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Does the Type of Housing a Child Lives in Predict Blood Lead Level?

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Abstract

Background and Significance: Childhood lead exposure continues to be a global health problem that can compromise children's long-term health. Identifying factors that predict which children may be at the highest risk of exposure is a strategy that could help focus child lead surveillance. Lead is a natural element found in small amounts in the earth's crust and has been widely used in industry and consumer products since the time of the Romans. Lead, however, is highly toxic for humans and serves no biological purpose in the human body. There is substantial evidence that, even at the lowest levels of exposure, lead is especially harmful to young children. Because not all children can be tested, identifying factors that predict which children are at greatest risk can help focus surveillance of smaller high risk subgroups. Downtown neighborhoods in El Paso, Texas provide an opportunity to begin to better understand factors that predict risk of early child lead exposure. Similar to many cities nationwide, children living in downtown El Paso, Texas are at higher than average risk of early lead exposure, for reasons that are not well understood. Some have suggested that children living in rental properties may be at increased risk of lead exposure as compared to those who live in family-owned homes. This possibility needs to be tested.

Aim: The aim of this study was to experimentally test the suggestion that children living in rental properties are at greater risk of lead exposure.

Hypothesis: Children who live in rental properties have higher blood lead levels (BLLs) than children who live in owner-occupied properties.

Methods: Participants were recruited through public schools and community events, and by parent self-referral. This study included 92 children, 40 boys and 52 girls, between 1 and 12 years of age, living in downtown neighborhoods; 50 lived in rental properties and 42 lived family-owned homes. In homes with more than one child, all children were tested, and the child with the highest current BLL was included for these analyses. Because BLL was not normally distributed, non-parametric tests (Kruskal-Wallis) were used for group comparisons. Chi-square test was used for exploratory analyses that compared the frequencies of children with and without lead exposure, with regard to selected demographic variables.

Results and Conclusions: In this sample of 92 children, property type did not predict child BLL. Interestingly, in exploratory analyses, other possible predictive factors were tested and revealed that children from mothers with less than a high school education had significantly higher BLLs. The finding that children from mothers with lower educational levels needs to be explored further.

Recommendations: All children deserve to live in a healthy environment. Children are not able to speak for themselves and preventative programs can help to protect these vulnerable members of our communities. Further studies and preventative programs are needed.

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Introduction

1.1: Background and Significance

Lead is a naturally occurring element found in small amounts in the earth's crust (Committee on Environmental Health, 2005). Lead is toxic to humans, animals, and other living organisms and serves no purpose in the human body. Amounts of lead can be found in the air, water, food, dust, and soil (Committee on Environmental Health, 2005). Lead can enter the body through ingestion, inhalation, and absorption of lead dust particles (Azadani, 2018). Lead is toxic to humans because lead mimics calcium (Aizer et al., 2018). When lead is ingested or inhaled, the cells absorb lead in the same way that they absorb calcium. As lead is absorbed in the cells, lead interferes with normal cell functions that depend on calcium. Lead can interfere with body systems including the renal system, endocrine and cardiovascular systems, reproductive system, and the central nervous system (Aizer et al., 2018).

There is a substantial amount of evidence-based literature that supports the idea that lead exposure is harmful to young children. Previous studies have shown that most of the chemical forms of lead poisoning in children affect various organ systems, for example, the liver, kidneys, lungs, brain, muscles, spleen, and heart. It can have the same effects regardless if it is inhaled or ingested (Azadani, 2018). Lead is much harder for a young child than an adult to metabolize, detoxify, and excrete (Landrigan, 2004) and as result, during early brain and nervous system development, children are particularly susceptible to long-term permanent effects of lead poisoning. These effects can include irreversible neurocognitive issues such as, lowered intelligence and increased rates of attention-deficit hyperactivity disorder (Filippelli & Laidlaw, 2010). The child's brain is more vulnerable to lead exposure than the adult brain partly because the blood-brain barrier is believed to be less developed in young children than in adults and since the child's nervous system is still developing in the first few years of life (Aizer et al., 2018).

The main function of the blood-brain barrier is to prevent the passage of harmful substances into the brain that could damage developing brain tissue (Loeffler G. & Hart N. Michael, 2015).

1.2: LITERATURE REVIEW

Blood lead level (BLL) measurements are the primary method for determining the amount of lead exposure the child may have. BLL can also suggest the types of adverse health effects that a child may be experiencing (Hauptman et al., 2017). The amount of lead in blood is represented as micrograms of lead per deciliter of whole blood (µg/dL) (National Center for Environmental Health, 2016). Children with blood lead levels below 5 µg/dL have been shown to exhibit weakened academic performance and problem behaviors (Hauptman, Bruccoleri, & Woolf, 2017). Children with blood lead levels of 5-10 µg/dL can be prone to delayed puberty (in both girls and boys) and reproductive and developmental effects. Children with blood lead levels of 10 to 44 µg/dL have shown to have slower nerve conduction, and decreased hemoglobin production, and anemia (Hauptman et al., 2017). Blood lead levels ranging from 45 to 69 µg/dL produce gastrointestinal effects, triggering abdominal pain, constipation colic, vomiting, and anorexia. Extremely high blood lead levels above 70 µg/dL can generate severe neural effects including convulsions, loss of voluntary control, and death (Hauptman et al., 2017).

Young children are highly vulnerable to lead exposure because they engage in hand-to-mouth exploratory behavior, and also because they play close to the ground where they are susceptible to being exposed to lead dust (Landrigan, 2004). Children with developmental disabilities such as autism spectrum disorder and other neurological syndromes, can be at a higher risk of lead poisoning because they have a higher risk of pica behaviors (Filippelli & Laidlaw, 2010). Pica behaviors are when children eat non-nutritive and non-food substances, for example, soil and paint chips (Koller et al., 2004). Pica can also occur in children with low iron deficiency (Filippelli & Laidlaw, 2010). Children also eat lead-based paint chips because they taste sweet.

Lead exposure among children often continues to cause detrimental health and psychological impacts throughout their developing years. Children who are exposed to lead have a higher risk for juvenile delinquency and criminal behavior (Committee on Environmental Health, 2005). For example, previous studies described behavioral reports from teachers of students with elevated tooth-lead concentrations. Teachers rated these students as being more disorganized, and less able to follow directions as compared to other students with no tooth-lead concentrations. Follow-up studies of these same lead-exposed children showed higher rates of not graduating from high school, reading disabilities, and excess absenteeism (David C. Bellinger, Ph.D, Herbert L. Needleman, M.D., 2003). Also, elevated bone lead concentrations have been linked with aggression and delinquency. In another research study, pre-and post-natal child BLL measurements were associated with self-reported delinquent behavior at 15 to 17 years of age. The study concluded that the effect of lead exposure could be long-lasting and permanent (Committee on Environmental Health, 2005).

As evidence accumulated over the past 7 decades showing the harmful effects in children of lead exposure, the reference level for child “exposure” was gradually lowered from 60 μg/dL in the 1960's, to 30 in 1975, to 25 in 1985, to 10 in 1991, and to 5 μg/dL in 2012. Medical research has shown that toxicological effects exist even in children exposed to lowest levels of lead (Filippelli & Laidlaw, 2010). From the 1990's the CDC has stated that no level of lead exposure is safe for children (Council on Environmental Health, 2016).

