5-2010

Factors associated with blood lead levels of children in southern Nevada

Mackenzie Suzanne Burns
University of Nevada, Las Vegas

FACTORS ASSOCIATED WITH BLOOD LEAD LEVELS OF CHILDREN IN SOUTHERN NEVADA

by

Mackenzie Suzanne Burns

Bachelor of Arts
University of the Pacific
2003

A thesis submitted in partial fulfillment of
the requirements for the

Master of Public Health
Department of Environmental and Occupational Health
School of Community Health Sciences
Division of Health Sciences

Graduate College
University of Nevada, Las Vegas
May 2010

THE GRADUATE COLLEGE

We recommend the thesis prepared under our supervision by

Mackenzie Suzanne Burns

entitled

Factors Associated with Blood Lead Levels of Children in Southern Nevada

be accepted in partial fulfillment of the requirements for the degree of

Master of Public Health
Environmental and Occupational Health

Shawn Gerstenberger, Committee Chair

Linda Stetzenbach, Committee Member

Chad Cross, Committee Member

Jennifer Keene, Graduate Faculty Representative

Ronald Smith, Ph. D., Vice President for Research and Graduate Studies
and Dean of the Graduate College

May 2010

ABSTRACT

Factors Associated with Blood Lead Levels of Children in Southern Nevada
An Abstract

by

Mackenzie Suzanne Burns

Dr. Shawn Gerstenberger, Examination Committee Chair
Executive Associate Dean of Environmental and Occupational Health
University of Nevada, Las Vegas

Exposure to lead continues to be a public health concern, particularly for young children. The Centers for Disease Control and Prevention report that approximately 250,000 children currently have blood lead levels (BLLs) above the level at which adverse health effects are apparent and intervention is recommended (10µg/dL). National surveillance data on childhood lead exposure has been collected for children under the age of 6 years old since 1995. However, not until 2006 did a program begin in Nevada (limited to Clark County); therefore, statewide data about childhood lead exposure in Nevada remains limited.

The goal of this study was to identify possible sources of lead exposure through increased screening efforts and to identify the factors most associated with blood lead levels in Southern Nevada children. Throughout the study period, a total of 1,048 families received educational materials regarding the dangers of childhood lead poisoning. Of those, 564 children were recruited into the study. Blood samples were collected for each of the participants by either venous blood draw or capillary finger stick, depending on the availability of the method and parental preference. Blood lead

level (BLL) analysis identified 35 children with detectable BLLs, with a range of 3µg/dL to a high of 7µg/dL.

Study participants also completed a five question questionnaire intended to identify behaviors and items which could put them at risk for atypical lead exposures. A number of potential sources were identified; the most common including: the habit of putting non-food items into the mouth (particularly toys), the ingestion of paleta imported candies, the use of pewter home goods in the household, and "take-home exposure" from household members whose occupation exposed them to lead. Statistical analysis, by Fisher's exact test, indicated that there was a significant difference in the proportion of children with detectable BLLs who had the habit of putting non-food items into their mouths versus the proportion of children with detectable BLLs who did not have the same habit. These results, while restricted to the study population, indicate that further research is needed to identify what items are posing the greatest risk for oral lead exposure.

This research suggests that Southern Nevada children may have relatively low BLLs. However, since the study results are not considered representative, further research is needed to truly identify the prevalence of the problem. These data indicate that Southern Nevada children may likely be exposed to a variety of atypical sources which may increase their risk for lead poisoning. As such, further educational, screening, and research efforts are essential for the primary prevention of future childhood lead poisoning cases in Southern Nevada.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

To the University of Nevada, Las Vegas and the School of Community Health Sciences -

I thank you for the opportunity to complete a challenging and enlightening Master level education. The talent, passion, and dedication exhibited by the faculty have enriched my experience and set a standard of excellence I will strive to achieve.

To Dr. Gerstenberger -

Thank you for giving me direction, mentorship, and support. From the beginning, you had faith in my abilities and I can only hope that I met your expectations. Your enthusiasm for this project helped me understand its significance and I thank you for the opportunity to complete such meaningful work. Without you, I had no clear course to my degree. As such, I am eternally grateful for your encouragement and persistence.

To my thesis committee -

Dr. Stetzenbach, I am grateful for the opportunity to have been a student in your courses and to have benefited from your knowledge and experience. I greatly appreciate your commitment to me and this process even after your retirement. Dr. Cross, I thank you for your patience while a less-suited mind attempted to understand biostatistics. Your expertise in the field is obvious and I am grateful to have received your guidance. Dr. Keene, I thank you for your willingness to serve on my committee without any prior knowledge of my work. You have offered unique insights and I am grateful that my project had more depth due to your suggestions.

To the study contributors -

Special thanks to the Trust Fund for Public Health for funding the grant which paid for the study. I would also like to thank the University of Nevada, School of Medicine affiliated clinics Lied and Kid's HealthCare, where we were lovingly referred to as "sharks", for allowing us to recruit in their facilities. A big thank you to the attending physicians, Dr. Shah, Dr. Denton, and Dr. Neyland, who were instrumental in setting up the project and who put forth a great deal of effort to ensure its success. I would also like to thank the resident physicians and the nursing and administrative staffs who supported the study and facilitated both recruitment and blood draw activities. Last but not least, I would like to thank the Southern Nevada Health District Childhood Lead Poisoning Prevention Program for providing capillary blood lead testing for the study participants and for their willingness to provide surveillance data to support the study.

To Erika and Diana -

Without your support, this project would have been a complete and utter disaster. You both spent a great deal of time and energy helping overcome the many, many challenges this project faced and for that I am forever indebted. Only you can understand the rigors of the study's IRB process and the joy of pinning down screaming children to benefit public health. Even more than that, I thank you for making my days at the clinic so much more enjoyable - you have become truly great friends.

To my family -

To my parents, John and Pat, thank you for encouraging me to always do my best. You have always been supportive of my endeavors and proud to celebrate my accomplishments. Without you, I would not be the person I am today. To my sisters, Kim and Brittany, thank you for your confidence and friendship. You have shown me many different ways a person can be successful in life and I hope I have shown you one as well. To my brother-in-laws, Mark and Andy, thank you for opening your hearts to me as extended family. I consider you the brothers I never had and thank you for taking good care of my sisters. To my niece, Brynn, I am so excited to watch you grow up and am thrilled that you enjoy school so much. I hope that your Auntie has set a good example and has shown you what can be achieved in education. I love you all.

To my friends -

To my best friend Meghan, thank you for a lifetime of friendship and fun. I literally would not be here were it not for your suggestion, so for that I am forever grateful. To my boyfriend Michael Jones, thank you for showing me what it is to truly be loved and appreciated. I am grateful for your support of my dreams and hope that I can return the favor. To all my friends, which are too numerous to mention (you know who you are), thank you for your faith in me. It is comforting to know that near and far I will always be able to find encouraging words. I am truly blessed to have such an amazing group of friends. In your own way, each of you has been instrumental to my success and I can never thank you enough. I only hope I can do the same for you one day.

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Purpose of the Study

The primary purpose of the study was to determine which factors are most associated with the blood lead levels of children in Southern Nevada. The study was also designed to increase the number of children in Southern Nevada tested for lead exposure. By increasing the number of children tested, the study served to further educate the public about the importance of childhood lead screening, as well as, identify populations at higher risk for lead poisoning in Southern Nevada. Information pertaining to possible exposures to lead was analyzed in an attempt to find such associations. These associations are the basis for the study's research questions and subsequent hypotheses.

Research Questions

- What are the blood lead levels (BLLs) of children in Southern Nevada and are the children at risk for lead poisoning?
- Is there a relationship between possible exposure to lead-contaminated products and a child's blood lead level (BLL)?

