

Assessing the effectiveness of cleaning for lead dust and communicating results on family cleaning patterns

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There were two purposes for this study. The first purpose of the study was to determine whether participants' cleaning behaviors changed after the two cleaning visits or through knowledge of pre-cleaning dust lead levels to post-cleaning dust lead results. The second purpose was to determine if dust lead results were reduced after cleaning. Six Crawford County families consented to participate in the study, which consisted of dust lead testing in their home, two cleaning visits, administration of an oral open-ended questionnaire, and a follow-up phone call. *Healthy Homes-Healthy Children (HHHC)* research associates tested each of the residents' homes for lead prior to the intervention. During the first visit I performed a "deep cleaning" in the home. Two weeks after the first visit I conducted a second "general cleaning." One week after the second visit researchers re-tested all homes in the study for lead, and administered an oral open-ended questionnaire to the head of the household containing questions related to current and future cleaning routines. After the third visit, letters indicating lead results were mailed to families sharing before and after cleaning dust lead levels. Finally, a follow-up phone call was made to families to determine if the change in lead levels motivated cleaning behavior change. Analysis of responses to the questionnaire revealed that all six participants reported they would maintain current cleaning practices after the cleaning visits. However, after mailing the letters indicating lead results and making a follow-up phone call to families, five of the six subjects indicated the lead results motivated them to make behavior change in their cleaning methods and frequency.

Keywords. Healthy home, cleaning, dust, lead, behavior change

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1.0 Introduction

People spend approximately 90% of their day indoors, including home, school, and work (Lupoli et al., 2009; Srinivasan et al., 2003; Kegler et al., 1999). Of that 90%, people spend on average at least 60% of each day in their own home (Lupoli et al., 2009; Kegler et al., 1999; "Connection," 2009). According to the United States census projections, the United States has more than 130 million family homes that are part of the built environment ("Home," 2011). For public health reasons, the quality of the built environment is currently a large topic of interest as it has been outlined by a number of individuals and groups, including the U.S. government. Within the United States, the most significant public health accomplishment during the twentieth century was reducing the number of infectious diseases (Larson et al., 2001). Some of the infectious diseases that were reduced have been attributed to a better built environment (Larson et al., 2001). Healthy People 2010, an American health initiative, include the United States environmental health goal to, "promote health for all through a healthy environment" (Friis, 2007). The environment people live in is linked to outcomes of families' health. By creating a healthy home, human illnesses and diseases should continue to decrease (Srinivasan et al., 2003; Jacobs, 2006; Nir et al., 2008).

Because people spend a large amount of their time indoors, they are exposed to confined and concentrated environmental health hazards. Top home health risk factors that need to be addressed in the United States include personal home hygiene and sanitation, poor indoor air quality, chemical toxins, moist environment conditions, and lead poisoning (Klitzman et al., 2005; Breysse et al., 2004; Srinivasan et al., 2003; Sandbeck, 2006; Krieger et al., 2005; Delaney, 2009; Nir et al., 2008; "Connection," 2009; Lupoli et al., 2009; Campbell et al., 2003; Landrigan et al., 2008; Keall et al., 2008). Such exposure can result in people experiencing adverse health outcomes such as allergies, asthma, respiratory illnesses, damaging effects to the nervous system, reproductive system, and mental development (Klitzman et al, 2005; Mahon, 1997; Kegler et al., 1999). Behavior and choices also contribute to exposure levels, as inadequate cleaning impact hazards present in the home environment. Inadequate cleaning can harm people's health by being exposed to environmental risk factors within the home, over the long term (Klitzman et al., 2005).

Because children spend the majority of their first years indoors, they are greatly affected by the quality of the home environment and are most susceptible to illnesses and diseases in the environment around them (Gavigan, 2008; Landrigan et al., 2008; Friis, 2007; "Connection," 2009; Nir et al., 2008; Breysse et al., 2004, Krieger et al., 2002; Smallin, 2006; "R & S," 2009; Imus, 2007; Sandbeck, 2006). Of the top health risk factors, children are most susceptible to lead exposure. The most common source of lead poisoning among children comes from lead based paint (Kegler et al., 1999; Ewers et al., 1994; Jacobs et al., 2002; Mahon, 1997; Brooten et al., 2008). Lead poisoning has damaging effects to the nervous system, reproductive systems, and mental development (Mahon, 1997; Kegler et al., 1999). Lead was banned from paint in 1978 (Campbell et al., 2003; Ewers et al., 1994). However, a significant number of United States homes today still contain lead based paint. Sixty percent of homes built before 1979 contain lead and 90% of homes built before 1940 contain lead (Kegler et al., 1999). Maxwell (2009) writes, "…it was believed that children were exposed to lead in paint mostly by eating chips of paint or gnawing on furniture, toys, or windowsills. This exposure indeed occurs, but later research indicated that most of children's exposure to lead paint occurs through the incidental ingestion of house dust indoors…" Children have a high rate of hand to mouth behaviors where they can acquire lead through touching lead contaminated objects and putting their hands in their mouth after touching the affected area. Once lead is ingested, lead blood levels rise (Rust et al., 1999). Wet cloth cleaning is an effective counter-measure for reducing lead dust (Ewers et al., 1994; "Household," 2005; Landrigan et al., 2008; Friis, 2007; Noyes, 2009). This typical scenario suggests residential lead abatement activities should include wet cloth cleaning in areas where children frequently play. Studies focus on rural and low-income communities throughout the United States because people are less likely to own newer homes or have the money to professionally remediate the home environment (Levy et al., 2006; Jacobs et al., 2007; Krieger et al., 2005). It is estimated that three to four million children in the United States have elevated blood lead levels, affecting children in all geographic locations (Mahon, 1997). Many parents do not recognize lead poisoning as a leading health concern (Mahon, 1997). Of those participants that noted lead poisoning as a leading problem, only 15% of the population surveyed by Mahon (1997) recognizes lead paint dust as a source for lead poisoning. Lead poisoning and asthma are two leading sources of childhood illness in the United States (Klitzman et al., 2005; Krieger, 2005).

Many homes are contaminated with invisible air pollutants that are present in multiple forms including: dust mites, tobacco smoke, toxic cleaning, mold spores, and volatile organic compounds (Breysse et al., 2004; Sublett et al., 2010; Lupoli et al., 2009; Krieger et al., 2005; Levy et al., 2006; Srinivasan et al., 2003; Landrigan et al., 2008; Jacobs et al., 2007; Loftness et al., 2007). Mold spores are one of the greatest factors contributing to allergies and asthma (Somerville et al., 2000). Moisture and mold are common risk factors contributing to poor health including allergies and asthma (Maxwell, 2009; Gaitens et al., 2009; Sandel et al., 2004). Mold is an indoor air polluter if it is not monitored and eliminated. Clean and dry home environments eliminate most harmful mold spores from developing (Klitzman et al., 2005; Loftness et al., 2007). Exacerbating the problem of toxins, cleaning products contain harsh, toxic chemicals negatively affecting families' health (Breysse et al., 2004; Loftness et al., 2007; Srinivasan et al., 2003; Krieger, 2005; Noyes, 2009; Gavigan, 2008; Delaney, 2009; "R&S," 2009; Smallin, 2006; Landrigan et al.,2008; Berthold-Bond, 1990; Imus, 2007). Using toxic-free chemicals reduces incidences of eye, skin, or respiratory irritation while cleaning ("Greening," 2010). Therefore, human health can improve by creating or maintaining proper home hygiene using "green," toxic-free cleaning products to improve the home environment.