The only method for eliminating the effects of lead exposure in children is identifying and removing lead sources and thus stopping children from ever being exposed. The creation of "lead laws" that restricted the use of lead in consumer products in past decades contributed to a significant decrease in the prevalence of childhood lead poisoning from higher levels of exposure among young children in the United States (Committee on Environmental Health, 2005).

A significant source of lead exposure for children before the late 1970's was lead in gasoline and lead in house paint. In 1973, the U.S. Environmental Protection Agency (EPA) began to gradually phase-out the use of leaded gasoline and eventually generated the ban of lead gasoline in 1986 (Kennedy et al., 2016). Lead-based paint was banned from use in 1978. Lead paint laws prohibited the sale of leaded paint and therefore restricted the residential use of lead-based paints. Nonetheless, because of widely available lead-paint surpluses, lead-based paint was used in homes well into the 1990s (Kessler Rebecca, 2014). The Residential Lead-Based Paint Hazard Reduction Act of 1992 states that low-level lead poisoning is widespread among American children. The ingestion of household dust containing lead from deteriorating or abraded lead-based paint is believed to be the most common cause of lead poisoning in children (US EPA, 2013b). The Lead-Based Paint Poisoning Prevention Act (LBPPPA) required inspection and remediation of federally supported pre-1978 housing and all remediation was required to be completed by 1996 (US EPA, 2013b).

Similar to many U.S states, Texas established their own state-based guidelines. On February 19, 1996, the Department of State and Human Services (DSHS), issued the Texas Environmental Lead Reduction Rules (TELRR) (Texas Department of State and Human Services, 2019). The rule pays special attention to "target housing" which applies to child-occupied facilities built before January 1, 1978 (Texas Department of State and Human Services, 2019). The rule defines the training and certification of persons conducting lead-based inspections, risk assessments, abatements, and project design. On April 22, 2008, the Environmental Protection Agency issued a new regulation called Renovation, Repair, and Painting (RRP), which provides guidance for the renovation of residential housing and child-occupied buildings before 1978 (Texas Department of State and Human Services, 2019).

Housing affordability and the environments typically surrounding lower-income housing directly impact children's health. Where a child lives and spends most of their time is an essential element to their growth, development, and well-being (Rogers et al., 2014). Numerous families live in unsafe housing without the knowledge of the possible health hazards that may exist (Cureton, 2011). According to the Environmental Protection Agency (2013), there are still millions of homes that have deteriorating lead-based paint that is hazardous to children and require remediation. Low-income families in particular may have few choices regarding where they can live due to financial struggles. According to the National Center for Children in Poverty (2010), the families of 13 million children in the United States live below the poverty level (Cureton, 2011). Although the federal housing mandate is to affirmatively provide fair housing, most federally assisted housing is located in low-income, isolated areas which are at a higher risk of exposure to lead poisoning (Benfer, 2017).

Disadvantaged children are more likely to live in properties that are located near heavily polluting industries, areas with high traffic volume, contaminated water and soil, and in older housing with deteriorating lead-based paint (Cureton, 2011). Minority children are especially at a higher risk. For example, it was noted that black children are nearly three times more likely than white children to have elevated blood-lead levels (BLLs) (Benfer, 2017). One study found astonishingly high rates of lead toxicity in black and Hispanic neighborhoods. The prevalence rates were 90% of the child populations in these neighborhoods (Benfer, 2017).

Although BLLs have decreased over the past 30 years, approximately 4.5 million households in the United States are vulnerable to high levels of lead exposure; it is currently estimated that half a million-preschool aged children have elevated BLLs (Aizer et al., 2018). Despite decades of efforts and remarkable progress in some regards, the problem of child exposure in America is not yet solved. The only approach to protecting children is the removal of lead sources, including those contributing to lower level exposures. Identifying which children have current exposure and thus which types of housing may be most in need of mitigation, is still a significant problem.

To make improvements in locating children living in housing that exposes them to lead, it is essential to identify specific factors that might be predictive. For instance, low-income populations are disproportionately affected by unhealthy housing (Polletta et al., 2017). HUD policies require surveillance and mitigation for lead hazard exposure sources in HUD-operated housing. Lead remediation regulations for privately-owned rental properties where children reside are far more demanding and expensive than guidelines for private homeowners (HUD.Gov, 2012). The overall costs of renovating large properties are much higher than the cost of renovating a private home. Also, lower-income rental properties draw lower rents leaving fewer funds available to landlords for property upkeep. Moreover, lower-income tenants may have more difficulty keeping up with monthly rental payments requiring landlords to absorb losses that further cut into funds for property improvement (Polletta et al., 2017). Landlords commonly understand they are responsible for healthy housing practices and know their legal responsibility for providing safe housing for families with children (Polletta et al., 2017). Rental payments are a source of income, and due to frustration over tenant behavior, landlords may be unwilling to learn about or consider potentially costly mitigation efforts. For these reasons, non-HUD rental properties may pose much greater risk of child lead exposure than privately-owned residences in lower-income neighborhoods.

1.3: Study Aims and Goals

El Paso Texas is an ideal location to identify specific factors that predict risk of early child lead exposure. Like many cities nationwide, children living in downtown El Paso, Texas are at higher than average risk of early lead exposure. One critical factor is the number of properties built before 1978. For example, in 2016, the recorded number of properties including houses, condos, duplexes, and apartment complexes located within Downtown El Paso, Texas with the zip code 79901 are as follows; built from 1970-1979 (313 units), built from 1960-1969 (654 units), built from 1950-1959 (970 units), built from 1940-1949 (966 units) and built in 1939 or earlier (982 units) (*City-Data.com*, 2019). Many properties have never been tested for lead hazards (US EPA, 2013a). According to HUD lead hazard inspection and assessment guidelines, any property built before 1978 is assumed to have lead-based paint unless it can be proven otherwise.

There are many other potential child lead hazard sources. Border communities with easy access to Mexico may also be at increased risk overall because inexpensive lead-based paint continues to be sold in stores in Mexico and can be brought across the border for use in U.S. homes (Kessler Rebecca, 2014). Furthermore, companies who manufacture toys abroad in countries with no restrictions or regulations on the use of child products have been found to have high lead content. Lead-based paint is cheaper to produce and continues to be used in these products because it reduces overhead costs. Monitoring and controlling toys is very challenging for U.S agencies (Kessler Rebecca, 2014). Culturally traditional items can also be sources of child lead exposure including for example, ceramic pottery and dinnerware with leaded glaze, glassware, and dishes made of leaded glass, imported foods, and candies (Levin Ronnie et al., 2008). Even though traditional pottery imported from Mexico is supposed to be labeled "Lead Free", tests have shown that even these labeled items are unsafe and contain traces of lead (Nutrition, 2010).

To more efficiently identify clusters of homes in need of mitigation and thereby better protect children from lead exposure, it could be essential to determine whether children living in non-HUD rental properties are at higher risk of lead exposure than children living in privately owned homes. If child blood lead levels are predicted by the type of housing the child lives in, this could provide important guidance for cities regarding home mitigation priorities and the allocation of scarce funds.