Hypotheses

The concentration of lead in the blood, considered an appropriate test of lead exposure, may be dependent on the potential lead exposures experienced by the child. In this study, a five question questionnaire was completed for all participants (APPENDIX

3), which served to identify potential lead exposures, particularly those considered to be atypical. These questions served as the source for the research hypotheses.

H_{A1}: The proportion of children with detectable blood lead concentrations will be different between those who have the habit of eating, chewing, or sucking non-food items and those who do not have the same habit.

The basis for this hypothesis is that when a child puts non-food items in their mouth, there is a greater opportunity for oral lead exposure.

H_{A2}: The proportion of children with detectable blood lead concentrations will be different between those who ingest imported candies and those who do not ingest imported candies.

The basis for this hypothesis is that consumption of imported candies by a child, which may be contaminated with lead, represents a greater opportunity for oral exposure.

H_{A3}: The proportion of children with detectable blood lead concentrations will be different between those whose families use certain home goods, associated with lead contamination, and those whose families do not use the same home goods.

The basis for this hypothesis is that use of certain home goods by a child's family, which may contain lead, increases the opportunity for exposure to the child primarily through the leaching of lead during food and beverage preparation or storage.

H_{A4}: The proportion of children with detectable blood lead concentrations will be different between those whose families use ethnic remedies or cosmetics and those whose families do not use ethnic remedies or cosmetics.

The basis for this hypothesis is that use of ethnic remedies and cosmetics by the family, which may contain lead, increases the opportunity for exposure to the child, particularly when intentionally administered.

H_{A5}: The proportion of children with detectable blood lead concentrations will be different between those whose household members are exposed to lead in their occupation and those whose household members do not have lead exposure in their occupations.

The basis for this hypothesis is that household members exposed to lead through their occupation provide opportunities to unknowingly bring lead into the home environment and increase exposure to their children.

All hypotheses were analyzed by comparing the frequency of affirmative responses on the questionnaire for each individual question. The frequency of affirmative

responses was then compared within a study-identified group, based on resulting blood lead level (BLL) laboratory findings. Study participants were placed in the Detectable BLL Group if their BLL was found to be in excess of the respective method detection limit for either their venous or capillary blood draw. Once the group members were defined, a test of two proportions was conducted for each question and results were analyzed using Fisher's exact test p-values. A detailed description of the questionnaire responses for all detectable BLL cases is also included in the document.

Significance of the Study

In the late 1990s, the Centers for Disease Control and Prevention proposed their document *Healthy People 2010*, a set of objectives aimed at ensuring good health and long lives are afforded to all individuals. With Objective 8-11, the goal of eliminating elevated blood lead levels in children was established (DHHS, 2000). In order to realize this goal, state and local data are necessary to determine trends in childhood blood lead levels, develop effective prevention measures, and monitor progress towards its achievement (CDC, 2003b). This research study was designed to enhance local surveillance, identify sources of lead exposure, and find the factors most associated with blood lead levels of children in Southern Nevada. The study is significant in that it contributes to the greater goal established by *Healthy People 2010*.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Chemical and Physical Properties of Lead

Chemically, lead is an element found in Group 14, Period IV on the periodic table (Petrucci, Harwood, & Herring, 2002). The atomic symbol for lead is represented as Pb, for the Latin *plumbum*; its atomic number is 82. With an atomic radius of 175.0pm, lead has an atomic weight of 207.2g (Los Alamos, 2003). Natural lead is a mixture of four stable isotopes resulting from the decay of uranium, actinium, and thorium (ATSDR, 2007b). In order of abundance from greatest to least, stable lead isotopes include: ^{208}Pb (52.4%), ^{206}Pb (24.1%), ^{207}Pb (22.1%), and the relatively uncommon ^{204}Pb at 1.4% (Petrucci et al., 2002). There are twenty seven additional radioactive lead isotopes which are also recognized (Los Alamos, 2003).

Inorganic lead exists in three oxidation states: the familiar bluish-gray metal which exists rarely in nature, Pb(0); the most prevalent environmental form, Pb(II); and Pb(IV) which is not naturally occurring and is formed only under extreme oxidizing stress (Petrucci et al., 2002). Pb(IV) is the oxidation state responsible for most organolead compounds (ATSDR, 2007b). In contrast, Pb(II) typically forms compound salts and deposits in various ores throughout the world (Petrucci et al., 2002). The most common lead compounds found in ores are PbS (galena), $PbSO_4$ (anglesite), and $PbCO_3$, (cerussite) (Witkowski & Parish, 2001). Although not particularly abundant, as compared to aluminum and iron, the lead ores in the Earth's crust produce lead at approximately 15-20mg/kg (ATSDR, 2007b). More than one third of the world's lead

reserve is in North America and is readily accessible. It is frequently mined in both Alaska and Missouri (ATSDR, 2007b).

Metallic lead is heavy, dense (density at 20 ºC = $11.34 g/cm^3$), and has a relatively low melting point at 327 ºC. These properties make lead both durable and malleable (Petrucci et al., 2002). Additionally, lead is extremely resistant to corrosion when exposed to air or water. When exposed, lead compounds form a film on the surface to protect the underlying metal, essentially slowing or completely stopping corrosion (ATSDR, 2007b). While metallic lead is insoluble in water, lead compounds, also known as lead salts, are water soluble (Williams, James, & Roberts, 2000). Lead compounds are also unique in that they are amphoteric; they can be dissolved into component ions in both acids and bases (ATSDR, 2007b). Lead can also be combined with other metals to form strong alloys (Petrucci et al., 2002). These distinctive chemical and physical properties of lead have resulted in its extensive use by humans.

Human Use of Lead

As mentioned, lead occurs naturally in the environment, albeit relatively scarcely. Interestingly, environmental lead levels, particularly outside of ores, have increased dramatically due to recent human activity (Williams et al., 2000). Human interest in the use of lead is not new, as lead has been identified as one of the first metals used by early civilizations (Su, Barrueto, & Hoffman, 2002). However, it is estimated that environmental lead levels have increased by over 1000 times throughout the past few centuries, with the greatest increase between the years 1950 and 2000 (ATSDR, 2007b).

Humans release lead into the environment through the processes of mining, and the production, recycling, or waste management of lead alloys and compounds (ATSDR, 2007b). Historically, lead has been used as an additive in paint, dyes, and glazes (Petrucci et al., 2002). Lead has also been used as a solder for pipes and plumbing fittings, and as a component in pesticides (ATSDR, 2007b). Perhaps the most well known human use of lead was as the anti-knock, octane-boosting gasoline additive, tetraethyl lead (Nriagu, 1990). Fortunately, as the adverse health effects associated with lead exposure became more apparent, the United States began regulation (over the past three decades) of lead content in these products (Wigle, 2003). These regulations have resulted in a dramatic decrease in the human release of lead into the environment (ATSDR, 2007b).

Conversely, the use of lead is not as strictly regulated in other parts of the world; for example, leaded gasoline and pesticides are still in use outside of the United States (Wigle, 2003). Also, even in the U.S., the use of lead in car batteries, ammunition, shielding for x-rays, and corrosion resistant building materials continues (Williams et al., 2000). As elemental lead does not degrade, humans are still contributing a significant amount of lead to the environment, which continues to pose both environmental and human health risks (Su et al., 2002).

Toxicokinetics

The presence of lead in the environment due to natural or anthropogenic causes does not itself constitute a health risk. In order to be adversely affected by the presence of lead, one must be exposed via a pathway such as inhalation, ingestion, or in few

instances, dermal contact. The resulting degree of harm is then dependent on individual characteristics (i.e. age, gender, current health status, and behaviors), as well as, the exposure dose, duration, and exposure pathway (ATSDR, 2007b).