Human behaviors play a role in health outcomes. One model for behavioral change includes the Health Belief Model (HBM). The HBM is a widely used theory among human health educators (Turner et al., 2004). Health behaviors can play a role in reducing or eliminating disease. However, personal perception of the severity of disease also affects the course of action families take upon making change. With the explanation of the HBM, people can learn how human behaviors can help families reduce or eliminate disease. There are four main points that create the Health Belief Model; "perceived seriousness, perceived susceptibility, perceived benefits, and perceived barriers" (Turner et al., 2004; Jordan et al., 2007). The suite of factors alone or combined can be used in analyzing how humans react to different diseases and perceived severity of disease (Turner et al., 2004). Along with the four main factors, three other points have been added to the model, which include "cues to action, motivating factors, and self-efficacy" (Turner et al., 2004).

Perceived seriousness is one's belief regarding the severity of the disease, which is information that is typically built on medical data or common knowledge. House cleaning is not

a highly discussed topic among families in our society. An individual perceives the severity of a disease by the effects the disease will have on their life and the effect on those lives around them (Turner et al., 2004). Many families do not focus on house dust as a main source of exposure of lead in their children's blood.

Perceived susceptibility is one's belief of the chances of acquiring an illness or disease. Many people believe that only children who eat lead paint chips get lead poisoning. Perceived susceptibility is influential when a family tries to reduce the risk of a disease (Turner et al., 2004). When families do not see immediate effects resulting from change in risk factors, they typically continue with unhealthy behaviors (Turner et al., 2004). There is a lack of incentive to clean if home environments are not recognized as an immediate threat. When perceived seriousness and susceptibility are combined, only families with high risk appear to make change (Turner et al., 2004). Turner et al. (2004) write, "People tend to adopt healthier behaviors when they believe the new behavior will decrease their chances of developing disease." Making changes in behavior is particularly difficult in reducing an individual's perception of barriers that exist (Turner et al., 2004; Kegler et al., 1999).

Healthy Homes – Healthy Children (HHHC) is a comprehensive community-based outreach program that addresses environmental health issues with families to create a safe and healthy home environment. This group focuses on supporting families in northwestern Pennsylvania to improve their families' health by encouraging a clean home environment. *HHHC* was established in 2007 and is based at Allegheny College, in Meadville, PA. *HHHC* provides free in-home testing for lead, mold, and radon. The non-profit group conducts educational outreach through community events and local public elementary school visits to raise awareness on environmental health topics. This group also educates the public about hygiene techniques that will turn local homes into healthy and safe environments for families to live, develop, and thrive.

Because 80% of homes in Crawford County were built prior to 1978, there was a need for environmental home testing to educate the public on the severity of disease and how to create easy, low-cost strategies to improve the problem ("Home" 2011). The first phase of the *HHHC* program included finding baseline data to assess whether lead was a key concern in this rural, low-income region. Forty-nine in-home dust lead tests have been conducted since 2007. *HHHC*

has found 41% of homes that were tested had at least one dust sample exceed the U.S. Department of Housing and Urban Development (HUD) and Environmental Protection Agency (EPA) threshold standards.

Creating and maintaining a clean home environment is essential for high-quality health and reducing or eliminating disease (Collins, 2007; Chaudhuri, 2004). If environment conditions are not favorable to early childhood development, then children can suffer adverse health effects including illnesses and disease (Haas, 2008; Bland et al., 2005; Stewart and Rhoden, 2006). Studies have found a strong correlation between children's health status and adult health outcomes (Haas, 2008; Fasulo et al., 2007). Completing cleaning visits provides participants with the knowledge of how to create a clean home. There are barriers between knowledge and carrying out cleaning behaviors.

HHHC previously tested homes for lead and wrote a letter summarizing the lead result for the highest floor and windowsill sample. After receiving feedback from families, *HHHC* recognized the need to educate families on how to make effective change in their home. This led to my senior thesis where I entered six *HHHC* participant homes three times: cleaning twice, testing for dust lead levels, administering an oral open-ended questionnaire, writing a letter indicating lead results, and making a follow-up phone call to families to determine if cleaning behavior changed. I am attempting to improve home environments by cleaning the home environment, which could in turn reduce related illnesses and diseases.

There were two purposes for this study. The first purpose of the study was to determine whether participants' cleaning behaviors changed after the two cleaning visits or through knowledge of pre-cleaning dust lead levels to post-cleaning dust lead results. The second purpose was to determine if dust lead results were reduced after cleaning.

2.0 Methods

The Institution Review Board at Allegheny College previously approved multiple home interventions with participants through the *HHHC* program methods. Home interventions contained confidentiality of lead test results between *HHHC* research associates and the subject.

2.1 Participants

Nine residents of Crawford County agreed to participate in the study. All participants were selected from a list of people who have had a *HHHC* home visit within the past year. Three were unable to complete the study: two due to time constraints and one due to financial hardship. Six subjects completed the study.

2.2 Description of the intervention

Each family's head of household consented over the phone to participate in the study, which consisted of lead testing using HUD and EPA protocol, cleaning twice, administration of an oral open-ended questionnaire, writing and mailing a letter indicating lead results, and making a follow-up phone call to families. *HHHC* research associates previously tested each family's home for dust lead levels. During the first visit, "deep cleaning" was performed in the home. Deep cleaning consisted of the following: washing walls and windows, vacuuming carpeted surfaces, sweeping and mopping uncarpeted floors, and dusting horizontal surfaces with moistened paper towels. Two weeks after the initial visit I conducted a second "general cleaning." General cleaning consisted of all of the above except washing the walls and windows. Cleaning supplies were left with the participant after the second visit. One week after the second visit, I re-tested for dust lead levels in each home, and administered an oral open-ended questionnaire to the head of the household. Participant responses were summarized in written form. Dust lead samples were paired with original sample sites to compare pre to post dust lead results. The results were summarized in a letter indicating change between before cleaning and after cleaning dust lead results and was mailed to families. A follow-up phone call was made to each family to determine if the letter containing lead levels before and after the cleaning visits changed the family's cleaning behavior. I cleaned three of the six homes alone, while the other three homes were cleaned with the help of a small group of student volunteers.

2.3 Cleaning tools

Cleaning materials for each visit included a step ladder, fan, four buckets, a mop, a broom, a dust pan, a high efficiency particulate air (HEPA) filtered vacuum, sponges, garbage bags, gloves, cleaning cloths, paper towels, concentrated Simple Green all purpose cleaning solution, a labeled plastic spray bottle to mix the solution, Palmolive Pure and Clean dish

detergent, Windex glass cleaner, and Clorox disinfecting bathroom cleaner. All products used were toxic-free, except the Clorox bathroom cleaner.

2.4 Cleaning methods

Before cleaning, rooms and cleaning tasks were prioritized based on frequency of room use. Rooms that were used more frequently by children were highly prioritized, and rooms that were not heavily used were lower priority. During the first cleaning visit "deep cleaning" was performed. Deep cleaning tasks were prioritized following the pattern of: vacuuming or sweeping, washing walls, windows, surfaces, vacuuming or sweeping again, then mopping or hand washing hard floors. Deep cleanings ranged from an hour and half to six hours, time increased with a greater number of rooms.