Methods

It is recognized that children living in lower-income neighborhoods are at a considerably increased threat of early lead exposure (Polletta et al., 2017). To develop effective preventative strategies, the factors that influence this risk need to be better understood. There is limited literature that investigates whether living in a rental property as compared to an owner-occupied property increases the risk of lead exposure in young children. The objective of this study is to examine and compare the blood lead levels (BLLs) of children living in rental and privately owned homes, controlling for the sex and age of children. If the results of this study show significantly higher BLLs among children living in rental properties, this could indicate that implementing lead prevention programs targeting parent renters and landlords is needed. In addition, the findings could all suggest the need for increased outreach and monitoring of children living in rental properties. The methods described are approved by the UTEP Institutional Review Board (Study # 1309985, C. Sobin, PI).

2.1: Hypothesis

Children who live in rental properties have higher blood lead levels (BLLs) than children who live in owner-occupied properties.

2.2: Study Participants

The participants included girls and boys between 1 and 12 years of age, living in downtown, El Paso, Texas, neighborhoods, and residing in either rented or owner-occupied homes. The residences included single or dual-family dwellings, duplexes, or apartments. Children living in homes built before 2001 were included. Participants were recruited through public schools and community events, and by parent self-referral. Parents completed informed consent at the time of recruitment or at the beginning of the first home visit (see below) prior to any data collection.

The sample size included 100 girls and boys, 50 currently residing in rental properties and 50 currently residing in owner-occupied properties. In homes with more than one child, all children were tested and the child with the highest current BLL was included. Children who were unable to provide a finger-stick blood sample and any child who had not resided in their current place of residence for a minimum of one month were not included in the study.

2.3: STUDY DESIGN

A cross sectional 2x2 quantitative study design (Robert H. Friis & Thomas A. Sellers, 2009) was used to compare the blood lead levels (BLLs) of children living in rental and owner-occupied properties, controlling for sex and the age of the child.

2.4: MEASURES

For each child, parents completed a Health and Personal History form. The survey queries basic demographic and health information about the child and family, whether the family lived in a rental or owned property, and if there were any known lead paint hazards on the property. Anthropometric data were also collected for all children including weight, height, hip, and waist measurements, and blood pressure. To determine the child's BLL, a small amount of blood (about 50 microliters) was collected into an EDTA micro-viral using a finger prick method. The participant's blood samples were sent to a collaborating laboratory for analysis of the blood lead using the Inductively Coupled Plasma Mass Spectrometry method (ICP-MS).

2.5: DATA COLLECTION PROCEDURE

Initial child recruitment was conducted through community health fairs. At these events, educational material that provided information about the harmful effects of lead in children was handed out to each booth visitor in the person's preferred language (either in English or Spanish). Research team members explained the goals of the study to parents and when parents were interested, recorded the parent's name, address, zip code, phone number, and permission to call to schedule a future home visit for blood lead level screening. If parents declined, only a name was recorded to track the number of booth visitors during the event.

For the first health fair event, the total number of booth visitors was 74 of whom 55 gave permission for the follow-up contact. At the second health fair event, there were 119 booth visitors of whom 85 gave permission for follow-up contact. Families from these lists were contacted by phone by a team member to schedule the home appointment. Home visits were scheduled during the week after the workday ended, or on the weekends.

Two team members attended each scheduled home visit. Each team member oversaw specific tasks to ensure the appointment was conducted as smoothly as possible and in a timely manner. The first team member began by reviewing the screening process to the parent (s) or legal guardian in their preferred language. The screening process involved gathering anthropometric data and the drawing of a blood sample. All questions and concerns were addressed to ensure the parent(s) or legal guardian understood and were comfortable with the study procedures. The team member clarified that their information is strictly confidential and that the family can opt out of the study at any time. The team member then obtained informed consent from the family, in addition to completing the child assent form. Only after the forms were signed and collected did the second team member begin the screening session.

The first team member initiated the interview process with the parent (s) or legal guardian. The interview consisted of using the household survey (Appendix A) to identify family child demographics, health history, and home characteristics. An example of a survey question is if the parent (s) or legal guardian knows the year when the property was built. Other survey questions included, for example, if there is any visible peeling paint inside or outside the premises, and where in the house or outdoors the child spends most of his/her time.

Simultaneously, the second team member set up a portable lab station that includes a height measuring device, weight measuring scale, blood pressure monitor, measuring tape, and a blood collection tray. That team member designated an adjacent clean workspace that was primarily used for collecting the blood sample from the child. The team member inspected and cleaned the area to reduce contamination from airborne and surface lead. Before moving forward, the team member put on a new pair of disposable latex gloves, and disposing of the gloves that were previously used when cleaning the workspace area. If there is more than one participant, the team member used a new pair of latex gloves for each child seen. The team member collected and recorded the child's weight, height, waist, and hip measurements, and blood pressure. Following the measurements and depending on the age of the child, the team member asked the child to do ten jumping jacks before the blood sample is drawn; this helps reduce the child's nervousness and improves blood flow. If the child is very young, a toy is provided for comfort. The team member asked the child to wash their hands with soap and water, and then used a disposable wipe (D-Wipe Towels, ESCA-Tech Inc., Milwaukee, WI) specially formulated to remove any surface lead. The child's finger was then pricked with a shallow lancet and a small amount of blood (about 50 microliters) was collected into an EDTA micro-viral. After the sample is collected, the team member labelled the micro-viral with the child's identifying study code number and secured the tightly closed sample in the lab tray. Immediately following the home visit, the blood samples were stored at the university lab until they were transported to our collaborating laboratory, for analysis (Kansas State University, Department of Agronomy, Dr. G. Hettiarachchi, laboratory head).

When the session was completed, the team members explained to the parent (s) or legal guardian that when their child's blood lead level (BLL) was analyzed, a follow-up call would be made to schedule a second home visit to deliver the results. The team members thanked the parent (s) or legal guardian for their time and for participating in the study. The team members left a contact number where they could be called if they had any questions. The team members left additional study pamphlets with the parent (s) or legal guardian, so that they may inform others who might be interested in participating. (As part of our larger ongoing study, children's BLLs are monitored every 3 to 4 months).

2.6: STATISTICAL ANALYSIS

All data were entered into an Excel database and double-checked for accuracy as data were collected. The descriptive and inferential analysis were conducted using SPSS. Descriptive statistics were calculated to show the demographic characteristics of the sample. Inferential statistics were used to compare the BLLs of children living in rental and dweller-owned properties, with sex and age added as co-factors. ANOVA were used to test the main effects of dwelling (rental/owned), sex (male/female) and age, and the interaction of (dwelling x sex).

Results

The study included 92 child participants 42 of whom lived in privately owned homes and 50 of whom lived in rental properties. Table 1 shows the clinical and demographic characteristics of the entire sample, and compares the children by type of residence (living in owned vs. rental properties).

