process) • Facilitate discussion after group complete mold, carbon monoxide, radon activity	Call on participants to share their learning from activity and ask remaining questions
5 min	**Evaluate Understanding/Assessment:** *(How will I know if students have achieved today's objective?)* • Administration of Post-test	
5 min	**Closing Activities/Summary:** *(How will I tie up loose ends, reinforce/revisit the objective and connect the lesson to the unit?)* • Share with participants plan for the second class session	

Resources/Instructional Materials Needed: *(What do I need in order to teach the lesson?)* Science Take-Out kit: A Healthy Home?
Notes:

Structure	Strategies Included in the City School/ Model of Highly Effective Literacy Instruction – English 9-12		
Whole Group	-Anticipatory guides/sets -Close Reading -Text annotation	-Book/author talks -Questioning the Author (QtA) -Think aloud	-Cornell Notes -Question-Answer-Relationships (QAR) -Think/Pair/Share
Guided Practice/Small group	-Anticipatory guides/sets -Close Reading -Question-Answer-Relationships (QAR) -Strategy groups -Think/Pair/Share	-Book/author talks -Literature Circles -Reading conferences -Text annotation -Writing Conferences	-Cornell Notes -Questioning the Author (QtA) -Reciprocal teaching -Think aloud
Independent Practice	-Anticipatory guides/sets -Close Reading -Question-Answer-Relationships (QAR) -Strategy groups -Think/Pair/Share	-Book/author talks -Literature Circles -Reading conferences -Text annotation -Writing Conferences	-Cornell Notes -Questioning the Author (QtA) -Reciprocal teaching -Think aloud

Appendix B: Science Take-Out CEH Kit Group Activity

A Healthy Home?

Introduction

Mr. and Mrs. Smith want to be certain that their home is a healthy environment for their two children, ages 2 and 6. They know that environmental health hazards are especially dangerous for young children.

Luckily, the town where the Smith family lives has a healthy homes program. This program trains volunteers to visit homes to identify indoor environmental health hazards and offer suggestions for creating a healthier home.

Part 1: Carbon Monoxide

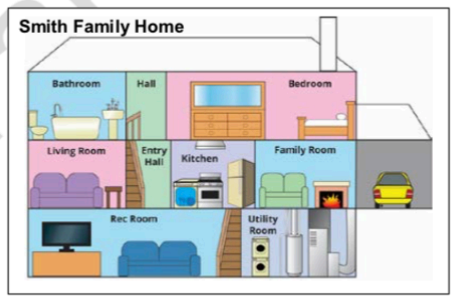
The healthy homes volunteer noticed that the Smith family has only one carbon monoxide (CO) detector installed in the kitchen. The CO detector needed new batteries. There was no installation date on the CO detector, so the volunteer could not tell if it should be replaced. He recommended that the Smiths install new carbon monoxide detectors as soon as possible.

Use the **Carbon Monoxide Fact Sheet** in your kit to answer questions 1 through 4.

1. Why is CO (carbon monoxide) harmful?

2. Why might people not realize that their home has dangerous carbon monoxide levels?

3. Mrs. Smith purchased three carbon monoxide detectors. She wants to know where they should be installed. Your kit contains a large diagram of the **Smith Family Home** and a bag with beads. Place the three **red** beads on the three places in the home where you think the carbon monoxide detectors should be installed.

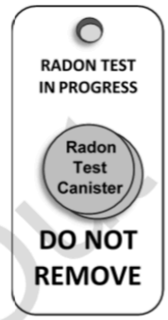


Red beads = CO detector locations.

4. What are some things that Mr. and Mrs. Smith can do to prevent exposure to carbon monoxide in their home?

Part 2: Radon

Short Term
Radon Detector



The healthy homes volunteer notes that the Smith's home has <u>not</u> been tested for radon. He set up a detector from a short term radon test kit. After 5 days, Mr. and Mrs. Smith followed the kit instructions and mailed the radon test detector to a laboratory for analysis. Below is the result of the radon testing on the Smith's home.