When vacuuming, the height of the vacuum was adjusted to accommodate carpet height or uncarpeted floors. The vacuum hand piece was used to vacuum stair corners between wall trim and the carpet. When sweeping, loose dirt and garbage was gathered into a pile with the broom before brushing it into the dustpan. A hot soapy water mixture was made in the buckets to dampen a wall cleaning cloth. Windows and mirrors were washed using Windex and paper towels. Horizontal hard surfaces including: kitchen counters, sinks, dining room tables, end tables, and entertainment systems were wiped with the Simple Green solution and paper towels. A hot soapy water mixture was made to use for mopping or hand washing hard floors. Bathroom toilets and sinks were sprayed with the Clorox disinfecting bathroom cleaner and then were wiped with paper towels. Two weeks after the first cleaning visit, researchers conducted a second, "general cleaning." The general cleaning consisted of all of the above except washing the walls and windows. General cleanings ranged from forty-five minutes to two and a half hours, time increased with a greater number of rooms. I chose not to follow EPA and HUD lead cleaning methods because they used toxic cleaners and their cleaning methods were not practical for people to follow on a regular basis (Dixon, n.d.; "Laboratory," 2010).

2.5 Lead sampling and processing

Lead testing materials included Pampers Kandoo aloe free baby wipes, HUD and EPA approved windowsill and floor area forms, five, fifty-milliliter plastic tubes, masking tape, permanent markers, and *HHHC* home lead sample site sheets to record data. HUD and EPA

protocol was used to test for dust lead samples during the *HHHC* intervention, prior to cleaning visits, and again during the third home visit to re-test the dust for lead to determine change ("Lead speak," 2010; "Lead-based," 1997). Five samples were collected prior to the deep cleaning and five samples were collected at the third home visit. HUD and EPA protocol was also used to prepare samples for the Perkin Elmer Aanalyst 700 atomic absorption spectrometer ("Lead speak," 2010; "Lead-based," 1997; "Residential," 2010). Letters were written to families indicating lead results before and after the cleanings.

2.6 Data analysis

Study analysis was conducted on responses to the administered questionnaire, dust lead results and follow-up phone call conversations. Analysis was determined based on change in dust lead results from before cleaning to after cleaning and according to responses on current cleaning frequency and practices. Analysis of change in dust lead levels were assessed by subtracting pre dust lead results from post results in each sample site. Percent change, floor sample averages, and windowsill sample averages were calculated overall for each home result. I administered an oral open-ended questionnaire to the head of the household at the third home visit (Appendix 1). Questions included past cleaning habits, frequency, cleaning intervention effectiveness, future cleaning methods and frequency, easiest cleaning task, most challenging cleaning task, cleaning responsibility, outsourcing cleaning tasks, and barriers to cleaning.

3.0 Results

3.1 Lead dust results

The change in lead levels, percent change, and number of samples above HUD and EPA standard threshold (>40 $\mu g/ft^2$ floor, and >250 $\mu g/ft^2$ windowsills) were analyzed. Four of the six homes exceeded HUD and EPA standard threshold prior to the intervention (Table 1). Samples of lead in the dust floor samples prior to the intervention ranged from 12 $\mu g/ft^2$ to 2030 $\mu g/ft^2$ (Table 1). Samples of the lead in the dust windowsill samples prior to the intervention ranged from 14 $\mu g/ft^2$ to 154 $\mu g/ft^2$ (Table 1). One of the four homes exceeded HUD and EPA standard threshold after the cleanings (Table 1). The samples of lead in the dust floor samples after the cleaning visits ranged from 14 $\mu g/ft^2$ to 465 $\mu g/ft^2$ (Table 1). The samples of lead in the dust windowsill samples after the cleanings ranged from 10 $\mu g/ft^2$ to 50 $\mu g/ft^2$ (Table 1). All elevated

dust samples were sampled from the floors (>40 µg/ft^2) (Table 1). Ten paired sample sites indicated a small increase in dust lead levels.

Table 1. Dust lead levels change between before and after cleaning.

ID	Sample	Floor or window sample	Lead in dust prior to intervention *(µg/ft2)*	Lead in dust post-intervention *(µg/ft2)*	Net change	% change	exceeded HUD standards prior to intervention *(>40 µg/ft2 floor, and >250 µg/ft2 windowsill)*	exceeded HUD standards post-intervention *(>40 µg/ft2 floor, and >250 µg/ft2 windowsill)*
Participant 1	D1A	F	19.85	18.65	-1.2	-6.05%		
	D2A	F	32.25	31.95	-0.3	-0.93%		
	D3A	F	20.25	24.2	3.95	19.51%		
	D4A	F	57.5	21.45	-36.06	-62.71%	**X**	
	D5A	F	18.55	21.7	3.15	16.98%		
	average	F	29.68	23.59	-6.092	-20.53%		
Participant 2	D1A	F	12.15	30.1	17.95	147.72%		
	D2A	F	15.5	16.95	1.45	9.35%		
	D3A	W	18	19.75	1.75	9.72%		
	D4A	F	22.35	14.45	-7.9	-35.35%		
	D5A	F	14.5	20.55	6.05	41.72%		
	average	F	16.13	20.51	4.38	26.87%		
	average	W	18	19.75	1.75	9.72%		
Participant 3	D1A	F	54.75	36.4	-18.35	-33.52%	**X**	
	D2A	F	65.05	27.7	-37.35	-57.42%	**X**	
	D3A	W	14.1	23.15	9.05	64.18%		
	D4A	W	37.9	33.35	-4.55	-12.01%		
	D5A	F	17.7	30.2	12.5	70.62%		
	average	F	45.83	31.43	-14.4	-31.42%		
	average	W	26	28.25	2.25	8.65%		
Participant 4	D1A	W	154.2	38.85	-115.35	-74.81%		
	D2A	F	63.25	34.2	-29.05	-45.93%	**X**	
	D3A	W	31.65	20.15	-11.5	-36.33%		
	D4A	F	64.25	25.85	-38.4	-59.77%	**X**	
	D5A	W	48.35	35.1	-13.25	-27.40%		
	average	F	63.75	30.03	-33.72	-52.89%		
	average	W	78.06	31.37	-46.69	-59.81%		
Participant 5	D1A	W	31.9	50.15	18.25	57.21%		
	D2A	W	14.55	13.8	-0.75	-5.15%		
	D3A	W	24.45	10.9	-13.55	-55.42%		
	D4A	W	24.9	14.75	-10.15	-40.76%		
	D5A	W	28.95	19.95	-9	-31.09%		
	average	W	24.95	21.91	-3.04	-12.18%		
Participant 6	D1A	W	31.6	7.85	-23.75	-75.16%		
	D2A	W	20.65	11.85	-8.8	-42.62%		
	D3A	W	19.6	26.9	7.3	37.24%		
	D4A	F	2034	465.2	-1568.8	-77.13%	**X**	**X**
	D5A	W	79.8	22.45	-57.35	-71.87%		
	average	F	2034	465.2	-1568.8	-77.13%		
	average	W	37.91	17.26	-20.65	-54.47%		

3.2 Statistical significance

SPSS, a statistical computer software program was used to determine significance by using paired t-test methods. There was no significant difference in pre and post dust lead levels from windowsill samples ($p=0.087$), floor samples ($p=0.297$), and a combination of windowsill and floor samples ($p=0.228$), $p > 0.05$. Ten paired samples indicated no change or a small increase in lead (Table 1).