The demographic and clinical characteristics were first examined for obvious differences among the two groups of children that might need to be controlled in the primary analysis. With regard to the entire sample of 92 participants, 40 were males (43.5%), and 52 were females (56.5%). Among children living in owner-occupied properties, 21 were male (22.8%) and 21 were female (22. 8%). There was an apparent difference however among the 50 children living in rental properties, in which 19 were male (20.6%), and 31 were female (33.6%). The mean ages of the children living in owned as compared to rental properties were somewhat younger, 6.83 (± 3.95) years as compared to 7.94 (± 3.43) years, respectively. Also, the annual family income for residents of owned as compared to rental properties differed, $17,401 (± 14,028) as compared to $8,245 (± 11,656), respectively. When the annual family income was compared to the calculated poverty limit [$12760 + (4480 * family size)] for the year 2020, it was found that for the 71 families who reported annual income, 67 (94%) were living at or below the poverty line at the time the study was conducted.

As shown in Table 1, the mothers' educational attainment levels differed substantially. Mothers with less than a high school education living in owner-occupied properties were 7.14% (3/42) as compared to mothers living in rental properties of 40% (20/50), respectively. The percentage of mothers with a high school education or who obtained a higher educational degree and living in owner -occupied properties was 80.9% (34/42) as compared to a the percentage of mothers living in rental properties with a high school or more than a high school education, which was 48% (24/50).

Table 1 also shows the mothers' self-identified ethnicity. In owner-occupied vs. rental properties, the distribution of Hispanic/Non-Hispanic mothers differed somewhat. The number of Non-Hispanic mothers residing in owner-occupied properties was 6/42 (14.3%) as compared to 3/50 (6%) Non-Hispanic mothers living in rental properties. The number of Hispanic mothers residing in owner-occupied properties was 36/42 (85.7%) as compared to 47/50 (94%) Hispanic mothers living in rental properties.

Table 1. Household Demographics, Characteristics, and Clinical Blood Lead Levels of Children Residing in Owner-Occupied and Rental Properties N=92

	Owned Property			Rental Property		
Variable	Male (n=21) (22.8%)	Female (n=21) (22.8%)	Total (n=42) (45.6%)	Male (n=19) (20.6%)	Female (n=31) (33.6%)	Total (n=50) (54.3%)
Age *M* (SD)	7.99 (±4.37)	5.69 (±3.18)	6.83 (±3.95)	7.92 (±315)	7.95 (±3.65)	7.94 (±3.43)
BLL *M* (SD)	4.12 (±8.66)	3.25 (±6.12)	3.69 (±7.41)	1.82 (±1.49)	3.94 (±6.03)	3.14 (±4.91)
Family Size *M* (SD)	4.71 (±1.93)	4.48 (±1.40)	4.60 (±1.67)	4.32 (±1.45)	4.42 (±1.52)	4.38 (±1.48)
Annual Income *M* (SD) [a]	14,484 (±13121)[1]	20,109 (±14773.)[2]	17,401 (±14028.)[3]	7,874 (±8236.)[4]	8,502 (±13689.)[5]	8,245 (±11656.)[6]
BLLs Above 5 μg/dL	6/13 (46.15%)		6/13 (46.15%)		7/13 (53.84%)	7/13 (53.84%)
Residence Built Before 1978						
No	8/21 (38.1%)	7/21 (33.3%)	15/42 (35.7%)	6/19 (31.5%)	14//31 (45.16%)	20/50 (40%)
Yes	13/21 (61.9%)	14/21 (66.6%)	27/42 (64.2%)	13/19 (68.4%)	17/31 (54.8%)	30/50 (60%)
Mother's Education						
Less than High School	2/21 (9.52%)	1/21 (4.76%)	3/42 (7.14%)	6/19 (31.57%)	14/31 (45.16%	20/50 (40 %)
High School	3/21 (14.28%)	2/21 (9.52%)	5/42 11.9%)	3/19 (15.8%)	3/31 (9.68%)	6/50 (12%)
More than High School	16/21) (76.1%)	18 /21 (85.7%)	34/42 (80.9%)	10/19) (52.6%)	14/31 (45.2%)	24/50 (48%)
Mother's Ethnicity						
Non-Hispanic	3/ 21 (14.3%)	3/21 (14.3%)	6/42 (14.8%)	2/19 (10.5%)	1/31 (3.23%)	3/50 (6%)
Hispanic	18/21 (85.7%)	18/21 (85.7%)	36/42 (85.7%)	17/19 (89.5%)	30/31 (96.7%)	47/50 (94%)

a. n=71; [1] (Range=4,200-54,000) [2] (Range= 3,000-60,000) [3] (Range=3,000-60,000) [4] (1,200-30,000) [5] (Range=960-72,000) [6] (960-72,000)

Independent sample t-tests (for the continuous variables age and family income) or chi-square tests (for categorical variables sex, education, and whether property was pre-1978) were calculated to determine whether observed differences in age, family income, sex, and the education level of mothers were statistically significant.

With regard to continuous variables (age and family income by type of residence), only the observed difference in annual income for homeowners and renters was statistically significant, t (48) =2.8, p=.007) (Table 2).

Table 2. T-test Comparing Annual Income with Type of Residence.

Annual Income	n	Mean	SD	df	p
Homeowners	27	17,401	14,028	48	.007
Renters	44	8,245	11,656		

With regard to categorical variables (sex, mothers' ethnicity, and whether the property was pre-1978), chi-square tests showed that the frequencies of sex, (X^2 (df=1, N=92) =13.34, p =.247), mothers' ethnicity, (X^2 (df=1, N=92) =1.78, p=.183), and property age by residence type, (X^2 (df=1, N=92) =0.18, p=.673) were not significantly different. However, there was a significant difference in the categorical variable mothers' education by type of residence. The percentage of mothers living in owner-occupied properties with a minimum of a high school education was 3.3% (3/92) as compared to 21.7% (20/92) mothers with a high school education living in rental properties. Mothers with at least a high school education, or who obtained a higher degree, living in owner-occupied properties were 37% (34/92) as compared to 26.1% (24/92), for mothers living in rental properties. The differences were statistically significant, (X^2 (df=2, N=92), =13.79, p=.001). How these differences relate to child BLLs is discussed further on page 26.

Prior to conducting the main analysis, the distributions of the variables were also examined. Age was normally distributed (approximately). As expected, blood lead level was not normally distributed and instead, was positively skewed (most values occurred in the lower end of the scale). To test the BLL distribution, a Shapiro-Wilk's test (p>.05) (Doane & Seward, 2011) was performed and a histogram of values was visually inspected (Figure 1). As shown in Table 3, the distribution of children's BLL differed significantly from a normal distribution (skewness=3.637 (±251), Kurtosis=14.834 (±.498).

Table 3. Shapiro-Wilk's Test for blood lead levels.

		Statistic	Std. Error
Blood Lead Level	Mean	3.3891	.64139
	Median	1.3000	
	Variance	37.847	
	Std. Deviation	6.15198	
	Minimum	.10	
	Maximum	38.70	
	Range	38.60	
	Skewness	3.637	.251
	Kurtosis	14.834	.498

Since the BLL data were not normally distributed, a log transformation of BLL (natural log) was attempted and the distribution of the transformed data was again tested. The log transformation failed to produce a normal distribution of values (skewness=.610 (±.251), Kurtosis=.622 (± .498). Thus, for the main analysis, a non-parametric test was used to test the main hypothesis that BLL differed for children living in owned vs. rental properties.