Radon Test Result = 3.8 pCi/L

The US EPA (US Environmental Protection Agency) action level for indoor radon is 4.0 pCi/L. If the radon test result is between 2.0 to 3.9 pCi/L, the EPA recommends further tests using a long-term radon test kit. If the long term results remain between 2.0 to 3.9, there is little short-term risk, but you should consider fixing your home to reduce radon exposure. Additionally, if you make any structural changes to the home, you should test again.

Use the **Radon Fact Sheet** in your kit to answer questions 1 through 3.

1. How does radon get into a home?

2. Why is it important that <u>all</u> homes be tested for radon?

3. What are some things that Mr. and Mrs. Smith can do to prevent exposure to radon in their home?

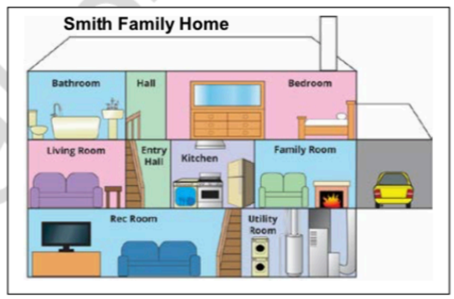
Part 3: Mold

The healthy homes volunteer notices a musty odor in the Smith home that might indicate the presence of mold. He suspects that mold may be causing the Smith children's coughing and runny noses. The volunteer explained that all homes have invisible mold spores in the air but locations where moisture is present are more likely to have higher concentrations of mold spores.

Use the **Mold Fact Sheet** in your kit to answer questions 1 through 3.

1. Why is mold harmful?

2. Your kit contains a large diagram of the **Smith Family Home** and a bag with beads. Place the three **black** beads on the three places in the home where you think mold is most likely to be growing.



Black beads = Likely locations for mold

3. Explain why it is usually NOT worth the cost of doing mold tests on a home.

4. What are some things that Mr. and Mrs. Smith can do to reduce exposure to mold in their home?

Appendix C: Carbon Monoxide Fact Sheet

Carbon Monoxide Fact Sheet

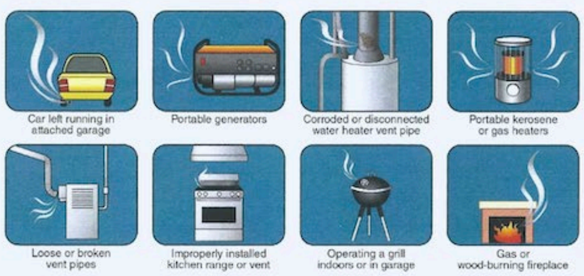
What is carbon monoxide?

- Carbon monoxide, or CO, is an odorless, colorless gas.
- Carbon monoxide can be deadly because it blocks the transport of needed oxygen to all parts of the body.

Symptoms of carbon monoxide poisoning:

- The symptoms of low levels of CO exposure, such as headaches, dizziness, weakness, nausea, chest pain and confusion, are similar to symptoms of other health problems.
- High levels of CO can cause loss of consciousness and death.
- People are most at risk for death from carbon monoxide poisoning when they are sleeping because they may not notice the symptoms of CO exposure.

Possible Sources of carbon monoxide in the home:



Ways to prevent CO in your home:

- Have your furnace and chimney inspected each year.
- **Never** use a gas stove or oven to heat a home.
- **Never** leave the motor running in a vehicle parked in an enclosed or partially enclosed space, such as a garage (even if the garage door is open).
- **Never** run a generator, pressure washer, or any gasoline-powered engine inside a basement, garage, or other enclosed structure, even if the doors or windows are open.
- **Never** use a charcoal grill, hibachi, lantern, or portable camping stove inside a home, tent, or camper.

Carbon monoxide detector alarms save lives!

- Install a battery-powered or battery back-up CO detector alarm in the basement and in every floor of your home.
- Read the manufacturer's recommendations for CO detector locations.
- CO detectors should be installed near each sleeping area of your home and near attached garages.
- Change the batteries in your CO detector every 6 months.
- Check the expiration date on your CO detectors because they usually last for only 5 to 7 years.
- Avoid putting CO detectors near fuel burning appliances or in areas with high humidity, high temperatures, blowing air, or direct sunlight.
- If CO poisoning is suspected, you should open the windows, leave the building, and call emergency responders. Consult a health care professional right away.