3.3 Oral open-ended questionnaire

I administered an oral open-ended questionnaire to each participant at the third home visit. First, participants were asked to talk about their past cleaning methods and habits. All six subjects included dusting as a main practice (Table 2). Five of the six participants stated they vacuumed regularly (Table 2). Three of the six verbalized that they mopped (Table 2). One of the six included they do the dishes and take out the trash as their cleaning methods (Table 2). Additionally, one answered that they de-clutter their house in their regular cleaning methods, and one stated they clean the sinks and toilet when performing their regular cleaning routine (Table 2).

Table 2. Questionnaire of participants' perceptions and cleaning behaviors.

Question	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6
past cleaning methods	dust and vacuum	dust, vacuum, mop	dust, vacuum, mop	dishes, taking out trash, dust	dust, vacuum, sinks, toilet, windows	dust, vacuum, mop, pick up
frequency	2 times/week	1 time/week	1 time/week	1 time/week	1 time/week	2 times/week
cleaning intervention effective	yes	yes	yes	yes	yes	yes
future cleaning methods	maintain	maintain	maintain	maintain	maintain	maintain
frequency	2 times/week	1 time/week	1 time/week	1 time/week	1 time/week	2 times/week
easiest cleaning task	sweeping	sweeping	picking up	dishes	dusting	vacuuming
most difficult cleaning task	deep cleaning	scrubbing shower	deep cleaning	sweeping	vacuuming	dishes
cleaning responsibility	everyone in household	self	everyone in household	self/woman's job	self	everyone, especially parents
if could have regular cleaning by someone else	yes	yes/no	yes	yes	no	yes
barriers	time	time	time	laziness	none	time and 4 young children

3.3.1 Cleaning frequency

Four of the six participants replied they conduct their cleaning practices once a week (Table 2). The two other subjects said that they clean twice a week (Table 2).

3.3.2 Cleaning effectiveness

All participants said the cleaning intervention was effective, many commenting on how much they appreciated the deep cleaning to reach a baseline cleanliness level (Table 2). All subjects stated that they do not deep clean as often as they desire. Efforts washing walls and windows to eliminate dust and marks off the walls was appreciated by each family to complement regular cleaning practices (Table 2). All six participants answered they would not make behavior change and would maintain their prior cleaning practices (Table 2).

3.3.3 Difficulty level of cleaning tasks

Three of the six participants claimed vacuuming, one stated picking up, one said doing the dishes, and one suggested dusting (Table 2). When asked the most difficult cleaning task to perform, two claimed deep cleaning, two said vacuuming, one declared doing the dishes, and another affirmed scrubbing the shower was the most difficult task (Table 2).

3.3.4 Cleaning responsibility

While everyone at some point mentioned cleaning responsibility was the occupants of the home, some listed a particular person within the household. Three of the six participants stated that the responsibility of cleaning was everyone's job, even the children who get smaller tasks (Table 2). The three others said it was the woman's role (Table 2). Two of these participants were single females the only ones to claim responsibility (Table 2). The other participant was a male who thought cleaning was a woman's job. However, he claimed he had to do it himself or it would not be performed since he was divorced (Table 2).

3.3.5 Outsourcing

Four of the six participants said they would appreciate the effort and time they would save by outsourcing cleaning tasks (Table 2). The two other people said, while cleaning would

be less individual work, they, one, would not want to spend the money on outsourcing and, two, they would clean their home before the cleaner arrived, defeating the purpose (Table 2).

3.3.6 Barriers

Three of the six said time was their greatest barrier (Table 2). One stated that they were being honest but affirmed laziness (Table 2). One mentioned she watches and cares for so many young children that she does not have the time to clean as frequent and as detailed that she would like (Table 2). The last participant verbalized she faced no barriers to cleaning (Table 2). This participant lives alone and says she makes cleaning part of her weekly routine.

3.4 Phone call

After lead samples were analyzed and letters indicating lead results were mailed, I made an additional phone call to all families asking whether the letters indicating lead results affected their behavioral patterns. All four people that had dust lead levels exceed HUD and EPA standards said they increased the frequency and refined cleaning methods to include wet wiping. One of the two participants that did not have dust lead levels exceed HUD and EPA standards said she did not make behavior change based on the results of the letter. The other subject said, while she did not change her cleaning behaviors for the entire house, she made targeted cleaning tasks part of her change in cleaning methods. She elaborated that dust lead levels were higher near her front door. So, she has focused on having her children take their shoes off when entering the house, and mopping the area more frequently.

4.0 Discussion

4.1 Cleaning effectiveness

Even though all six participants were aware of the effects that their home environment had on their families' health, my cleaning visits were not effective in making behavior change among families. All six participants claimed they dusted as a regular house-cleaning task and performed this task at least once a week which was clearly not occurring. Receipt of misinformation during a survey is not uncommon as Berger (2005) claims that individuals will use their "pleasing false self" as a way "to impress others." False self is defined as "a set of behaviors that is adopted by a person to combat rejection, to please others or to try out as a

possible self" (Berger, 2005). The responses that were received from the oral open-ended questionnaire raises a question of whether the responses that were reported were true self-reports or false self-reports. Since most homes did not appear clean at my visits, the validity of the responses that were received raises questions to the accuracy of responses for each family. False self-reports may be avoided in future efforts by not conducting the questionnaire orally, by making reports anonymous, by creating a scale with long time intervals in between reports and cleanings (cleaning one time a month, cleaning one time every two to three months, cleaning one time every six months, cleaning one time a year), or by using a recall method. However, given the nature of the study, it is possible that questionnaire methods are not able to account for accurate data.

While all six participants claimed cleaning at least one time a week, other studies suggest that frequent cleanings are challenging to sustain. Kegler (1999) found that low to moderate levels of behavioral patterns were changed after the intervention. Jordan et al. (2007) suggest that the amount of effort and people's unpleasant feelings towards strategizing change is enough to overwhelm people, which led to no change in behavior. Studies have concluded cleaning immediately decreased dust levels, however, dust re-accumulated three to six months after because appropriate cleaning techniques were not sustained by people's behavioral patterns (Campbell, 2003; Lanphear et al., 1999).

Studies suggest that frequent cleaning including wet mopping and wet dusting contributed to a significant reduction in dust lead levels (Campbell et al., 2003; Noyes, 2009; Delaney, 2009; Breysse et al., 2004; Farfel et al., 1994). I anticipated that cleaning techniques including mopping and wet dusting should have been beneficial in reducing toxic dust. Through this study, I was surprised to find the lack of statistical significance of the cleaning effectiveness. The lack of statistical significance could be influenced by the date of the pre dust test or other confounding factors. Since homes enlisted in the study were tested within the past year; this variable could influence the change in dust levels since the pre-test. In future home visits, I would recommend testing during the initial visit to gain consistent baseline data for each family.

It is also important to highlight that three of the EPA and HUD high-risk homes showed reduction in lead dust levels from the cleaning visits, but these data were not statistically significant. Additionally ten paired dust sample sites were not reduced from the cleaning visits.

This could suggest that there are other sources of active lead contamination including carpets, furniture, and toys. In order to reach statistical significance in other comparative studies, I would increase the sample size.

4.2 Behavior change

After cleaning and administering the oral open-ended questionnaire on subjects' cleaning behaviors, methods, and frequency, this study suggests improved behavior change is hard to implement. All participants expressed they would "maintain their current cleaning methods and frequency." People's cleaning decisions were based not knowing the change from pre-cleaning to post-cleaning dust lead results. Decisions were based only on their experiences of having their home cleaned.