The Kruskal-Wallis Test (non-parametric) was conducted to examine if there was a significant difference in BLL between children living in owned vs. rental residences. Table 4 shows the summary of the mean ranks for child BLL and type of residence with 42/92 (45.6%) participants (BLL mean rank=44.77) were living in owner-occupied properties, and 50/92 (54.3%) participants (BLL mean rank=49.95) were living in rental properties. Table 5 provides the results of the Kruskal-Wallis test. No significant difference was found (X2=.323, p=.570, df=6, .570 >.05).

Table 4. Summary of Kruskal-Wallis Mean Ranks for Children's Blood Lead Level and Type of Residence.

	Type of Residence	N	Mean Rank
Blood Lead Level	Owner-Occupied	42	44.77
	Rental Property	50	49.95

Table 5. Summary of Kruskal-Wallis Test for Children's Blood Lead Level and Type of Residence.

Groups	N	M	SD	X^2	df	p-value
Blood Lead Level	92	3.39	6.15	.323	1	.570
Type of Residence	92	1.54	.501			

Because the BLLs for children living in owned vs. rental properties did not differ, the BLLs of children from these two categories (owned vs. rental residences) were combined, and several exploratory analyses were conducted to determine whether other factors might be predictive of child BLLs in the target neighborhoods.

First, whether family income predicted child BLLs was tested using simple regression. The test indicated there was no significant association. Annual income accounted for only 1.7% of the variance of children's BLL, F (1, 69) =1.161, p=.285.

Next, whether mothers' educational level predicted BLL was examined using the Kruskal-Wallis (non-parametric) Test. Table 6 shows the summary of mean ranks. Children of mothers having an education level of less than high school (23/92, 25%) had higher BLLs (BLL mean rank=57.96), than children of mothers with a high school education level or who obtained a higher educational degree (58/92, 63%) (BLL mean rank=40.49). Table 7 shows that this difference was statistically significant, (X^2=8.105, p=.017, df=2).

Table 6. Summary of Kruskal-Wallis Mean Ranks for Children's Blood Lead Level and Mother's Educational Level.

	Mother's Education Level	N	Mean Rank
Blood Lead Level			
	Less than High school	23	57.96
	High school	11	54.23
	More than High school	58	40.49

Table 7. Summary of Kruskal-Wallis Test for Children's Blood Lead Level and Mother's Education Level.

Groups	N	M	SD	X^2	df	p-value
Blood Lead Level	92	3.38	6.152	8.105	2	.017
Mother's Education Level	92	2.38	.862			

Property age was also tested as a predictive factor using the Kruskal-Wallis test, Table 8 shows that the BLLs of children who did not live in properties that were built before 1978, (35/92, 38%) was lower, (BLL mean rank=40.81) as compared to children who lived in properties built before 1978 (57/92, 61.9%), (BLL mean rank=49.99) Table 9 shows that this difference was not statistically significant however the p-value may suggest a trend. (X^2=2.565, p=.109, df=1)

Table 8. Summary of Kruskal-Wallis Mean Ranks for Children's Blood Lead Level and

Property Age/Pre-1978.

	Property Age/ Pre-1978	N	Mean Rank
Blood Lead Level			
	No	35	40.81
	Yes	57	49.99

Table 9. Summary of Kruskal-Wallis Test for Children's Blood Lead Level and Property Age/Pre/1978.

Groups	N	M	SD	X^2	df	p-value
Blood Lead Level	92	3.389	6.152	2.565	1	.109
Property Age/Pre-1978	92	.62	.488			

For the final set of tests, each of these variables was tested in a chi-square analysis in which lead exposure was defined as any BLL equal to or greater than 2.5 µg/dL (yes/no). Thus, these analyses tested whether any of the above factors were associated with greater numbers of children with detectable lead exposure of 2.5 µg/dL or higher.

First, whether child lead exposure was associated with type of residence (rented or owned) was tested. The percentage of children living in an owner-occupied property with lead exposure (BLL> 2.5 µg/dL) was 10/42 (23.8%) as compared to children living in rental property of 14/50 (28%). The difference was not statistically significant, X^2 (df=1, N=92) =0.21, p=.648).

Next, whether age of residence (pre-1978 yes/no) predicted child lead exposure was tested. The percentage of children with lead exposure living in properties built after 1978 was 6/35 (17.1%) as compared to the percentage of children living in properties built before 1978 which was 31.6% (18/57) While the results showed that there were almost twice as many children with lead exposure in the older properties, the statistical test was not significant, (X^2

(df=1, N=92) =2.34, p=.126).

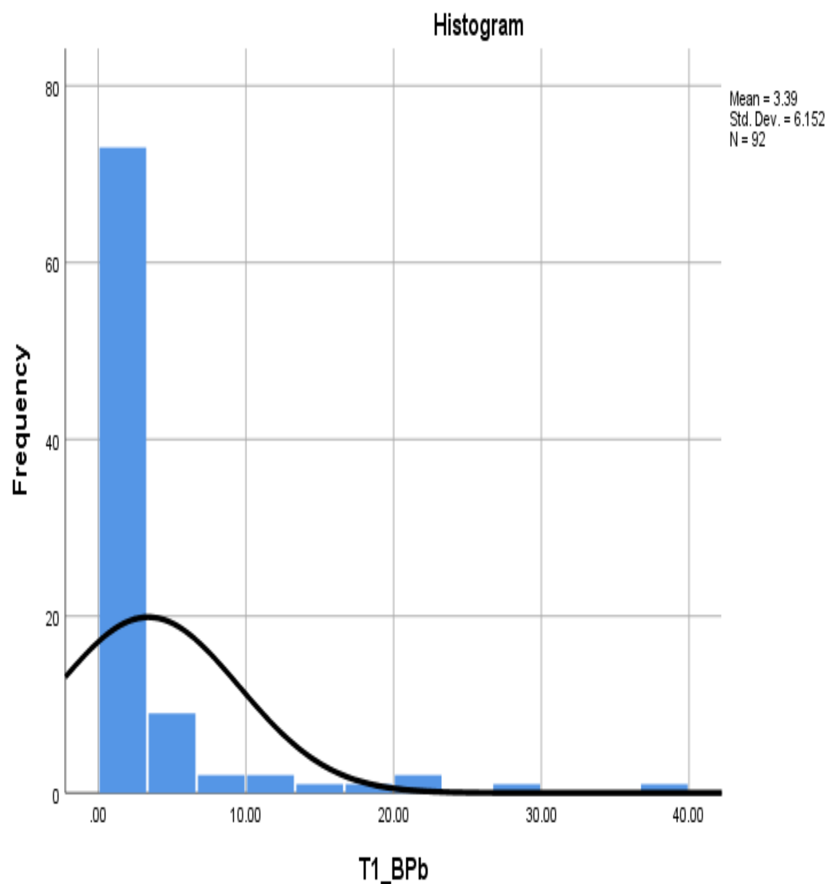
The next chi-square analysis tested whether child lead exposure (yes/no) was associated with family income. Because 94% of the families in this study were living at or below the poverty level, it was decided to run this analysis excluding 4 families living above the poverty level. Of the 67 families analyzed, income categories were defined simply to create categories with roughly equal numbers of subjects in each grouping. Thus, category 1 included families with annual incomes between $960 and $3,720 (n=21), category 2 included families with annual incomes between $4,116 and $9,600 (n=23) and category 3 included families with annual income between $11,280 and $36,000 (n=23). These three categories were labelled low, middle, and high income ranges. Among children from families' in the low category (1), the percentage of lead exposed children was 33.3% (7/21), as compared to children from families with incomes in the middle category (2) which was, 17.4% (4/23) and as compared to the percentage of lead exposed children from families with incomes in the high category (3) which was 26.1% (6/23). There was no significant effect of income level on child BLL.