Absorption

Absorption of lead into the human body, specifically into the bloodstream, can occur via one of the three identified exposure pathways: inhalation, ingestion, or dermal contact (ATSDR, 2007b). However, it is important to note that the adverse health effects associated with lead exposure are the same regardless of the exposure pathway (Williams et al., 2000).

Inhalation

Inhalation exposures are responsible for the greatest proportion of lead dose to occupationally exposed individuals (Williams et al., 2000). Absorption via inhalation occurs when small lead particles, typically <1.0µm, are inhaled from the ambient air and deposited deep within the respiratory tract. In the alveolar region, small lead particles can be ingested by phagocytes or dissolved extracellularly (James et al., 1994). Some studies suggest that up to 95% of the small lead particles which are deposited in the deep respiratory tract can be absorbed by the body, representing the greatest absorption rate of the three exposure pathways (Hursh, Schraub, Sattler, & Hofmann, 1969). These numbers approximate the absorption via inhalation for both inorganic and organic lead. For larger lead particles (>1.0µm but <2.5µm) deposition into more superficial portions of the respiratory tract may lead to subsequent ingestion. Ciliated cells of the upper respiratory tract are able to transport larger particles to the esophagus (Hursh et al., 1969).

Ingestion

In contrast to inhalation, ingestion exposures are responsible for the greatest proportion of lead dose to the average individual (Williams et al., 2000). Absorption of lead via ingestion may be the result of the mucociliary transport of lead particles from the respiratory tract, described above (Hursh et al., 1969), or the result of oral contact and ingestion of lead dust or lead contaminated products. As with inhalation, gastrointestinal absorption of lead is also dependent on particle size, but is also affected by various other physiological states of the exposed individual, as well as, physiochemical characteristics of the lead itself (Wigle, 2003).

There are vast differences in the absorption of lead based on the age of the exposed individual. Children absorb as much as 50% of ingested inorganic lead (Alexander, Clayton, & Delves, 1974), while adults absorb typically less than 10% (Heard & Chamberlain, 1982). The explanation for this difference is not well understood, but may be the result of differing diets or physiological differences between child and adult intestines. Additionally, the presence of food in the stomach and the overall nutritional status of the individual also greatly impacts lead absorption (Heard & Chamberlain, 1982). The presence of food in the stomach, which is rich in minerals, seems to decrease lead absorption (Blake & Mann, 1983). Additionally, there is an indirect relationship between dietary iron and calcium intake and gastrointestinal absorption of lead. This relationship is evident in both children and adults (Mahaffey & Annest, 1986).

There is also evidence that the percentage of lead absorbed in the gastrointestinal tract is affected by both dose and lead particle size. There seems to be a nonlinear relationship between absorbed lead and lead intake, which suggests that the human capacity to absorb

lead is limited (Pocock et al., 1983). While interesting, the dose at which the process is limited has not yet been identified. Further, similarly to inhalation, smaller lead particles (<100μm) are more easily absorbed in the gastrointestinal tract versus larger particles (Healy, Harrison, Aslam, Davis, & Wilson, 1982). Additionally, the surface area and morphology of the lead particles can also have an effect on absorption rates (Davis, Ruby, & Bergstrom, 1994).

Dermal Contact

Of the three identified exposure pathways, dermal contact with lead is the least significant route of lead absorption. Some studies suggest that inorganic lead, in certain compounds such as lead acetate, can adhere and possible penetrate the skin of exposed individuals; although the relative absorbed doses appear to be small (<1%) (Moore et al., 1980). Of course, damaged or wounded skin may allow the absorption of more lead into the body. However, organic lead has been shown to be easily and readily absorbed by the skin [in animal studies], posing a greater risk for absorption than inorganic lead (Bress, 1991).

Distribution

Regardless of the route of exposure, absorbed inorganic lead appears to be distributed throughout the body similarly and is mostly consistent among both children and adults (Kehoe, 1987). Absorbed lead is transported to blood, bone, and soft tissues, and can cross the placenta in pregnant women (CDC, 2002). The total amount of absorbed and distributed lead in a human body is referred to as body burden (Williams et al., 2000).

Lead in Blood

Once absorbed, lead enters the blood stream and binds preferentially (approximately 99%) to red blood cells (Bergdahl, 1997). The lead is typically bound to interior proteins of the red blood cells, as opposed to being bound to the exterior cell membrane. Very small amounts of lead may exist in the plasma, typically bound to plasma proteins such as albumin (Al-Modhefer et al., 1991). It is approximated that lead in the blood stream has an excretory half-life of approximately 30 days (Chamberlain et al., 1978). As such, venous blood lead levels can be a useful measure of recent or ongoing lead exposures.

Lead in Bone

In humans, the majority of an individual’s body burden is carried in the bones and teeth (approximately 73% for children and 94% for adults) (Barry, 1975). Lead accumulates primarily in the areas of bone undergoing calcification during the time of exposure (Aufderheide & Wittmers, 1992). This may be due to the valence similarities of lead to calcium (Su et al., 2002). Some bone lead is considered inert and will have an excretory half-life of multiple decades. Although lead is not easily released from the bones, it can and does occur slowly as a result of diffusion or bone resorption; this allows for the maintenance of blood lead levels long after exposure (Rabinowitz, Wetherill, & Kopple, 1976). The release of lead from bone stores often occurs in times of stress, such as during pregnancy, during menopause, at the site of broken bones, or when other disease conditions exist (ATSDR, 2007a).

Lead in Soft Tissue

Much less of an individual’s lead body burden is found in soft tissues. Of the lead deposited in soft tissue, most can be found in the liver (approximately 33% of all soft

tissue lead) (Schroeder & Tipton, 1968). However, lead can also be found in skeletal muscle, connective tissue, fat tissue, the kidneys, the heart, and the brain (Barry, 1975). The excretory half-life of lead in soft tissue is approximately 40 days (CDC, 1992).

Lead Transfer from Mother to Child

Unfortunately, one way that a mother's lead body burden can be reduced is through pregnancy. As mentioned, during pregnancy, the mother's body is under stress, so much of the maternal bone lead stores are released. The released bone lead is then transferred to the fetus through umbilical cord blood. One study found that as much as 80% of the lead concentration in cord blood can be attributed to the mother's bone lead (Gulson, Mizon, Korsch, Palmer, & Donnelly, 2003). Further, maternal lead can be transferred to children in breast milk. The release of lead from the mother's bones is somehow accelerated by lactation, and can be the source of up to 80% of a breast-fed child's subsequent lead body burden (Gulson et al., 1998).

Metabolism

Inorganic lead is not metabolized by the body, as there is no biologic transformation (CDC, 1992). Instead, as described in the distribution of lead in blood, lead typically forms complexes with protein ligands, such as albumin. It may also form complexes with non-protein ligands, such as cysteine and other sulfhydryls (Al-Modhefer, Bradbury, & Simmons, 1991). Conversely, organic lead is metabolized. Organic lead metabolism occurs in the liver, in cell cytosol or cell nuclei, by oxidative dealkylation. Organic lead metabolites may then remain in the liver, transfer to the brain or kidneys, or may be excreted (Zhang, Zhang, He, & Bolt, 1994).

Excretion

Lead is primarily excreted in urine and feces. Approximately one third of the total excretion of absorbed lead is accounted for in the feces, a figure which can rise if the lead was ingested (Chamberlain et al., 1978). Alternatively, a small portion of inhaled lead can be excreted during normal exhalation (Heard, Wells, Newton, & Chamberlain, 1979). Following dermal contact, some lead may also be excreted in sweat (Moore et al., 1980). Other minor routes of excretion include: saliva, hair, nails, and breast milk (Chamberlain et al., 1978). Interestingly, adults may excrete up to 99% of their absorbed dose of lead over time. However, children may only excrete up to 32% of their absorbed dose, resulting in greater accumulation of lead in the body (ATSDR, 2007b).