It is important to recognize that this study method design included an oral open-ended questionnaire. Questions were asked based on generalizing families own perceptions of their cleaning methods and frequency. Since false self-reports are used among people to "impress or please others," I would recommend using a recall method in future studies to validate participant's behavior. Using the generalized cleaning questions may have skewed results from the questionnaire. Those that used false self-report are more likely to over state their cleaning commitments (Rubin and Babbie, 2010). People typically have trouble recalling general information, such as cleaning (Rubin and Babbie, 2010). This produces misleading results because people forget small details. While it is hard for people to remember when and how they cleaned, I would recommend having participants record their cleaning methods and frequency for a week to see if the same results were produced from the oral open-ended questionnaire.

After receiving the follow-up letter with the pre-cleaning lead levels and the change in the dust levels that resulted from cleaning, five of six participants said they changed their cleaning behaviors. The participants of all four homes that exceeded HUD and EPA standards before cleaning said they changed the frequency and methods of how they cleaned after receiving the letter summarizing dust lead results. All participants stated that they now dust with a wet cloth. Other studies suggest caregivers are only motivated if they feel they can conquer a beneficial task in timely manner (Pampel et al., 2010). Use of health knowledge should affect health behavior (Pampel et al., 2010). Similar studies suggest that dust sampling is performed to

distinguish the potential exposure that children have to lead from dust present in their home over a period of time (Lanphear et al., 1999; Tibbetts, 2002).

Four participants indicated that time was a barrier to cleaning their home on top of work and caring for their children. Perceived barriers influence people's decisions on making behavior change (Turner et al., 2004). Since the deep cleaning ranged from an hour and a half to six hours, some participants highlighted cleaning for that length of time is not possible with their current cleaning practices, even if cleaning is only performed a couple times a year. This same group also observed that it took me a time range from forty-five minutes to two hours to perform a general cleaning in their home. Families, again, suggested this was too much time to take from their weekly schedule. Jordan et al. (2007) suggests implementing simple, easy, fun, and appealing tasks among the engaged participants to maintain interest and drive for effective behavior change.

Four of the six participants in this intervention mentioned putting off some, if not all, cleaning tasks because they knew I was coming to clean for them. This suggests the demand for maximizing limited time. The demand capability claim suggests as the number of rooms and extensiveness of tasks increase, the number of domestic services that are outsourced increases, too (de Ruijter et al., 2005). Some people claimed the amount of effort involved in cleaning and frequency contributed to individual's views in denying a health problem, busyness, lack of motivation and sense of control, as well as a weak social support system between family members and cultural practices (Jordan et al., 2007).

Jordan et al. (2007) also suggest some cleaning practices and cleaning overall led to unpleasant feelings toward strategies of cleaning regularly. Studies have suggested when people feel overwhelmed nothing happens behaviorally to make the needed change (Jordan et al., 2007). Subjects' schedules and taking time to raise their children conflicted with cleaning as frequent as desired (Jordan et al., 2007). Jordan et al. (2007) highlight one of their participants saying, "One can't keep cleaning the house all the time. Children are very messy. The house gets dirty again as soon as you clean it." Families shared similar comments that cleaning is a never-ending task.

Four of six participants suggested they would benefit from a house cleaner on a regular basis. However, other barriers including reliability and financial means hindered families from outsourcing their cleaning tasks. Interestingly, cleaning for the cleaner is viewed as labor, but cleaning for the homemaker or homeowner/renter is viewed as unpaid leisure (Collins, 2007).

When outsourcing work, the homeowner/renter thinks cleaning should be done cheap because it would otherwise be done by the wife or homeowner/renter. These tasks often go unnoticed and unrecognized (Collins, 2007).

Even though five of the six participants said they have made behavior change after receiving the letter indicating lead results, other studies have focused on change between cleaning intentions and cleaning behavior change. Mahon (1997) found that participants in their study had intentions to make change, but did not make the behavior change. This suggests that there are other factors, if any that contribute to families making behavior change.

One of the two participants that did not have dust lead levels exceed HUD and EPA standards stated they did not change their cleaning behaviors after receiving the letter indicating dust lead results. The other subject stated while she did not change her cleaning behaviors for cleaning the entire house, she changed spot cleaning methods by encouraging her children to take their shoes off when entering the house and mopping more frequently. Interestingly, Collins (2007) explains when a person cares for someone they care about taking appropriate steps to make sure their well being and comfort levels are accounted for. People that live alone still clean their homes. Many participants suggested their motivating factor for cleaning regularly was their children's health. However, this statement did not echo change in participants' behaviors after the cleaning visits, but did resonate the statement after receiving the letter indicating lead results. "Cleaning is thought of as essential for survival" (Collins, 2007). The definition of clean has been socially defined by, "society, class, gender, race, religion, and advertising" (Collins, 2007).

4.2.1 Factors contributing to willingness to change

The only way for families to know the consequences of poor health and the benefits of behavior change is to educate families and communities at large. Communities with older homes, which have a higher frequency of lead exposure, should be targeted directly (Bland et al., 2005; Hood, 2003). *HHHC* participants are educated on lead and the effects lead can have on health during the initial testing visit. Typical education strategies include emphasizing regular, effective house cleaning to remove leaded dust, good nutrition to lower lead absorption, and hand washing to lower lead intake (Bland et al., 2005; Kegler et al., 1999). However, there is a missing link between knowing the information and putting the information to use in behavior patterns. This study suggests the cleaning visits were not effective in making participant behavior change after

the cleaning visits. However, families indicated they would change their cleaning patterns after receiving the letter summarizing lead results.

This suggests that there are variables that attribute to effective change. In this study, cleaning was not enough to initiate effective change. However, the combination of the cleanings and the letter was enough for families to indicate that they were making cleaning behavior changes. In addition, I was accepted into homes because I share many values with family members. Some of the values that I shared with families included living in a rural community, sharing a similar culture and life experiences. Having these connections allowed families to share extensive information and stories with me though conversations at each visit.

4.2.2 Baseline cleaning patterns

It is important to highlight that the definition of cleaning varies from family to family. Some families included dusting and vacuuming in their cleaning methods, another it meant washing dishes and taking out the trash, and to another cleaning included scrubbing toilets and sinks. Cleaning can be performed to different degrees, because there is not one way to clean. Cleaning has not been taught in a class at school or at a job. Most people's cleaning exposure has been through cleaning they have seen performed in their home or another home while growing up. Consequently, "cleaning" to a degree sufficient to eliminate leaded dust may appear to be "much more" work than a half hour spent tidying toys or washing dishes.

4.2.3 Barriers to cleaning

Common barriers to cleaning participants listed during the oral questionnaire included: time, laziness, and having numerous children present. Studies have suggested to overcome barriers, families need to strongly believe the benefits of change outweigh the price of old behaviors (Turner et al., 2004; Kegler et al., 1999). Modifying variables including culture, skill, educational level, and experiences affect personal perception on the health disease and how to overcome the challenges associated with it (Turner et al., 2004; Kegler et al., 1999). Sociological trends, such as events, people, or objects, influence families' behavior patterns (Turner et al., 2004). This was demonstrated through participants' behavior change after receiving the letter indicating lead results. People typically only make change if they see perceived benefits and are determined to make the change (Turner et al., 2004). Five of the six subjects saw the benefit of

the cleaning visits after receiving their letters summarizing lead results, which prompted families to promise to make behavior change.