The last chi-square test tested whether mother's level of education was associated with greater numbers of children with lead exposure. The percentage of lead exposed children of mothers with less than a high school education was 39.1% (9/23) as compared to children whose mothers graduated from high school and/ or who obtained a higher degree, which was 20.7% (12/58). Once again, while the percentage of lead exposed children from mothers with less than a high school education was almost twice that of other mothers, the differences were not statistically significant, (X^2 (df=2, N=92) =2.91, p=.233)

3.1: SUMMARY OF RESULTS

Contrary to the hypothesis, there were no meaningful differences in the BLLs of children living in rented vs. family-owned properties. Because children in rented vs. family-owned properties did not differ, the groups were combined and exploratory analyses were conducted to examine whether other factors might predict higher blood lead levels in subgroups of children. The analysis showed that there is a significant difference between mothers with less than a high school level education and type of residence.

Figure 1



Discussion

4.1: HYPOTHESIS

The purpose of the study was to examine factors that might predict children who are at risk of lead exposure. If such factors can be identified in designed experimental studies, the identified factor could then guide us to specific groups of children that require special monitoring. Ultimately, this could significantly reduce the cost and efficiency of finding children with lead exposure and eliminating sources of exposure. However, our results did not support the hypothesis. If the outcome had shown significant differences in BLL between children living in rental vs. owned properties, and the children living in rental properties had higher BLLs, that would justify focusing testing on children who reside in rental properties compared to family-owned properties, thereby saving time and money.

In El Paso, there is a high number of rental properties in lower income neighborhoods known to be at high risk for child lead exposure. Previous studies have suggested that children living in rental properties may be at higher risk of lead exposure. Landlords are responsible for maintaining a healthy environment for their tenants; nevertheless, that is often not the case. (Polletta et al. 2017). It was hypothesized that children living in rental properties would have higher blood lead levels than children living in family-owned properties, but this hypothesis is not supported by the results. This is discussed more in the following section.

4.2: WHY WERE THERE NO BLL DIFFERENCES IN CHILDREN LIVING IN RENTAL VS. OWNED PROPERTIES?

The lack of differences in BLLs among children living in rental properties vs. owner-occupied could be that the rental properties visited were in relatively good condition. Many rental properties are under The Housing Authority of the City of El Paso. Working with the voluntary participation of landlords and investors, The Housing Choice Voucher (HCV) Program provides approximately $30 million in housing assistance payments, on behalf of the 5,300 lower-income clients, directly to landlords each year. (Housing Authority of the City of El Paso 2020). The properties under the program are well maintained, and most buildings have been renovated. Unlike other private landlords that do not participate in the program, they often find it difficult to provide healthy housing. Past studies have described how landlords find preventative measures to be expensive (Polletta et al. 2017). The reason is a high turnover rate in which landlords have reported losses due to the inconsistency of rental payments from the tenants. Landlords are responsible for fixing the rental space before a new tenant moves in. Therefore, they may choose to use the least inexpensive method to help with the costs, which in time may compromise the new tenant's health (Polletta et al. 2017).

Another possibility, is that rental properties were not necessarily the oldest properties. There are many older private homes that have not been renovated since the early 1900s, making these homes riskier for children than newer rental properties. A former study administered by researchers at the Cincinnati Children's Hospital Medical Center, identified that interior renovation of older housing is associated with a modest increase in children's BLL (Cincinnati Children's Hospital Medical Center, 2008, May 5.) A positive finding is that the City of El Paso, Texas is improving the conditions of federal housing for families by renovating older buildings. Therefore, reducing lead exposure among young children. The assumption that rental properties are necessarily worse environments for children is not necessarily true, particularly in downtown neighborhoods where single family homes have not been renovated.

The other consideration is the popularity of "do it yourself" reality shows that seem to be influencing more and more homeowners. Homeowners who want to supplement their income are known to purchase properties at a low price that require renovation. The owners conduct the repairs themselves and sell the renovated home for profit, which is commonly known as flipping houses. However, if not done correctly, it may compromise the health of the new homeowners. A previous study of 249 children, all living in homes built before 1978, found that those who resided in houses where renovations had been conducted, had higher BLLs than children living in houses where no renovations had been performed (Cincinnati Children's Hospital Medical Center, 2008, May 5).

There were participants from the study that were working on their home renovations and their children had higher BLLs. With regards to the total sample of 92, 13 children had BLLs above 5 µg/dL. As shown in table 1, the number of children living in owner-occupied properties with BLLs above 5 µg/dL was 6/13 (46.15%) as compared to children living in rental properties of 7/13 (53.84%.). Interestingly, children living in owner-occupied homes were all male, and the children living in rental properties were all female. Of the 13 properties, only one property (rental) was not built before 1978. There were similarities in the conditions of the properties. The properties were mainly in fair condition, some with wood paneling, and minor paint chipping. It was reported that of the 13 properties, in 4 of the privately-owned homes, minor renovations had been made, including painting, and one homeowner had replaced a gas heater eight years prior. Additional studies are needed to further examine the connection between renovated older homes and children's BLLs in the years following the renovation. Another factor to examine is whether current reality shows influence property owners to perform the work themselves rather than hiring professionals. This may be an area where targeted community education and outreach are needed.

Another explanation for the lack of differences in BLLs between children living in rental vs. family-owned properties could be the contribution of consumer products to child lead exposure in the downtown neighborhoods. For instance, products exported from other countries can contain lead and can be found in numerous products ranging from electronics, dishware, makeup, candies, spices, and candles (Levin Ronnie et al., 2008). Several types of Mexican candies contain chili powder and tamarind, which also may be a source of lead exposure. The process of the candy preparation includes mixing, grinding and drying. If done improperly, lead can enter the candy. The other known hazard in candy is the ink used to decorate the candy wrappers. The wrappers have been shown to contain lead that can leach onto the candy (Centers for Disease Control and Prevention, 2019).

Hispanic traditional medicines such as Greta and Alarcon are often used for stomach pain, as well as for teething infants. These products are available as a bright orange powder. Previous studies have shown that both products have a high amount of lead (Centers for Disease Control and Prevention 2019). All the above described products are easily available in El Paso, TX because it is situated on the U.S.-Mexico border. Residents cross back and forth regularly and whether downtown residents end up with lead-contaminated consumer products in their homes is unrelated to the type or age of home where they live. It is important to note that consumers are usually unaware of the lead content found in their products. Education is greatly needed to make consumers aware of these common hazards.