Appendix D: Radon Fact Sheet

Radon Fact Sheet

What is radon?

- Radon is a cancer-causing, radioactive gas. You can't see radon, and you can't smell it or taste it.
- Radon gas comes from radioactive substances in the ground beneath a home.
- Radon can enter a home from the ground through cracks and other holes in the foundation. If radon is trapped inside a home, it can build up in the air you breathe.

Exposure to radon:

- Exposure to radon is the second leading cause of lung cancer in the United States today.
- Only smoking causes more lung cancer deaths than radon.

Testing for radon:

- All homes should be tested for radon because radon can be found in any part of the country and in any type of home.
- Radon testing is the only way to know if you and your family are at risk from radon in your home.
- Radon testing is inexpensive and easy.
- There are many kinds of low-cost "do-it-yourself" radon test kits.
- You can also hire a qualified radon tester to do the testing for you.

If there is radon in your home:

- You should reduce the radon level in your home if the radon level is 4.0 picocuries of radon per liter of air (pCi/L) or higher.
- The cost of reducing radon levels in your home depends on how your home was built and the extent of the radon problem.
- Most homes can be fixed by installing a radon ventilation system.
- Lowering high radon levels requires technical knowledge and special skills.
- A qualified radon reduction contractor can study the radon problem in your home and help you pick the right treatment method.

Appendix E: Mold Fact Sheet

Mold Fact Sheet

What is mold?

- Mold is a type of fungus that reproduces by making small spores that are released into the air.
- Mold grows best in warm, damp, and humid conditions.
- Mold can be found in areas of a home where humidity levels are high, such as basements, bathrooms, or areas where water is leaking.

Exposure to mold:

- Exposure to mold spores may cause upper respiratory tract symptoms such as runny nose, coughing, wheezing, and asthma.
- People who have allergies or asthma may be more sensitive to mold spores.

Testing for mold:

- Testing can be expensive if done by professionals, and it often does not change mold remediation actions.
- Do-it-yourself mold kits may be unreliable and may not identify types of mold that are particularly hazardous.

Ways to prevent mold growth in your home:

- Control moisture problems inside your home.
- Keep humidity levels at 30 – 50% by using an air conditioner or dehumidifier to remove excess moisture in the air.
- Install and use exhaust fans in the kitchen and bathrooms.
- Check for leaks and moisture around sinks and tubs.
- Do not use carpets in bathrooms or in damp basements.

If there is mold growth in your home:

- Fix moisture or water leakage problems.
- Remove mold growing on hard surfaces by using a detergent or soapy water solution and a sponge or rag.
- Consider removing and discarding porous materials (such as carpet and ceiling tile) that are contaminated with mold.

Appendix F: Session Two Lesson Plan

Daily Lesson Plan

Teacher: Sara Kuner **Lesson Date:** February 2020
Subject: Session Two

CCSS/CLGs/SC Assessment Limits/Standards: *(What are the skills being taught? Which standards are being specifically addressed in this lesson?)* 1) Improve caregiver awareness of environmental health 2) Reduce exposure to pollutants	**Agenda:** *(What is the snapshot of my class flow?)* Review radon and carbon monoxide levels, allergen triggers, secondhand smoke, and pesticide exposure as common environmental health concerns in the home.
Lesson Objective: *(What will my students KNOW by the end of the lesson? What will they DO to learn it?)* Assess caregiver awareness of factors that influence indoor air quality related to radon and carbon monoxide levels, allergen triggers such as mold and secondhand smoke, and pesticide exposure after the implementation of a two-session educational program. Assess the intention of caregivers to implement action steps to reduce exposure to indoor pollutants.	