Another person identified with gender ideology theories, believing that cleaning is a women's job. Many studies have suggested gender plays a large role in which sex performs the vast majority of household tasks (Nakhaie, 2009; Poortman and Van Der Lippe, 2009). Gender role is more highly suggestive when determining household cleaning tasks than the socioeconomic status, available time, number and presence of children, age, and racial status (Nakhaie, 2009). Domestic tasks, including house cleaning, are often felt by women as unclear and unnoticeable work. "…more traditional gender role attitudes tend to feel higher levels of gratitude than those with more liberal attitudes" (Yun-Suk and White, 2010). Because typically women spend more time in the home environment than men, women are faced with gender imbalance in housework (Ruppanner, 2010; Poortman and Van Der Lippe, 2009). Men and women's contributions to cleaning are affected by education level, employment hours, gender ideology, enjoyment, standards, and responsibility and attitude levels (Poortman and Van Der Lippe, 2009).

One subject's barriers to cleaning included laziness and not having a functional vacuum. The lack of self-worth could suggest a mental illness. Another participant is a full time college student, and works full time on top of being a mom. One of the participants said she makes time each week to clean. She lives alone, having fewer distractions with no children or large immediate family to care for, other than when family and grandchildren visit. The final participant indicated because they have many children and live in a small house; it is hard to get cleaning done consistently.

4.3 Confounding Factors

There are a number of confounding factors that could have influenced the results of my study. Highlighting the validity of families' cleaning routines prior to the home visits is important because without accurate information it is difficult to target cleaning methods and techniques appropriately. It would also be important in future studies to use a recall method of past cleaning habits without generalizing them. For example, in the future I would have families

complete a journal for a week's worth of tasks that they performed. This method can reduce the number of false self-reports.

It is important to focus on other variables that were not studied to examine the impact and accuracy of the results. One variable includes at least two families had a young child that was diagnosed with elevated blood lead levels. The questionnaire did not include blood lead testing. Nonetheless, families may have been motivated to make behavior change with information from their physician stating that their children had elevated blood lead levels. This variable alone, or with the cleaning visits and letter summarizing lead results could have affected families cleaning behavioral patterns.

Another important variable is access to effective cleaning materials. One participant stated that they did not have a working vacuum cleaner, nor did they have the money to buy one. Not having the right resources limited their cleaning ability. Additionally, families' perception of time affects their cleaning behaviors. Families stated that if they had more time they would be able to clean more frequently. Therefore, implementing easy and fun tasks is important for effective behavior patterns and prioritizing time and energy to clean (Jordan et al, 2007).

If perceived seriousness and susceptibility were emphasized to a greater degree then more families would feel inclined to make changes in their home (Turner et al., 2004). As found in the Seattle-King County Healthy Homes Project, community health workers educated and supported behavior change for families to reduce asthma triggers in participants homes (Krieger et al., 2005). Krieger et al. (2005) targeted multiple triggers in homes to attempt to make effective change among families. Nearly nine million kids under the age of 18 have been told they have asthma and 434,000 children under the age of six have been diagnosed with lead poisoning (Gould, 2005). The acute manner in which asthma as a disease is manifested compared to the more hidden learning disabilities and other neurological impacts that develop over time from repeated low-dose lead exposure may make asthma appear to be more of a serious problem than lead poisoning. If asthma is perceived to be more serious than lead poisoning then families may have a greater concern for contracting the illness, which could influence the actions that they take to reduce their risk.

Finally, mental health could affect the behavior of parents, which in turn affects their motivation to clean. This is demonstrated through the oral open-ended questionnaire and raises the question of self-worth when one participant claimed laziness is a barrier. Lack of self-worth leads to less motivation to complete tasks (Crocker, 2002) People do not adopt goals based on their self-esteem rather they adopt goals based on "something greater than their self" (Crocker, 2002). For example, those that focus on "contributing to others" feel less susceptible to the negative effects related to low self-esteem (Crocker, 2002). Crocker (2002) writes, "It's about having a goal that is bigger than the self." Many untreated mental health conditions, such as a major depressive disorder, can paralyze individuals into inaction. In the Crawford County region, mental health conditions, particularly among high-risk low-income populations is high and few mental health practitioners exist ("2011 Crawford," 2011).

4.4 Study limitations

There are limitations to the study. Six out of nine people completed the home cleaning visits. Due to the involvement of the three-time intervention model and the time commitment needed, even an engaged population had a high participation turnover rate. However, a 67% response rate may be considered reasonable when other studies ranged from 32%-75% (Kegler et al., 1999).

4.5 Recommended next research steps

Since there were a number of confounding factors that played a role in the results of the study, future studies could improve research methods by: testing for lead initially at the first cleaning visit, measure the effectiveness of using a vacuum cleaner, use a recall method for questionnaires, and having families test for blood lead levels before and after the cleaning visits. There were at least two fa

milies that had children with elevated blood lead levels. While I did not measure if doctor visits testing for blood lead levels were motivating factors, I would include testing blood lead levels in children before and after cleaning interventions in the future to see if blood lead levels are reduced and if behavior change is affected by medical information.

In addition, future studies could include demographic analysis on one factor including effective de-cluttering methods, income levels, stress levels, gender ideology theories, and educational levels on cleaning behavioral patterns and change. Another important future study could include a similar research design to target a different illness. For example, study asthma to see if perceived seriousness and perceived susceptibility are greater which could in turn affect cleaning behavior patterns. Finally, three of the six homes participants rented. The other three participants owned their homes. Interestingly, the three homeowners were couples, and the three renters were single parents. Future studies should be conducted to determine if cleaning behaviors are influenced by the number of adults contributing to cleaning within the household, ownership status, and/or presence of children with diagnosed lead or asthma.

4.6 Recommended next steps for HHHC

Since cleaning is an appropriate mechanism to improve human health, I would recommend *HHHC* to use the Health Belief Model to communicate perceived seriousness, perceived susceptibility, perceived benefits and perceived barriers to families. The first approach with families should include trying to eliminate the exposure, whether that is lead, mold or radon. If the exposure mechanism cannot be reduced, then I would recommend trying to reduce the exposure. For example, since lead cannot be completely eliminated through cleaning, I would recommend encouraging wet mopping and dusting and washing children's hands frequently. Kegler et al. (1999) concludes wet dusting is the household cleaning task that has greatest perceived benefit. If families cannot find effective ways to reduce the exposure of risk factors, then they should find other ways to try to reduce the exposure without cleaning. For example if cleaning is not possible for families then they should try to eliminate exposure of absorbing ingested lead. To do this parents can encourage their children to eat iron, calcium, and vitamin-C rich foods or take a multi-vitamin ("Lead and," n.d.). Identifying future risks and emphasizing hypothetical long-term health outcomes will be essential in instilling knowledge and motivating cleaning behaviors (Jordan et al., 2007).

Additionally, it is important to communicate with families easy and fun tasks to perform since there is not one right way to clean. Also some families are not willing or able to clean to the level that reduces or eliminates related illnesses. Recommendations I would suggest for *Healthy Homes-Healthy Children* to promote during family home visits includes, child hand

washing, damp cloth dusting and mopping, annual blood lead tests, repainting, and finding safe areas for a child to play are potential strategies in reducing the levels of lead exposure (Kegler et al., 1999).

To improve families' behavioral patterns, I recommend *HHHC* research associates to encourage basic cleaning during home visits. To reduce childhood exposure, I would use targeted cleaning strategies with families. For example, I would recommend families to implement their cleaning methods focused on one or two rooms that are heavily used by their children. This will take less time for families to reach a level of clean, instead of cleaning the entire house. After mastering this, families can then accomplish other rooms and rotate them on a cleaning schedule based on room use.