Furthermore, many women are working in non-traditional jobs, among which are in the cleaning and custodial service. A few of the mothers in the study worked as housekeepers. The duties performed may cause exposure to unknown toxins that can be a hazard to their health (The National Institute for Occupational Safety and Health (NIOSH) 2014) but just as importantly the work tasks often include disinfecting and dusting. If the mothers are heavily exposed to lead dust without their knowledge, they could be bringing it into their homes and to their children. It would be interesting to conduct an additional study to see if there is a relationship between the mothers' type of work and children BLLs.

4.3: Exploratory Analyses: Why Were BLLs Higher Among Children Whose Mothers' Had Less Than a High School Education?

Exploratory analyses found that children whose mothers had less than a high school education had higher BLLs. One possible explanation is that mothers with less formal education do not have much access to public health information regarding child lead exposure. What is more, mothers may not be comfortable reading public health information. They may feel self-conscious about their educational level and perhaps do not ask health professionals for help. Another consideration is that they do not use computers as much or not at all because they cannot afford to buy one. Thus, mothers are unable to search for information on lead exposure.

Access to appropriate public health is not always available to low-income mothers and can get lost in the health care system. Low-income mothers who receive Medicaid benefits are eligible for blood lead level screening for their children at no cost (Texas Health and Human Services 2020). The Department of Health and Human Services requires blood lead testing for children beginning at the age of 12-months and again when the child is 24-months. Blood lead testing is required for any child 13 months through 5 years who is newly enrolled in the Medicaid or Texas Health Steps program (Texas Health and Human Services 2020). The program identifies concern for children BLLs as 5 µg/dL or higher. Under the CDC guidelines, children with BLLs of 5 µg/dL or greater require medical management from their primary care provider (Texas Health and Human Services 2020). Children with BLLs less than 5 µg/dL should continue to be monitored since previous studies have shown that BLLs below 5 µg/dL can influence children's neurobehavioral performance (Min et al. 2007).

Communication between a doctor and their patients is a crucial component in providing adequate health care. Most health care workers are not bilingual in English and Spanish since the majority transfer from other cities. Many of the participant's first language is Spanish. When the parent has a concern about the possibility that their child may have been exposed to lead, language barriers between mothers and doctors may be the cause of misinformation. When the patient does not speak the same language as their doctor, several misunderstandings may arise during the consultation. At the time of the visit, if a translator is present, whether, from the practice or is the parent's relative, important information or instructions might be lost in translation. The translator may not explain correctly what the care physician said. The parent may act like they comprehend when they do not because they may be too embarrassed to ask questions. Language barriers can also result in limiting the patient's access to other beneficial public health services, such as other medical and social services to which they are legally entitled to (Timmins 2002).

Of course, there are many socio-economic factors that are associated with fewer years of education. Another possibility is that less formal education (the identified variable) is associated with other variables, for example, maybe the quality of housing (whether owned or rented) that put children at greater risk of lead exposure.

4.4: NEXT STEPS

This study did not find that property type alone (rented vs. family-owned property) predicted child BLLs. Several other findings however might help guide next steps in the prevention of early child lead exposure. For example, the quality and condition of the property where children live may help to predict children's BLLs, regardless of whether the property is rented or owned. Also, and very importantly, whether an older house has been recently renovated may create hidden lead hazards for young children. Characterizing risk factors in children's residences, particularly in high-risk neighborhoods, could be critical for establishing preventative educational programs. For instance, if a child's family has a lower economic income but lives in a newer well-maintained property (whether owned or rented), the risk of lead paint in the home may be less. At the same time, consumer products may still be a significant source of exposure. Another contributing factor may be the cleanliness of the home. Lead hazards from outside the home such as lead contaminated soil, lead from industrial waste, car parts, and car-related repair activities particularly involving car batteries, when brought into the home, can be a significant source of exposure for young children. A clean home provides a healthy environment for the children and is essential for good child health. All adults living in the home have some responsibility to be aware of potential sources of contamination and to try to ensure cleanliness.

Alternatively, if the child resides in an older property with interior lead paint, mainly if the home is not maintained, the child may be at a higher risk of lead exposure from within the home. The property may contain old paint and plumbing that can put children at a higher risk of being exposed to lead hazards. The home environment is also an important consideration. In particular, the home should be kept clean and well-maintained, such as dusting and disinfecting regularly and painting when there is noticeable paint chipping on the interior walls.

The location of the property can be another variable to take into consideration. If the property is in a quiet neighborhood, surrounded by other families, and has less vehicular traffic, chances are the child is in a safe environment where the risk of lead exposure may be less. If the child lives in the inner city surrounded by factories, or near high traffic volume area where freight truckers may pass daily, the risk to lead exposure may be higher for the child. Properties near industrial businesses are also at risk for lead exposure through contaminated soil and dust.

The quality of the residence may be more important than the type of residence it is (whether owned or rental). According to a previous study, community characteristics such as maintenance and location of the properties contribute to elevated child BLLs (Lanphear et al. 1998). There is limited literature available on the possible relationship between the quality of housing and children BLLs

Limitations

CHAPTER 5.1: CONVENIENCE SAMPLING

The original goal to recruit 100 children, 50 residing in rental properties, and 50 residing in owner-occupied properties was not achieved. Although the sample size did include 50 residing in rental properties and 42 residing in owner-occupied properties with a total of 92 participants, the number may not have been enough to detect differences. If the sample size had been between 150 or more the findings may have been different. This study used convenience sampling and recruited families through health fairs and other public events. We did not have a way to know the extent to which the families included and/or the homes were truly representative of families living in the high-risk neighborhoods of interest. We were limited in validating the accuracy of the participant's responses. For instance, where the child was living and spending most of their time. For the reason that some of the families moved from their residence more than once. Because convenience sampling was used, it was not possible to balance the numbers of families from older vs. newer rental properties, and older vs. newer owned homes.

Conclusion

Childhood lead exposure, even at low BLLs, continues to be a global health problem that can compromise children's long-term health if not prevented. This study compared the BLLs of children living in rental vs. family-owned properties. The primary hypothesis was not supported, and additional studies are needed to identify factors that can help identify children at highest risk of lead exposure. Direct factors that may contribute include the age of the home, the physical condition of the property, the cleanliness of the home in neighborhoods where environmental lead contamination is likely. Indirect factors that may influence the first three include socio-economic and educational characteristics of the parents. With more time and resources, these types of studies may find other factors contributing to children's BLLs. Once additional factors are identified, these can be used to create risk-specific preventative educational materials.

There is a need to continue to bring awareness to the public on the effects of lead exposure among children. Previous studies have shown that preventative interventions help to improve and safeguard children's' health (Campbell et al. 2014). Community outreach is needed to gain trust and build relationships with the parent (s). Working alongside elementary schools and participating in local health events has also been shown to be beneficial in providing education and free child lead screenings. It may also be beneficial to partner with local businesses that have real estate connections, such as hardware and paint stores, which may help to reach more people further and provide continued education in both English and Spanish within the community. For example, educational materials could be provided on how to perform renovations on older homes safely, and what should be considered when hiring contractors.