Traditional Sources of Exposure

Humans have a found a wide variety of uses for lead and lead compounds. These specific uses for lead have increased the opportunity for lead absorption via the identified exposure pathways. Historically, lead in paint, soil, water, and air have been the most important sources of exposure, particularly to children (Williams et al., 2000).

Paint

Historically, leaded paint has long been indicated as the number one source of childhood lead exposure (Su et al., 2002). The use of lead-based paint for residential homes began in the late nineteenth century and peaked in the 1920s. Although its residential use was banned by the U.S. Consumer Product Safety Commission (CPSC) in 1978, numerous instances of childhood lead poisoning still occur today, as a result of the ingestion of deteriorating leaded paint (Mielke, Powell, Shah, Gonzales, & Mielke,

2001). Much of this deteriorating paint can have lead concentrations as high as 50% (ATSDR, 2007b). Often the source of the paint is indoors at the child's permanent or temporary residence, although outdoor sources of exposure, such as playground structures, have also been indicated in childhood lead poisoning cases (Health Canada, 1994). In addition to the direct ingestion of leaded paint chips, children are often further exposed when inappropriate renovations and remodels are conducted on homes and other structures with leaded paint. Many childhood lead poisoning cases can be traced to the creation of lead dust during both amateur and professional renovation projects. Further, this created lead dust settles on the other types of items which children may put in their mouth subsequently increasing their risk for lead poisoning (Mielke et al., 2001). Current regulatory standards limiting lead in paint can be found in Table 1.

Soil

Soil has been traditionally identified as a source of lead exposure to children, as children often come into contact with soil through play and hand-to-mouth behaviors (Frazer, 2008). Elevated lead content in soil from background levels historically has resulted from the deposition of lead-contaminated, deteriorating paint or from vehicular exhaust during the use of leaded gasoline (Haar & Aronow, 1974). Even as leaded paint and leaded gasoline have been phased out of use in the United States over the past three decades, their impact on the soil remains (Frazer, 2008). Urban areas, with older housing and heavily utilized roadways, continue to have lead-contaminated soils in excess of the standards set by the USEPA for bare soil areas (USEPA, 2004; Table 1). One study found that for every 1000 ppm increase in soil lead above the standard, an increase of

approximately 3µg/dL in blood lead levels may be expected (Mielke, Gonzales, Powell, Jartun, & Mielke, 2007).

Water

In general, very small amounts of lead are found in natural waterways, and the same is true for most municipal water supplies (CDC, 2003a). It is estimated that 99% of potable drinking water contains lead at concentrations less than 0.0005 ppb, far below the regulatory standard for safety (ATSDR, 2007b; Table 1). As such, exposure to lead in water is typically the result of lead leaching from existing lead plumbing or solder, typically found in residences greater than 20 years old. Current safe drinking water regulations now require that all pipes and solder be lead-free; considered as such when the lead content is <8% and <0.2% lead, respectively (USEPA, 1993). Unfortunately, lead exposure can still be problematic in areas where the water is acidic or "soft." Water acidity enhances corrosion of plumbing and the subsequent leachability of lead, posing a continued risk of exposure (CDC, 2003a).

Air

After a 1976 court decision, the USEPA was forced to include lead on its list of criteria air pollutants, as defined under the Clean Air Act. In response, the USEPA created regulations for airborne concentrations of lead (Table 1), which ultimately resulted in the elimination of lead as a gasoline additive (*NRDC v. EPA*, 1976). This regulation is largely credited with the dramatic reduction of lead particles in the air and since its inception major reductions have been observed in remote, rural, and urban locations (USEPA, 2008). Fortunately, lead emissions into the air have continued to decline even after the total phase-out of lead gasoline was complete. However, it is

estimated that 1,600 tons of lead per year are still being emitted into the air, primarily from the industrial sector. These point sources are the largest contributors to airborne lead concentrations today (USEPA, 2006). Children living in close proximity to mining areas, power plants, incinerators, battery plants, and foundries may be at higher risk for exposure to airborne lead (USEPA, 1986).

Table 1: Regulatory Standards Pertaining to Traditional Lead Exposures

<table>
<tr><th>Matrix</th><th>Standard</th><th>Regulatory Agency</th></tr>
<tr><td rowspan="3">Paint</td><td>Residential paint constituting a hazard</td><td rowspan="13">United States Environmental Protection Agency</td></tr>
<tr><td>600 ppm, new paint</td></tr>
<tr><td>5000 ppm, existing paint</td></tr>
<tr><td rowspan="3">Soil</td><td>Residential bare soils constituting a hazard</td></tr>
<tr><td>400 ppm, play areas</td></tr>
<tr><td>1200 ppm, average for other areas</td></tr>
<tr><td rowspan="2">Water</td><td>Maximum Contaminant Level for drinking water</td></tr>
<tr><td>15 ppb</td></tr>
<tr><td rowspan="2">Air</td><td>National Ambient Air Quality Standard</td></tr>
<tr><td>$0.15 \mu g/m^3$, as a maximum quarterly average</td></tr>
<tr><td rowspan="2">Gasoline</td><td>Gasoline standard for leaded fuel</td></tr>
<tr><td>0.1 grams Pb per leaded gallon</td></tr>
</table>

Atypical Sources of Exposure

As mentioned, over the past three decades a number of U.S. regulations have limited exposure to lead through traditional sources. Unfortunately, the risk of childhood lead exposure and subsequent poisoning has not been eliminated. In one systematic review of the literature from 1966-2006, eighty-two documented childhood lead poisoning cases could be attributed to atypical sources of exposure (Gorospe & Gerstenberger, 2008).

Further, it has been estimated that as many as 35% of elevated blood lead level cases may be attributable to atypical sources of lead exposure (Lynch, Elledge, & Peters, 2008). Therefore, exposure to atypical sources of lead must be considered a relevant risk factor for children.

Eating, Chewing, or Sucking Non-Food Items

It is well understood that younger children have an increased frequency of hand-to-mouth behaviors, which may put them at greater risk for oral exposure to lead-contaminated products (EPA, 2004). Numerous calls are made to poison control centers each year regarding the ingestion of nonfood items by children, and undoubtedly, some of those items are contaminated with lead (McKinney, 2000).

Jewelry and Metallic Accessories, Pendants, or Beads

Jewelry and other metallic trinkets have been indicated in the acute lead poisoning deaths of a small number of children in the United States (CDC, 2006). Many of the suspect trinkets are purchased from vending machines and some have been found to contain concentrations of lead as high as 44% (CDC, 2004b). The United States Consumer Product Safety Commission (CPSC) has recalled millions of lead contaminated trinkets in their efforts to reduce acute lead poisoning due to the ingestion of consumer goods (CDC, 2006). Unfortunately, the CPSC does not regulate lead levels in jewelry unless an exposure pathway is identified and is expected to result in a blood lead level of greater than 10µg/dL (Schmidt, 2008).

Toys

In addition to vending machine trinkets, some popular toys purchased from nationwide retailers also pose the threat of lead contamination. The U.S. toy industry is a

multibillion dollar industry which sells billions of toys every year, up to 87% of which are produced overseas in countries such as China, India, or Malaysia (Schmidt, 2008). Contaminant testing of imported toys is largely a voluntary procedure, expected to be conducted by the industry, and it is completed only sporadically. As such, the CSPC attempts to monitor imports as effectively as possible given funding and personnel restrictions, and the CPSC recalls toys which exceed the lead standard of 600 ppm set for new paint. Millions of toys have been recalled by CPSC to date and some which were found to have lead paint concentrations exceeding 5000 ppm (Schmidt, 2008). Unfortunately, many lead-contaminated toys go unidentified and remain in stores.