TIME	INSTRUCTIONAL SEQUENCE	FORMATIVE ASSESSMENT Note: A variety of formative assessments should be used at key points throughout the lesson.
5 min	**Get started/Drill/Do Now:** *(What meaningful activity will students complete as soon as they enter the classroom?)* • Introduction to DNP Student	
5 min	**Assessment Prior to Educational Intervention:** *(How will I know if students have achieved today's objective?)* • Administration of Pre-test	Assess basic knowledge of indoor air quality
20 min	**Whole Group Instruction:** *(Focus lessons [explicit teaching/modeling, strategy demonstration, activate prior knowledge], shared reading, shared writing, discussion, writing process.)* • Review fact sheets for secondhand smoke and pesticide exposure • Demonstrate setup and use for radon test kit and carbon monoxide test kit • Discuss mattress and pillow allergen cover • Review cost analysis of household items	
5 min	**Group Practice/Small Group Instruction:** (teacher-facilitated group discussion, student or teacher-led collaboration, student conferencing, re-teaching or intervention, writing process) • Facilitate discussion regarding material for indoor air quality	Call on participants to share their learning from activity and ask remaining questions
5 min	**Evaluate Understanding/Assessment:** *(How will I know if students have achieved today's objective?)* • Administration of Post-test	
5 min	**Closing Activities/Summary:** *(How will I tie up loose ends, reinforce/revisit the objective and connect the lesson to the unit?)* • Thank participants for attendance and raffle	

Resources/Instructional Materials Needed: *(What do I need in order to teach the lesson?)* Radon test kit (5) Carbon monoxide test kit Mattress and pillow allergen cover

Structure	Strategies Included in the City School/ Model of Highly Effective Literacy Instruction – English 9-12		
Whole Group	-Anticipatory guides/sets -Close Reading -Text annotation	-Book/author talks -Questioning the Author (QtA) -Think aloud	-Cornell Notes -Question-Answer-Relationships (QAR) -Think/Pair/Share
Guided Practice/Small group	-Anticipatory guides/sets -Close Reading -Question-Answer-Relationships (QAR) -Strategy groups -Think/Pair/Share	-Book/author talks -Literature Circles -Reading conferences -Text annotation -Writing Conferences	-Cornell Notes -Questioning the Author (QtA) -Reciprocal teaching -Think aloud
Independent Practice	-Anticipatory guides/sets -Close Reading -Question-Answer-Relationships (QAR) -Strategy groups -Think/Pair/Share	-Book/author talks -Literature Circles -Reading conferences -Text annotation -Writing Conferences	-Cornell Notes -Questioning the Author (QtA) -Reciprocal teaching -Think aloud

Appendix G: Secondhand Smoke Fact Sheet

Secondhand smoke **exposure among babies and children can cause:**

- **Sudden Infant Death Syndrome** (SIDS)
- **Lung problems**
- **Ear infections**
- **Asthma attacks**

Secondhand smoke **exposure among adults can cause**:

- **Heart disease**
- **Stroke**
- **Lung Cancer**

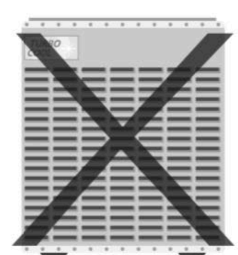
Did You Know?

Secondhand smoke can travel through doorways, cracks in walls, electrical lines, ventilation systems and plumbing.

Only 100% smokefree indoor air fully protects from secondhand smoke exposure.