All children deserve to live in a healthy environment. Further studies and preventative programs are still needed. Children are not able to speak for themselves and preventative programs can help to protect vulnerable members of our communities.

MPH Foundational Competencies

During my thesis research, I applied five MPH Foundational Competencies. The first one that I applied was Evidence-based Approaches to Public Health. Under this section the following components were applied; 1) Apply epidemiological methods to the breadth of setting and situations in public health, 2) Select quantitative and qualitative data collection methods appropriate for a given public health context, 3) Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate. The second MPH Foundational Competencies was Planning and Management to Promote Health. The component that I applied was, 7) Access population needs, assets and capacities that affect communities' health. Under this area, I researched child lead exposure and gained insight into the communities' needs by participating in community outreach. The third MPH Foundational Competencies was Leadership. The component that I applied was, 16) Apply principles of leadership, governance and management, which included the creating a vision, empowering others, fostering collaboration and guided decision making challenges. Under this area, I contributed to empowering families in the community by providing education on child lead exposure. I collaborated with health event coordinators on how to best reach the public during the local events. The fourth MPH Foundational Competencies was Communication. The component that I applied was, 19) Communicate audience-appropriate public health content, both in writing and through oral presentation. Under this area, I contributed by creating educational material in both English and Spanish. The fifth MPH Foundational Competencies was Interprofessional Practice. The component that I applied was, 21) Perform effectively on Interprofessional Teams. Under this area, I worked efficiently and well with other team members. Under the MPH Program Hispanic and Border Health Concentration Competencies the component that I applied was, 1) State the principals of prevention and control of disease, and discuss how these can be modified to accommodate cultural values and practices in Hispanic and border communities. Under this area, I prepared and provided Spanish educational material that best suits the Hispanic community.

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Appendix A

Family Demographics and Child Environment Characteristics Form
Department of Public Health Sciences
University of Texas at El Paso

Study ID # 75 - ___ ___ ___ Family ID Informant relationship to child: ______________ Date: __________

I. Family Demographics (fill one per family)

Address: ______________________________________ Phone #1 ________________

City ________________ State ________ Zip________ Phone #2 ________________

1. Does anyone smoke at home? YES NO
   a. If yes, who and for how long: ____

2. How many family members live at home (circle one): 2 3 4 5 6 7 8 9 10+

3. Estimate the weekly income of your family?: ______________________

4. Has anyone in your family been told that they have blood levels of lead, arsenic, or cadmium (circle all that apply)? YES NO

   If yes:
   a. When: ________________ What was the result? ____________________
   b. When: ________________ What was the result? ____________________
   c. When: ________________ What was the result? ____________________

5. If any family member was told that they had blood levels of lead, was the source of exposure identified? YES NO I DON'T KNOW
   a. If yes, what was it? ____

6. Do you store fruit juices, tomato sauces, other foods or drinks in pottery, porcelain, pewter, leaded crystal or cans? YES NO DON'T KNOW

7. Do you cook or store food in a bean pot or in pottery that is glazed? YES NO DON'T KNOW

8. Does your family use alternative, traditional, or home remedies such as Ayurvedic powders, or any medicine powders such as Greta, Azarcon, Alarcon, Maria Luisa or pay-loo-ah? YES NO DON'TKNOW

9. Does your family eat Mexican candy? YES NO DON'TKNOW
   a. If yes, what type?____
   b. If yes, how often? ____

10. Does the family eat rice (white or brown)? YES NO DON'T KNOW
    a. If yes, how many times per week does the family eat rice? ________________
    b. What brands of rice do you buy? ______________________________
    c. Where do you purchase your rice? ______________________________

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II. Home and Child Environment Characteristics (fill one per family)

11. Do you rent or own your home? RENTING HOMEOWNER OTHER:____________
12. Was your home built before 1978? YES NO DON'T KNOW
    a. If yes, how long has the family lived at this address? ____________________________
    b. What is the year that the home was built?____________________________
13. Have there been recent renovations or repairs to the house? YES NO DON'T KNOW
14. Is there any peeling paint anywhere on the outside or inside of your home?
    YES NO DON'T KNOW
    a. Where is the peeling paint (location)?____________________________
    b. Has the peeling paint ever been tested for lead? YES NO DON'T KNOW
15. Have you ever had your outdoor soil, indoor dust, paint, or water tested for lead?
    YES NO DON'T KNOW
    a. If yes, what and when was it tested, and do you know the result? ____________________
16. Have you recently moved to this address from another residence? YES NO DON'T KNOW
    a. If yes, could you give us the address and zip code of the prior residence? ______________
    b. When did you move into this current residence? ____________________________
17. Does your children spend time in any building other than your home (e.g., day care, grandparent's house, neighbor's house, etc.)? YES NO DON'T KNOW
    a. If yes, could you give us the address and zip code of the other building?
    ____
18. Is your family living near an industrial facility such as a battery recycling plant, smelter, or metal recycling plant? YES NO
    DON'T KNOW
    a. If yes, what type of facilitiy is it: ____________________________
    b. Is there any other building or activity you are concerned about in you neighborhood?
    YES NO
    If yes, describe:____
19. Do you have pets? YES NO
    a. If yes, how many and what type of pets do you have?
    b. ____
    c. If yes, where do the pets spend most of their time? INDOORS OUTDOORS
    d. Where do the pets sleep? ____________________________
20. Do you raise chickens for eggs? YES NO
21. Do you have a vegetable garden? YES NO
    a. If yes, do you eat leafy green vegetables from the garden? YES NO

Curriculum Vita

Elizabeth Alvarado Navarro was born and raised in El Paso, TX, the youngest of six siblings. Elizabeth is married and has one son. Elizabeth received her Bachelor in Business Administration, March 2016, from The University of Phoenix. Elizabeth pursed her Master in Public health at the University of Texas at El Paso, College of Health Sciences, where she graduated in May 2020. Thesis Title: Does the Type of Housing a Child Lives in Predict Blood Lead Level?

While attending graduate school, Elizabeth had the opportunity to perform volunteer work for Dr. Sobin's Lead Research Team, where she contributed many hours in research activities, including home visits, conducted household surveys, and inputting and analyzing data. Elizabeth also helped with coordinating and participating in local health events to educate the public and recruit interested participants for the study. Another contribution, Elizabeth assisted in creating the primary logo for the Lead Research team.

During her graduate studies, Elizabeth and her three other classmates created a public health service announcement (PSA). The class, Eliminating Health Disparities, was taught by Dr. Concha. Elizabeth presented the PSA at the American Public Health Association (APHA) Global Public Health Film Festival, which was on November 4, 2019, in Philadelphia, Pennsylvania. The category was Anti-Bullying. Film Title: Don't be a Follower, be a Hero.

Elizabeth's objective is to work in Public Health, where she can contribute and utilize her skills within her community.

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This thesis/dissertation was typed by Elizabeth Alvarado Navarro.