Bullets, Pellets, and Fishing Sinkers

Although not always immediately suspected, parental hobbies such as hunting and fishing may be associated with childhood lead poisoning (Mowad, Haddad, & Gemmel, 1998). The lead found in both ammunition and fishing sinkers presents unique exposure opportunities, during either their homemade production or subsequent ingestion (USEPA, 2007). It is estimated that the most common bullets and shotgun pellets currently available in the United States are between 50-100% lead (McQuirter et al., 2004). Acute ingestion of a large amount of such ammunition may result in a rapid increase of blood lead levels, and may result in renal failure, neuropathy, and encephalopathy, similar to the toxic effects of chronic lead exposures. The risk of acute toxicity increases when numerous items are ingested, items with large surface areas are ingested, or the items are not quickly eliminated from the child's gastrointestinal tract. Unfortunately, this is often the case with ammunition and fishing sinkers (McKinney, 2000).

Chalk

The ingestion of chalk or chalk dust may also be associated with elevated blood lead levels in children. The lead content of some chalks may be attributed to the source of the chalk or its manufacturing process, although the use of coloring agents is the most likely source; many chalk coloring agents are lead compounds (Miller et al., 1996). Accordingly, the CPSC has issued recalls of thousands of pieces of sidewalk chalk found to contain dangerous levels of lead (CPSC, 2003). Additionally, the ingestion of billiard (pool) cue chalk has been indicated in cases of childhood lead poisoning in both Europe and the United States (Dargan, Evans, House, & Jones, 2000). Millions of people play billiards each year and most do so in their homes (Miller et al., 1996). In addition to the direct ingestion of cue chalk, fine chalk dust may settle on the billiard table, the floor, the player's clothes, and surrounding surfaces in the home, further posing a lead risk to small children (Dargan et al., 2000). The cue chalks suspected in the poisoning cases were found to contain over 7000 ppm lead (Miller et al., 1996).

Imported Candies

Unfortunately, some sources of exposure to lead are items which are intended to be eaten by children. United States health officials, and particularly those in California, have put forth a great effort to begin educating the public about "toxic treats" (O.C. Register, 2004). Toxic treats are identified as candies which exceed the United States Food and Drug Administration (FDA) recommendations for a maximum lead level of 0.1 ppm in candy likely to be consumed frequently by small children (FDA, 2006).

The identified candies are most often imported from Mexico, and typically contain the popular ingredients of tamarind and chili, which are mostly absent from domestic

U.S. candies (FDA, 2006). Tamarind is the pulp of the fruit from the *Tamarindus indica* tree and is found in a variety of imported products (Lynch, Boatright, & Moss, 2000). Tamarind has a sticky consistency which makes for easy attachment of lead from pesticides or soil. Chili, which is a major ingredient in many imported candies, can also be contaminated with lead (Medlin, 2004). Unwashed chilies may be milled with leaded soil, they may be air-dried and exposed to leaded vehicular exhaust or fire-dried and exposed to petrochemical fires, or they may be milled in machines with lead solder or other components (Medlin, 2004). All of these sources contribute to the risk of lead poisoning associated with chili in imported candies.

In 2004, The Orange County Register tested and identified 112 distinct brands of imported candy; among these were Chaca Chaca, Tama Roca, Vagabundo, Lucas, and Vero, which were contaminated with unsafe levels of lead. Many of the identified brands had been previously implicated in childhood lead poisoning cases (CDC, 2002). In addition to the candies themselves, some candy wrappers and special packaging, like small clay pots or straws, may also contain unsafe levels of lead, some reported as high as 21,000 ppm. Continued ingestion of imported candies can easily expose a child to lead levels which exceed the FDA's 6µg/dL provisional tolerable daily intake level (PTIL) for children under 6 years old (FDA, 2006).

Home Goods

Children may also be put at risk for lead exposure through their family's use of certain lead-contaminated home goods. Alternative sources found in the home environment must be considered when children present with lead poisoning and

traditional sources, such as paint, dust, soil, and water have been excluded (Shannon, 1998).

Glazed Pottery and Ceramics

The use of glazed pottery and ceramics in the home has long been associated with elevated blood lead levels in children. The primary glaze on these products is typically lead oxide and, unfortunately, the glaze is often not heated to temperatures sufficient enough to heat-fix the lead (Lynch et al., 2008). As such, lead can easily leach from the pottery and ceramics into food during normal preparation and food storage, which subsequently poses a risk to the child, or any family member, who consumes the lead-contaminated food (Lynch et al., 2008). Although especially popular in the Hispanic population in the form of bean pots, commercially manufactured dinnerware from other countries has also been indicated in childhood lead poisoning cases (CDC, 2004a). Some studies have found that increased frequency of use of lead-glazed pottery and ceramics is directly associated with elevated blood lead levels in children (Azcona-Cruz, Rothenberg, Zamora-Munoz, & Romero-Placeres, 2000). The risk of exposure to lead also seems to increase with the age of such products. Repeated abrasive cleaning and use can further deteriorate the glaze and free more lead for consumption (Wallace, Kalman, & Bird, 1985). Additionally, many glazed pots and ceramics are manufactured in the home, making environmental contamination by lead dust created during the glazing process a further risk for childhood exposure (Katagiri, Toriumi, & Kawai, 1983).

Leaded Crystal

The addition of lead to glass began in the United States in the late nineteenth century. The use of between 24-32% lead oxides, as additives, increases the density, durability,

and brilliance of so-called leaded crystal (Graziano & Blum, 1991). The risk of acute lead poisoning exists with use of these products, as some studies suggest that lead can begin to leach from crystal within minutes (Graziano & Blum, 1991). Potable liquids stored in leaded crystal for long periods may also contain lead in extremely high concentrations. Additionally, lead is released from crystal in direct proportion to the acidity of the liquid it contains (Barbee & Constantine, 1994). Consequently, although leaded crystal is often used for the storage and enjoyment of alcoholic spirits, the risk of exposure remains for any child who drinks from a leaded crystal bottle or cup.

Pewter

Pewter is an alloy of primarily tin, with copper, bismuth, antimony, or lead added to harden and provide durability to the finished product. The lead content of pewter hollowware (domestic products such as bowls and cups) had historically been approximately 4%. However, given the potential risk of lead poisoning, modern-day pewter may contain no more than 0.5% lead (Hull, 2005). However, the use of antique pewter goods of unknown lead concentrations, therefore, still presents an additional opportunity for exposure to children.

Painted or Soldered Cooking and Dinnerware

Painted or soldered cooking and dinnerware may also contain unsafe levels of lead. The presence of solder, a metal alloy containing lead, has been found to increase lead levels in food by as much as 10% (ATSDR, 2007b). Due to the risk of lead poisoning associated with such products, the use of lead in paints and solder has decreased dramatically over the past three decades (Wigle, 2003). Hereto, antique pieces

manufactured before applicable regulations, may still be in use and pose a threat to children, in some cases resulting in lead poisoning (Shannon, 1998).

Metallic or Vinyl-Lined Lunchboxes

Lead has also been identified as a contaminant in some metallic and vinyl-lined lunchboxes used by children. Many of the identified lunchboxes are designed for use specifically by children, emblazoned with popular television characters, but others are manufactured by companies which typically specialize in adult outdoor apparel (Daluga & Miller, 2007). In contaminated products, the lining of the lunchbox was the primary source of lead. This is cause for concern, as contact with food is most likely with the interior of the lunchbox (CEH, 2008). Some lunchboxes have been found to contain lead as high as 25 times the regulatory limit for lead in paint (Daluga & Miller, 2007). Despite these alarming levels, the lead content is not suspected to be capable of acute lead poisoning with normal use. However, children with multiple exposure sources may increase their lead burden with continued use of contaminated lunchboxes (CEH, 2008).