Opening windows

using fans



heating, air conditioning and ventilation systems

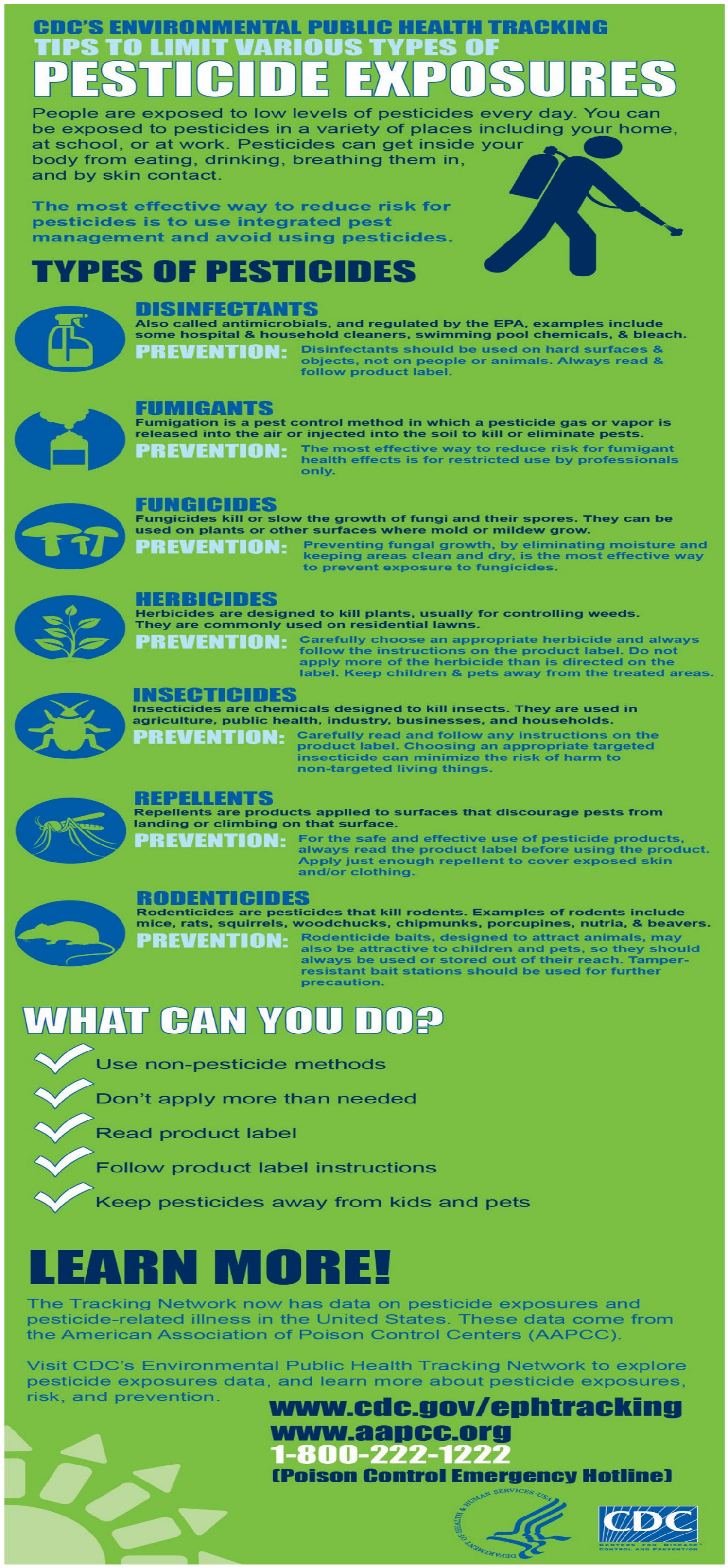
cannot eliminate **exposure to secondhand smoke.**

In fact, these systems can distribute secondhand smoke throughout a building.