Since it is difficult to get people to change cleaning behaviors, I would recommend targeting another mechanism to reduce poisonings. For example, if a family is not willing or able to clean frequently then they should try to complement minimal cleaning by giving children more iron, calcium, and vitamin-C in their diet. This may appear to be easier for families, reducing the time it takes to clean.

Finally, I would recommend *HHHC* to encourage families to play with their children outside as frequent as they can instead of playing inside. According to the National Wildlife Federation, "the average American boy or girl spends just four to seven minutes in unstructured outdoor play each day, and more than seven hours each day in front of an electronic screen" ("Be," n.d.). When children play outdoors, their physical activity increases, which contributes to healthier people and healthier bodies ("Be," n.d.). Exposing children to the natural environment has been suggested to reduce ADHD symptoms and other health illnesses ("Be," n.d.). With reducing exposure to indoor home environments, children's stress levels decrease, and playing outside "protects children's emotional development whereas loss of free time and a hurried lifestyle can contribute to anxiety and depression ("Be," n.d.). Creating opportunities for families to make behavior change to achieve a healthier, cleaner, and safer way of living is challenging but rewarding over the course of a lifetime if achieved and maintained frequently (Hendrickson, 2008; Chaudhuri, 2004).

References

2011 Crawford, Pennsylvania. (2011). Retrieved April 11, 2011, from http://www.countyhealthrankings.org/pennsylvania/crawford.

Be out there: National wildlife federation.(n.d.). Retrieved April 5, 2011, from http://www.nwf.org/Get-Outside/Be-Out-There/Why-Be-Out-There/~/media/PDFs/Be%20Out%20There/MindBodySpirit_FactSheet_May2010.ashx.

Berger, K. S. (2005). *The developing person through the life span.* p.386. Worth Publishing.

Berthold-Bond, A. (1990). *Clean & green : The complete guide to nontoxic and environmentally safe housekeeping* (1st ed.). Woodstock, N.Y: Ceres Press.

Bland, A. D., Kegler, M. C., Escoffery, C., & Malcoe, L. H. (2005). Understanding childhood lead poisoning preventive behaviors: The roles of self-efficacy, subjective norms, and perceived benefits. *Preventive Medicine: An International Journal Devoted to Practice and Theory, 41*(1), 70-78.

Breysse, P., Farr, N., Galke, W., Lanphear, B., Morley, R., & Bergofsky, L. (2004). The relationship between housing and health: Children at risk. *Environmental Health Perspectives, 112*(15), pp. 1583-1588.

Brooten, D., Youngblut, J. M., Royal, S., Cohn, S., Lobar, S. L., & Hernandez, L. (2008). Outcomes of an asthma program: Healthy children, healthy homes. *Pediatric Nursing, 34*(6), 448-455.

Campbell, C., Schwarz, D. F., Rich, D., & Dockery, D. W. (2003). *Effect of a follow-up professional home cleaning on serial dust and blood lead levels of urban children.*

Chaudhuri, N. (2004). Interventions to improve children's health by improving the housing environment. *Reviews on Environmental Health, 19*(3-4), 197-222.

Collins, G. (2007). Cleaning and the work-life balance. *The International Journal of Human Resource Management, 18*(3), 416-429.

The connection between health and housing - national healthy homes training center and network. (2009).

Crocker, J. (2002). Self-esteem that's based on external sources has mental health consequences. *American Psychological Association, 33*(11), 16. Retrieved from http://www.apa.org/monitor/dec02/selfesteem.aspx.

de Ruijter, E., Treas, J. K., & Cohen, P. N. (2005). *Outsourcing the gender factory: Living arrangements and service expenditures on female and male tasks.*

Delaney, K. (2009). *Clean home, green home: The complete illustrated guide to eco-friendly homekeeping*. Guilford, Conn: Knack.

Dixon, S. L., Tohn, E., Rupp, R., & Clark, S. (n.d.) How much cleaning is enough? an evaluation of alternative post-lead hazard intervention cleaning procedures. http://www.nchh.org/LinkClick.aspx?fileticket=gEgJEzOFIME=&tabid=233

Ewers, L., Clark, S., Menrath, W., Succop, P., & Bornschein, R. (1994). Clean-up of lead in household carpet and floor dust. *American Industrial Hygiene Association Journal, 55*(7), 650-657.

Farfel, M. R., Lees, P. S., Rohde, C. A., Lim, B. S., Bannon, D., & Chisolm, J. J.,Jr. (1994). Comparison of a wipe and a vacuum collection method for the determination of lead in residential dusts. *Environmental Research, 65*(2), 291-301.

Fasulo, A., Loyd, H., & Padiglione, V. (2007). Children's socialization into cleaning practices: A cross-cultural perspective. *Discourse & Society, 18*(1), 11-33.

Friis, R. (2007). *Essentials of environmental health.*

Gaitens, J. M., Dixon, S. L., Jacobs, D. E., Nagaraja, J., Strauss, W., Wilson, J. W., et al. (2009). Exposure of U.S. children to residential dust lead, 1999-2004: I. housing and demographic factors. *Environmental Health Perspectives, 117*(3), 461-467.

Gavigan, C. (2008). *Healthy child healthy world.*

Gould, E. (2005). Children's lead poisoning and asthma. Retrieved from http://epi.3cdn.net/4be09d422e9794d8d2_s4m6b95l7.pdf.

Greening your purchase of cleaning products: A guide for federal purchasers. (2010). Retrieved March 9, 2011, from http://www.epa.gov/epp/pubs/cleaning.htm.

Haas, S. (2008). Trajectories of functional health: The 'long arm' of childhood health and socioeconomic factors. *Social Science & Medicine, 66*(4), 849-861.

Hendrickson, S. G. (2008). Maternal worries, home safety behaviors, and perceived difficulties. *Journal of Nursing Scholarship, 40*(2), 137-143.

Home ownership. (2011). Retrieved March 10, 2011, from http://www.census.gov/multimedia/www/radio/black_history_month/black-15.php.

Hood, E. (2003). Economics of enforcement. *Environmental Health Perspectives, 111*(13), A692.

Household dust contains significant levels of 35 toxics.(2005, March 23). *Greenwire.*

Imus, D. (2007). *Greening your cleaning*. New York, NY: Simon & Schuster.

Jacobs, D. E. (2006). A qualitative review of housing hazard assessment protocols in the United States. *Environmental Research, 102*(1), 13.

Jacobs, D. E., Clickner, R. P., Zhou, J. Y., Viet, S. M., Marker, D. A., Rogers, J. W., et al. (2002). The prevalence of lead-based paint hazards in U.S. housing. *Environmental Health Perspectives, 110*(10), A599-606.

Jacobs, D. E., Kelly, T., & Sobolewski, J. (2007). Research - Built Environment - linking public health, housing, and indoor environmental policy: Successes and challenges at local and federal agencies in the United States. *Environmental Health Perspectives : EHP, 115*(6), 976.

Jordan, C. M., Lee, P. A., Olkon, R., & Pirie, P. L. (2007). Messages from moms: Barriers to and facilitators of behavior change in a lead poisoning preventive education project. *Journal of Health Communication, 12*(8), 771-786.

Keall, M. D., Baker, M., Howden-Chapman, P., & Cunningham, M. (2008). Association between the number of home injury hazards and home injury. *Accident Analysis & Prevention, 40*(3), 887-893.