Ethnic Remedies or Cosmetics

Many traditional ethnic remedies and cosmetics have been found to contain lead at unsafe levels. The presence of lead may be intentional, if thought to be useful in treatment of illness, or may be unknowingly introduced into the product during preparation. Unfortunately, it is impossible to identify the presence of lead visually or through the taste of such products. Additionally, even a small amount of lead contamination may be harmful to children. Therefore, the risk of childhood lead poisoning increases through the use of ethnic remedies and cosmetics (CDC, 2009b). Adding to the problem, there is often a reluctance to report the use of ethnic remedies and

cosmetics by family members of children with elevated blood lead levels, either out of fear of punishment or because they do not recognize the product as an "ethnic remedy" (CDC, 1993).

Azarcon

Azarcon is a traditional Hispanic remedy for the treatment of stomach ailments, collectively known as empacho (CDC, 2009b). Azarcon is an orange powder which may contain up to 95% lead tetroxide (Pb_30_4) and is administered orally to the ailing child. The use of azarcon has been connected to numerous childhood lead poisoning cases. Often the problem is confounded, as symptoms of lead poisoning may mimic empacho, therefore the poisoned child may be given additional azarcon treatments (Bose, Vashistha, & O'Loughlin, 1983).

Litargirio

Litargirio is a yellow or peach lead oxide (PbO) powder. It is most commonly used as an antiperspirant/deodorant in the Hispanic community, but may also be used as a remedy for skin burns or fungal infections. Litargirio is typically manufactured in the Dominican Republic and can be purchased in local markets. Litargirio has been implicated in childhood lead poisoning cases and, in such cases, the remedy was found to contain as much as 79% lead. In response to such cases, the FDA has issued alerts about the dangers of litargirio use (CDC, 2005).

Ghasard

Ghasard is a popular remedy in India given to children to ease digestion (Karri, Saper, & Kales, 2008). It is a brown powder, which is used to create tonic (CDC, 2009b). It has

been indicated in the lead poisoning death of a young child in Florida. The remedy was 1.6% lead by weight and had been given daily to the child for some time (CDC, 1984).

Sindoor

Sindoor is an orange-red powder, with a high lead oxide (PbO) content, traditionally used as a cosmetic by Hindu women as an expression of their marital status. The powder can be used to form a traditional bindi dot on the woman's forehead or spread along the part of her hair. Although not intended to be ingested, cases of sindoor use as a food coloring agent have resulted in lead poisonings of both children and adults (Vassilev et al., 2005). In response, the FDA has issued numerous warnings urging consumers to cease and avoid use of sindoor, as both a food additive and as a cosmetic, due to the dangerous level of lead found in the product (FDA, 2007).

Greta

Greta is also a traditional Hispanic remedy used for the treatment of empacho. Greta is an orange powder composed of approximately 89% lead oxide (PbO). The goal of greta use is to relieve the body of blockages in the intestines; therefore, diarrhea is seen as a sign of successful treatment. Unfortunately, as mentioned above, the diarrhea may actually be a symptom of acute lead poisoning (Trotter, 1985). Greta is often used as a glaze in traditional Hispanic pottery, and so is widely available from pottery suppliers (Baer, Garcia de Alba, Cueto, Ackerman, & Davidson, 1989). There seems to be considerable variation in the regional use of greta versus azarcon, but both are identified as cures for severe empacho (Trotter, 1985). Some studies suggest that their use is greater in poorer communities (Baer, Garcia de Alba, Mares Leal, Plascencia, & Goslin, 1998). However, there seems to be no discrepancy in the notion that use of these

empacho remedies poses significant lead poisoning risks to children treated with them (Trotter, 1985).

Surma, Kohl, and Kajal

The use of eye cosmetics has been identified as a traditional practice dating back to the time of the Ancient Egyptians. Often lead, in the form of lead sulfide (PbS), provided the distinct dark gray color desired for eye cosmetics (Witkowski & Parish, 2001). Known as surma, kohl, or kajal, depending on the region, these eye cosmetics continue to be traditionally used in the Middle East, India, and some parts of Africa, by children and adults of both genders. These products may contain up to 25% lead (Jones, Moore, Craig, Reasons, & Schaffner, 1999). These products are considered primarily decorative, however, in some studies participants have indicated that they believe these cosmetics also provide medical benefits to the eyes (Mojdehi & Gurtner, 1996). Some also use these products as a teething powder to promote strong teeth and gums (Karri et al., 2008). While these benefits cannot be established, the connection of the use of surma, kohl, or kajal to childhood lead poisoning cases has been confirmed (Mojdehi & Gurtner, 1996).

Moonshine

Moonshine is one designation for liquor which is illicitly distilled in the United States. Moonshine has historically had issues with lead contamination and associated adult lead poisonings. During its production, lead often leaches from the solder and automobile radiators, used to create ground stills, into the moonshine itself (Holstege, Ferguson, Wolf, Baer, & Poklis, 2004). Although not traditionally ingested by children, homes where moonshine is produced may provide opportunities for contact with lead-contaminated products and increase the risk of lead exposure to children.

Other Ethnic Remedies

The CDC has identified numerous other ethnic remedies and cosmetics which pose a lead exposure risk. Paylooah is a popular Southeast Asian remedy for the treatment of fever and rash. Similar to the Hispanic remedies azarcon and greta, kandu is an Asian remedy, in the form of a red powder, used to treat stomach ailments. Also in Asian communities, bali-goli is used to treat stomach aches. Bali-goli is a black bean that gets dissolved in “grip water” (IDPH, 2008). Finally, the use of ceruse, also known as lead acetate [$Pb(C_2H_30_2)_2$], was historically used by Ancient Greeks and Romans as a face whitener may still pose a risk if used today in traditional cosmetics (Witkowski & Parish, 2001).

Household Member Occupation

In addition to risks posed by familial hobbies, childhood exposure to lead may also be an unknown consequence of their household members' occupations. Occupational sources of lead poisoning in adults are well documented, and the secondary exposure to their children is becoming better understood (Dolcourt, Hamrick, O’Tuama, Wooten, & Barker, 1978). Often workers in lead industries are not trained adequately about lead safety and are unaware of the risk they pose to their children when they bring lead home; wearing the same clothes while working with lead and then returning home inevitably transfers harmful lead dust (Gerson, Van Den Eeden, & Gahagan, 1996). Some studies have found that clothes closets inevitably are contaminated with the greatest quantities of lead (Dolcourt et al., 1978). Another found that dust shaken from a mine worker’s clothes exceeded 3000 ppm lead (Chiaradia, Gulson, & MacDonald, 1997). These sources of lead exposure (contaminated clothes, shoes, and skin) are collectively

becoming known as “take-home exposure.” Unfortunately, not all household members are aware that lead exposure is a known hazard of their occupation, and certain protections are only afforded to workers exposed to airborne lead at concentrations of 50µg/m^3 or greater (Hipkins, Materna, Payne, & Kirsch, 2004). Even when the risks are known and precautions are taken (showering at work, changing from work clothes to street clothes, and taking clothes to commercial laundries), lead dust can be found in the home environment attributed to occupational exposure (Chiaradia et al., 1997).