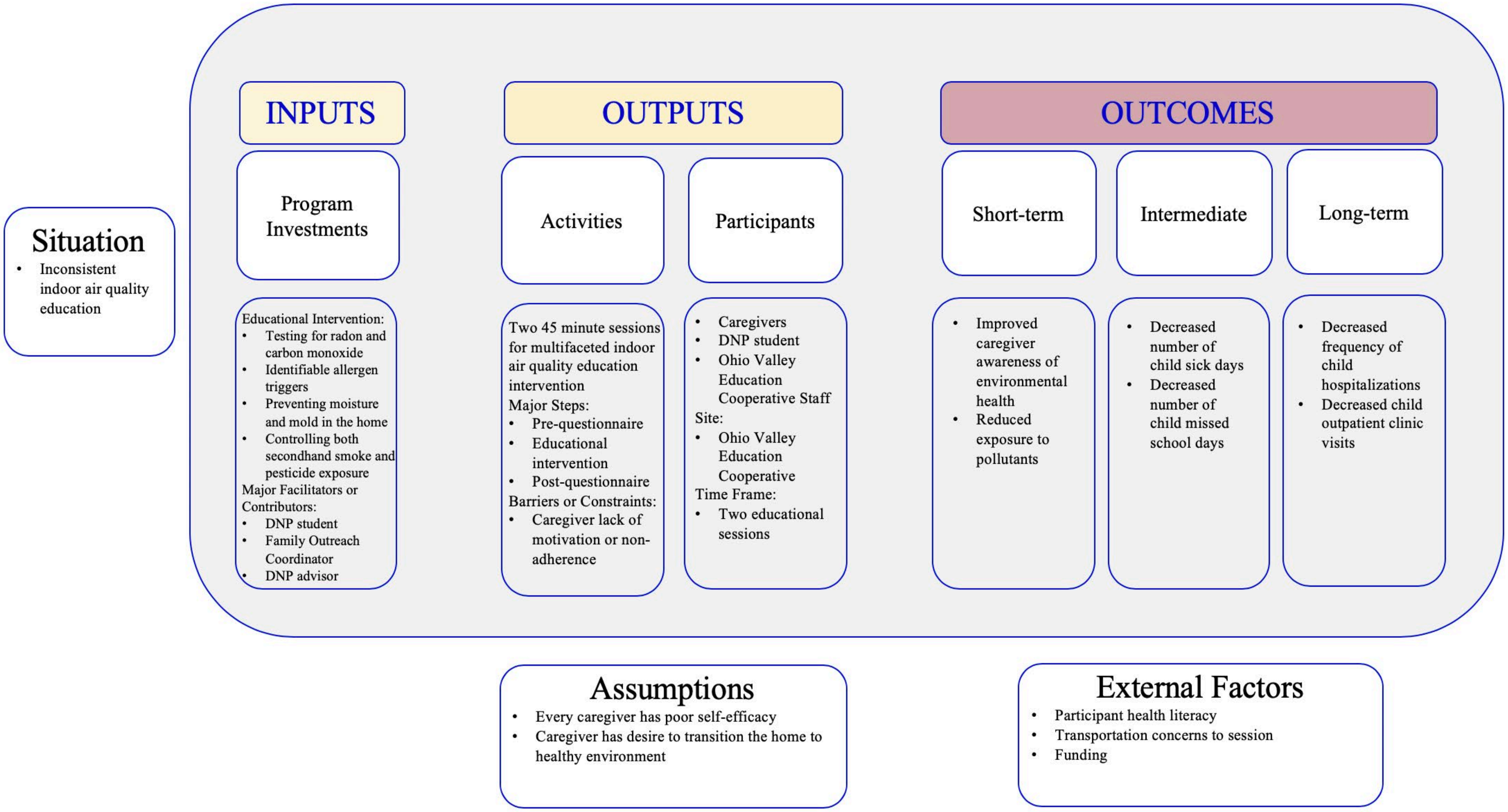
CDC
U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

www.cdc.gov/tobacco
Print Only

Appendix H: Pesticide Exposure Fact Sheet



Appendix I: Logic Model



Appendix J: Gantt Chart

Project Activity	Aug 2019	Sept 2019	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	June 2020	July 2020	Aug 2020
Proposal Development													
Obtain Measurement Tool													
Capstone Proposal Defense													
IRB Approval													
Assemble Science Take-Out Community Environmental Health (CEH) Kit													
Assemble Sample Toolkit													
Project Session 1													
Pre-Test													
Post-Test													
Project Session 2													
Pre-Test													
Post-Test													
Analyze Data													
Prepare Final Report													
Develop Final Poster													
Disseminate – Poster Session													

Appendix K: Predicted Budget

Resource	**Qty**	**Cost**
Science Take-Out Community Environmental Health (CEH) Kit		
Pre-Test Sheets	50	$0.50
Carbon Monoxide Fact Sheet	50	$0.50
Radon Fact Sheet	50	$0.50
Mold Fact Sheet	50	$0.50
Post-Test Sheets	50	$0.50
Assemble Sample Toolkit		
Pre-Test Sheets	50	$0.50
Secondhand Smoke Fact Sheet	50	$0.50
Pesticide Exposure Fact Sheet	50	$0.50
Radon Test Kit	5	$0.00
Cardon Monoxide Test Kit (Home Depot)	2	$18.00
Mattress Allergen Cover (Home Depot)	2	$46.00
Pillow Allergen Cover (Home Depot)	2	$60.00
Cost Analysis of Household Items Sheet	50	$0.50
Post-Test Sheets	50	$0.50
TOTAL		**$129.00**