Kegler, M. C., Malcoe, L. H., Kegler, S. R., Lynch, R. A., & Tolliver, R. (1999). Caregiver beliefs and behaviors in the prevention of childhood lead poisoning. *Family & Community Health: The Journal of Health Promotion & Maintenance, 22*(1), 50-65.

Klitzman, S., Caravanos, J., Belanoff, C., & Rothenberg, L. (2005). A multihazard, multistrategy approach to home remediation: Results of a pilot study. *Environmental Research, 99*(3), 294-306.

Krieger, J. W., Takaro, T. K., Song, L., & Weaver, M. (2005). The Seattle-King County healthy homes project: A randomized, controlled trial of a community health worker intervention to decrease exposure to indoor asthma triggers. *American Journal of Public Health, 95*(4), 652.

Krieger, J., Takaro, T. K., Allen, C., Song, L., Weaver, M., Chai, S., et al. (2002). Housing forum - the Seattle-King County healthy homes project: Implementation of a comprehensive approach to improving indoor environmental quality for low-income children with asthma. *Environmental Health Perspectives.Supplements, 110*(2), 311.

Laboratory study of lead-cleaning efficacy.(2010). April 2, 2011. http://www.epa.gov/lead/pubs/clean.htm.

Landrigan P.J., Needleman H.L., Landrigan M. (2008). *Raising healthy children in a toxic world.*

Lanphear, B. P., Howard, C., Eberly, S., Auinger, P., Kolassa, J., Weitzman, M., et al. (1999). *Primary prevention of childhood lead exposure: A randomized trial of dust control.*

Larson, E. L., Gomez-Duarte, C., Qureshi, K., Miranda, D., Kain, D. J., & Cablish, K. L. (2001). How clean is the home environment?: A tool to assess home hygiene. *Journal of Community Health Nursing, 18*(3), 139-150.

Lead and a healthy diet. (n.d.) Retrieved April 5, 2011, from http://www.epa.gov/lead/pubs/nutrition.pdf.

Lead speak - homes and communities - U.S. Department of Housing and Urban Development. (2010). Retrieved March 1, 2011, from http://www.hud.gov/offices/cpd/affordablehousing/training/web/leadsafe/leadspeak.pdf.

Lead-based paint and soil-metals survey. (1997). Retrieved March 1, 2011, from http://yosemite.epa.gov/r10/cleanup.nsf/4ca19ed6a0fe79d588256ec90061cea7/559663270b69278488256be60057aea6/$FILE/lbpsurv.PDF.

Levy, J. I., Brugge, D., Peters, J. L., Clougherty, J. E., & Saddler, S. S. (2006). A community-based participatory research study of multifaceted in-home environmental interventions for pediatric asthmatics in public housing. *Social Science & Medicine, 63*(8), 2191.

Loftness, V., Hakkinen, B., Adan, O., & Nevalainen, A. (2007). Elements that contribute to healthy building design. *Environmental Health Perspectives, 115*(6), 965-970.

Lupoli, T. A., Ciaccio, C. E., & Portnoy, J. M. (2009). Home and school environmental assessment and remediation. *Current Allergy and Asthma Reports, 9*(6), 419-425.

Mahon, I. (1997). Caregivers' knowledge and perceptions of preventing childhood lead poisoning. *Public Health Nursing, 14*(3), 169-182.

Maxwell, N. I. (2009). *Understanding environmental health: How we live in the world*. Boston, MA, US: Jones and Bartlett Publishers.

Nakhaie, M. R. (2009). Professors, ideology and housework. *Journal of Family and Economic Issues, 30*(4), 399-411.

Nir, S., Firestone, A., Leroux, S., Rey, E. and Living Series (Directors). (2008). *Green cleaning for a healthy home.*[Video/DVD] Toronto, Canada: The Living Series Ltd.

Noyes, A. K. (2009). *Nontoxic housecleaning*. White River Junction, Vt: Chelsea Green Pub.

Pampel, F. C., Krueger, P. M., & Denney, J. T. (2010). Socioeconomic disparities in health behaviors. *Annual Review of Sociology, 36*(1), 349-370.

Poortman, A., & Van Der Lippe, T. (2009). Attitudes toward housework and child care and the gendered division of labor. *Journal of Marriage and Family, 71*(3), 526-541.

R & S Information LLC. (2009). *Healthy baby happy home: Create a safe green home for your baby, be green on a budget baby guide* (1st ed.). Minneapolis, Minn: Two Harbors Pr.

Residential lead hazard standards - TSCA section 403. (2010). Retrieved March 9, 2011, from http://www.epa.gov/lead/pubs/leadhaz.htm.

Rubin, A., Babbie E.R. (2010). *Essential research methods for social work*. p.231 (Second Edition ed.). Belmont, CA: Brooks/Cole.

Ruppanner, L. E. (2010). Cross-national reports of housework: An investigation of the gender empowerment measure. *Social Science Research, 39*(6), 963-975.

Rust, S. W., Kumar, P., Burgoon, D. A., Niemuth, N. A., & Schultz, B. D. (1999). Influence of bone-lead stores on the observed effectiveness of lead hazard intervention. *Environmental Research, 81*(3), 175-184.

Sandbeck, E. (2006). *Organic housekeeping: In which the nontoxic avenger shows you how to improve your health and that of your family while you save time, money, and perhaps your sanity*. New York: Scribner.

Sandel, M., Phelan, K., Wright, R., Hynes, H. P., & Lanphear, B. P. (2004). The effects of housing interventions on child health. *Pediatric Annals, 33*(7), 474-481.

Smallin, D. (2006). *Cleaning: Plain & simple*. North Adams, MA: Storey Pub.

Somerville, M., Mackenzie, I., Owen, P., & Miles, D. (2000). Housing and health: Does installing heating in their homes improve the health of children with asthma? *Public Health, 114*(6), 434-439.

Srinivasan, S., Dearry, A., & O'Fallon, L. R. (2003). Reviewing the evidence- creating healthy communities, healthy homes, healthy people: Initiating a research agenda on the built environment and public health. *American Journal of Public Health, 93*(9), 1446.

Stewart, J., & Rhoden, M. (2006). Children, housing and health. *International Journal of Sociology and Social Policy, 26*(7-8), 326-341.

Sublett, J. L., Seltzer, J., Burkhead, R., Williams, P. B., Wedner, H. J., & Phipatanakul, W. (2010). Air filters and air cleaners: Rostrum by the American academy of allergy, asthma & immunology indoor allergen committee. *The Journal of Allergy and Clinical Immunology : Official Organ of American Academy of Allergy, 139*(1), 32.

Tibbetts, J. (2002). Buildings awareness of the built environment. *Environmental Health Perspectives, 110*(11), A670-3.

Turner, L., Hunt, S., DiBrezzo, R., & Jones, C. (2004). Health belief model. Jones and Bartlett Publishers, LLC.

Yun-Suk, L., & Waite, L. (2010). How appreciated do wives feel for the housework they do? 91 (2).

6.0 Appendix 1

Oral open-ended questionnaire

1. What were your past cleaning methods and frequency?
2. Were the two cleaning visits effective?
3. What are your intentions for future cleaning methods and frequency?
4. What is the easiest cleaning task for you?
5. What is the most difficult cleaning task for you?
6. Do you face barriers to cleaning? If so, what are those barriers?
7. Who is responsible for cleaning?
8. If you could outsource cleaning on a regular basis, would you?