This is an alarming fact, given that lead can be identified as a component of more than 100 industries (Hipkins et al., 2004). Elevated blood lead levels in children have been associated with household member occupation related to radiator repair, work with lead batteries, gun ranges, copper foundry, and construction (Gerson et al., 1996). Sadly, as with many lead exposures, children poisoned through these “take-home exposures” often are asymptomatic (Hipkins et al., 2004).

Human Health Effects

Lead is a xenobiotic metal, and therefore, is not expected to be present normally in the human body (Karri et al., 2008). Unfortunately, the anthropogenic uses of lead have resulted in lead being ubiquitous in the environment and have resulted in lead body burdens being detectable for all humans, to some degree (CDC, 1992). For example, the current U.S. background blood lead levels are below 5µg/dL (Karri et al., 2008). The degree to which adverse health effects are experienced is typically representative of blood lead level, although at many blood lead levels, an exposed individual will not look or act sick (USEPA, 2004). As of 1991, the CDC has identified 10µg/dL as a blood lead level

associated with lead toxicity in children (Williams et al., 2000). At this level of concern, CDC recommends lead educational materials be provided, as well as, diagnostic and follow-up testing within three months (ATSDR, 2007a). Table 2 is a listing of the CDC recommended actions based on detected blood lead levels.

Table 2: Blood Lead Levels and Corresponding Recommended Actions (Wigle, 2003)

Blood Lead Level	**Recommended Action**
<10µg/dL	Rescreen in 1 year; reassess if exposure sources change.
10-14µg/dL	Provide follow-up testing, lead education, and refer to social services if necessary.
15-19µg/dL	Same actions as the 10-14µg/dL range; proceed to actions of 20-44µg/dL range if levels persist in current range (or increase) at two follow up screens, separated by a minimum of 3 months.
20-44µg/dL	Provide case and clinical management; provide environmental investigation and begin lead-hazard controls.
45-69µg/dL	Within 48 hours, begin all actions above.
70µg/dL and above	Immediately hospitalize and begin medical treatment; immediately begin all actions above.

Unfortunately, adverse cognitive effects have been found in children with blood lead levels below 5µg/dL, which is well below the current action level (Schmidt, 2008). Exposure to even relatively low levels of lead can cause a myriad of devastating health

consequences. Large acute exposures to lead, and lower dose chronic exposures, can both adversely and irreparably affect numerous body systems (USEPA, 2004).

Nervous System

The nervous system is the human body system most affected by exposure to lead. Lead can damage or kill brain cells and impair the function of nerves (USEPA, 2004). Lead adversely affects nerve synapse formation and results in the failure of nerves to properly convey chemical messages (Wigle, 2003). Impaired nervous system function can result in body shakes, wrist or ankle weakness and drop, clumsiness, hallucinations, and irritability. At high lead exposures brain swelling (encephalopathy), coma, and death may occur (USEPA, 2004).

Circulatory System

Absorption of lead into the body results in the incorporation of lead into red blood cells. The presence of lead inhibits heme synthesis, altering hemoglobin production, which eliminates the ability of red blood cells to carry oxygen (USEPA, 2004). Further, lead can reduce the body's ability to produce more red blood cells, deplete hormones responsible for red blood cell maturation, and shorten the lifespan of existing red blood cells (USEPA, 2004). This depletion often results in anemia, increased blood pressure, and stresses the heart (Su et al., 2002).

Renal Function

The filtering of lead-contaminated blood occurs in the kidneys. Here, approximately 65% of the lead circulating in the blood at a given time is filtered and deposited (USEPA, 2004). As a result, lead can decrease the glomerular filtration rate of the kidneys, which can consequently result in increased systemic blood pressure (Su et al., 2002). At low

levels of exposure, lead can also impair the transport of proteins and glucose, resulting in the improper excretion of enzymes, proteins, and sugars in the urine (ATSDR, 2007b). At high levels of exposure, large amounts of lead can result in gout, which ultimately causes renal failure and death in 10% of the afflicted cases (CDC, 1992).

Reproductive System

Exposure to lead can be especially harmful to the reproductive health of women. Lead can decrease fertility, cause miscarriages, and cause premature deliveries (USEPA, 2004). To a lesser extent, lead may adversely affect the male reproductive system as well. Chronic lead exposures have been associated with lower sperm counts in men (Su et al., 2002). Further, lead can also easily pass through the placenta from mother to child (CDC, 1992). As such, babies born to lead poisoned mothers show reflective lead body burdens, and often suffer from birth defects, low birth weights, as well as, learning and behavioral problems later in life (USEPA, 2004).

Other Adverse Health Effects

Although the body systems mentioned are the most sensitive targets for lead poisoning, lead can potentially affect any and all systems in the body. The CDC and USEPA have also designated lead as a probable human carcinogen (Group B2), based on sufficient evidence from animal studies and limited evidence from human studies (Williams et al., 2000).

Susceptibility of Children

Lead is considered the most significant environmental hazard for children in the United States (USEPA, 2004). “Children are particularly at risk [for lead poisoning] due

to sources of exposure, mode of entry, rate of absorption and retention, and partitioning of lead in soft and hard tissues. The greater sensitivity of children to lead toxicity, their inability to recognize symptoms, and their dependence on parents and health care professionals makes them an especially vulnerable population" (USEPA, 1986, p. 12-2). It is important to note that no child is free from the risks associated with lead exposure (ATSDR, 2007a). Table 3 suggests possible health effects experienced by children with indicated blood lead levels.

Table 3: Child Reactions to Lead (USEPA, 2004)

Blood Lead Level	**Possible Health Effects**
10µg/dL	Slight loss in IQ; hearing and growth problems
20µg/dL	Moderate loss in IQ; hyperactivity; poor attention span; difficulty learning; language and speech problems; slower reflexes
40µg/dL	Poor bone and muscle development; clumsiness; lack of coordination; early anemia; fewer red blood cells to carry oxygen and iron; tiredness; drowsiness
50µg/dL	Stomach aches and cramps; anemia; destruction of red blood cells; brain damage
100µg/dL and above	Swelling of the brain; seizures; coma; death

Children have an increased risk of lead exposure due to their unique physiology and behaviors. With a rapidly developing brain and central nervous system, children can be poisoned by even a small dose of lead (USEPA, 2004). The blood-brain barrier is

incomplete in young children and this condition exacerbates the toxic effects of lead on the nervous system (CDC, 1992). Additionally, children are often exposed to lead at higher concentrations due to their proximity to contaminated floors and an increased frequency of hand-to-mouth behaviors (USEPA, 2004). Children also have greater rates of respiration than do adults, which increase their risk of airborne exposures (ATSDR, 2007a).

In the long term, lead poisoned children have poor growth, development, and coordination; speech, hearing, and language problems; and may have other attention and learning disorders (USEPA, 2004). Decreases in IQ, of between 1 to 5 points, have been associated with childhood blood lead levels of 10μg/dL or less, and the cognitive deficits seem to compound with age (ATSDR, 2007b). Some studies suggest that one quarter to one half of an IQ point may be lost with each 1μg/dL increase in blood lead (Su et al., 2002). Lead poisoned children also have higher rates of absenteeism, lower class standings, and overall lower high school graduation rates (CDC, 1992). Unfortunately, evidence suggests that there is no threshold for the toxic effects of lead in children (ATSDR, 2007b).

CHAPTER 3

METHODOLOGY

Collection of Data

Prior to the start of data collection, the University of Nevada, Las Vegas (UNLV), the University of Nevada, Reno (UNR), and the University Medical Center of Southern Nevada (UMC) Institutional Review Boards (IRBs) each granted approval for the use of human subjects in the collaborative study (APPENDIX 1). Upon approval recruitment for the study began in October 2008.

Potential participants were approached at two pediatric outpatient healthcare clinics in Las Vegas, Nevada and were asked to participate in the Clark County Children's Lead Screening Study, a grant project sponsored by the Trust Fund for Public Health. Potential participants were children, between the ages of one year to six years old who were patients, or siblings of patients at either Lied Pediatric Center (1524 Pinto Lane, Las Vegas, NV 89106) or Kid's HealthCare (3006 S. Maryland Parkway, Suite 315, Las Vegas, NV 89109), both affiliates of the University of Nevada, School of Medicine (UNSOM). Children outside of the specified age range, children who were wards of the state, and children who had been previously tested for lead exposure were excluded from the study.

Investigators approached potential participants in their private patient rooms, immediately following the patient's triage or prior to the patient's discharge. Every effort was made not to impede the patient's medical care. When the parent or legal guardian of the potential participant was approached, investigators explained the study, answered

questions, and provided educational materials (APPENDIX 4) developed by the Southern Nevada Health District (SHND).

The educational materials included information regarding common items where lead may be found, the dangers of lead exposure to children (specifically the adverse health effects), and the need for childhood screening to prevent lead poisoning. The materials also offered free residential lead inspections to families living in homes built prior to 1978. The educational materials were available in both English and Spanish, and were provided to all potential participants regardless of their subsequent decision whether or not to participate in the study. Ample time was provided for potential participants to review all study information and educational materials, before investigators inquired about a decision regarding participation.

Once a parent or legal guardian agreed to their child's participation in the study, appropriate (English or Spanish) Parental Permission and Authorization to Use Health Information forms were completed (APPENDIX 2). Numerous parental or legal guardian initials and signatures were obtained to signify consent. Parental Permission and Authorization to Use Health Information forms were approved by the Institutional Review Boards of all participating institutions. The original signed copies of all forms were retained for the research file, while a photocopy of all signed forms was provided to the study participant.

Once permission was granted, the parent or legal guardian then completed a brief questionnaire (APPENDIX 3) detailing the child's potential exposure to lead, as well as, additional personal information. Potential exposure to lead was measured through five questions pertaining to the child's eating, chewing, or sucking habits of non-food items,

the child's ingestion of imported candies, the family's use of certain types of home goods (i.e. glazed pottery, painted cookware), the family's use of ethnic remedies or cosmetics, and the family's exposure to lead in their occupation. Should elevated blood lead level (EBLL) children be identified, the questionnaire would also serve as a useful tool during the subsequent environmental investigation, particularly for guidance in the area of atypical sources of exposure. Completion of the questionnaire typically required less than ten minutes of the parent or legal guardian's time.

After completion of the questionnaire, participants were asked to give a blood sample to be used for blood lead level analysis. Blood samples were collected via venipuncture at the clinics or at a nearby Quest Diagnostics Laboratory. The samples were usually drawn from the participant's arm, with a minimum of 3cc of blood collected. The amount of blood collected from participants met IRB requirements and represented an appropriate standard for blood tests of this nature.

At Kid's HealthCare, a certified Quest Diagnostics Laboratory Technician completed the blood draws for participants on-site, after receipt of the pre-paid blood lead test request form. At Lied Clinic, a resident or attending physician would complete blood draws, when able. Blood samples were then properly labeled with patient information, a pre-paid blood lead test request form was included with each sample, and the sample was put in a refrigerator for Quest Diagnostics Laboratory pick-up. When blood draws could not be completed on-site for any reason, participants were provided with the pre-paid blood lead test request form, as well as, instructions and directions necessary for the later completion of a blood draw at a nearby Quest Diagnostics Laboratory.

All venous blood samples collected on-site or at Quest Diagnostics, were analyzed for lead content by Quest Diagnostic Laboratories (33608 Ortega Highway, San Juan Capistrano, CA 92675). All blood lead level laboratory results were sent to the patient's respective clinic for review by the investigators and the patient's physician, and for inclusion in the patient's medical record file. The venous blood lead levels for each participant were reported in µg/dL, with a method detection limit of 3µg/dL.

In April 2009, an additional blood collection method was approved by all involved IRBs. In addition to a venous blood draw on-site or at a Quest Diagnostics Laboratory, study participants were offered the option to provide a blood sample via a capillary finger stick at the Southern Nevada Health District (SNHD, 625 Shadow Lane, Las Vegas, Nevada 89106). Investigators arranged weekly appointments on Wednesdays for participants to receive capillary blood tests from certified personnel at SNHD. SNHD utilized the CDC-approved LeadCare® II system for the determination of lead in blood, collected via capillary finger stick (Magellan, 2009). Results from the capillary tests were reported in µg/dL, with a detection limit of 3.3µg/dL. Results were available to the participants within minutes and were retrieved by investigators weekly. All capillary finger stick results were also reviewed by the patient's physician and were included in the patient's medical record file.

The blood lead level results from both methods were then compared to the current Centers for Disease Control and Prevention guidelines for classification. Participants with blood lead levels at or above 10µg/dL would be considered to be at the level of concern. Diagnostic, venous blood testing was required for any capillary results ≥10µg/dL (SNHD, 2007). In all elevated cases, the Clark County Lead Poisoning

Prevention Program would be notified and a case file would be opened for said participant. All detectable (above detection limit) blood lead level results were automatically reported to Southern Nevada Health District per Clark County mandate.

Treatment of Data

All data collected as part of the Clark County Children's Lead Screening Study were maintained in secure research files. Research files contained applicable Parental Permission and Authorization to Use Health Information forms, questionnaires, and copies of blood lead level results (when available). Investigators completed UNLV's Office for the Protection of Research Subjects Collaborative Institutional Training Initiative (CITI) program and University Medical Center's Health Insurance Portability Accountability Act (HIPAA) training to ensure proper handling of research files to maintain participant privacy and confidentiality.

Information from the research files was accessible only to investigators and was entered directly into SPSS Statistics software through the use of a password-protected notebook computer. In addition to personal data, responses to each of the five questions on the questionnaire were entered individually to allow for statistical analysis of each hypothesis, as indicated in CHAPTER 1. Analysis of data obtained from the questionnaire is listed in CHAPTER 4 FINDINGS OF THE STUDY.

CHAPTER 4

FINDINGS OF THE STUDY

Analysis of Data

Demographic Data

Recruitment for the study began on October 20, 2008 and was terminated on June 19, 2009. In total, 1,048 families were approached for participation in the study and were provided educational materials from Southern Nevada Health District (SNHD) regarding common items where lead may be found, the dangers of lead exposure to children, and the need for childhood screening to prevent lead poisoning (APPENDIX 4). Additionally, the 1,048 families were offered free residential lead inspections for those living in homes built prior to 1978. One family who participated in the study accepted the offer and did receive a free residential inspection of their home.

Of the 1,048 families approached, 811 participants were initially enrolled in the study (initial participation rate of 77.4%). The 811 participants completed the required Parental Permission and Authorization to Use Health Information forms for each involved institution and a parent or legal guardian also completed the questionnaire. No demographic or other information was obtained from the 237 families which declined participation in the study.

The final population of participants in the study was reduced to 564. Of the original 811 participants, 247 were ultimately excluded as they failed to provide a useable blood sample for analysis. The final population is representative of a participation rate of 53.8%. Of the 564 participants, 435 (77.1%) were recruited from Lied Clinic and 129 (22.9%) were recruited from Kid's HealthCare.

The gender distribution of the 564 participants was 55.5% male (n = 313), with females representing 44.5% (n = 251) of the total population. The majority of the participants were aged 1 year (37.2% of the total population, n = 210), with a mean age of 2.57 ± 1.618 years. The age distribution of the participants can be seen in Figure 1. The percentages in Figure 1 are indicative of each ages' relative representation within each sex.

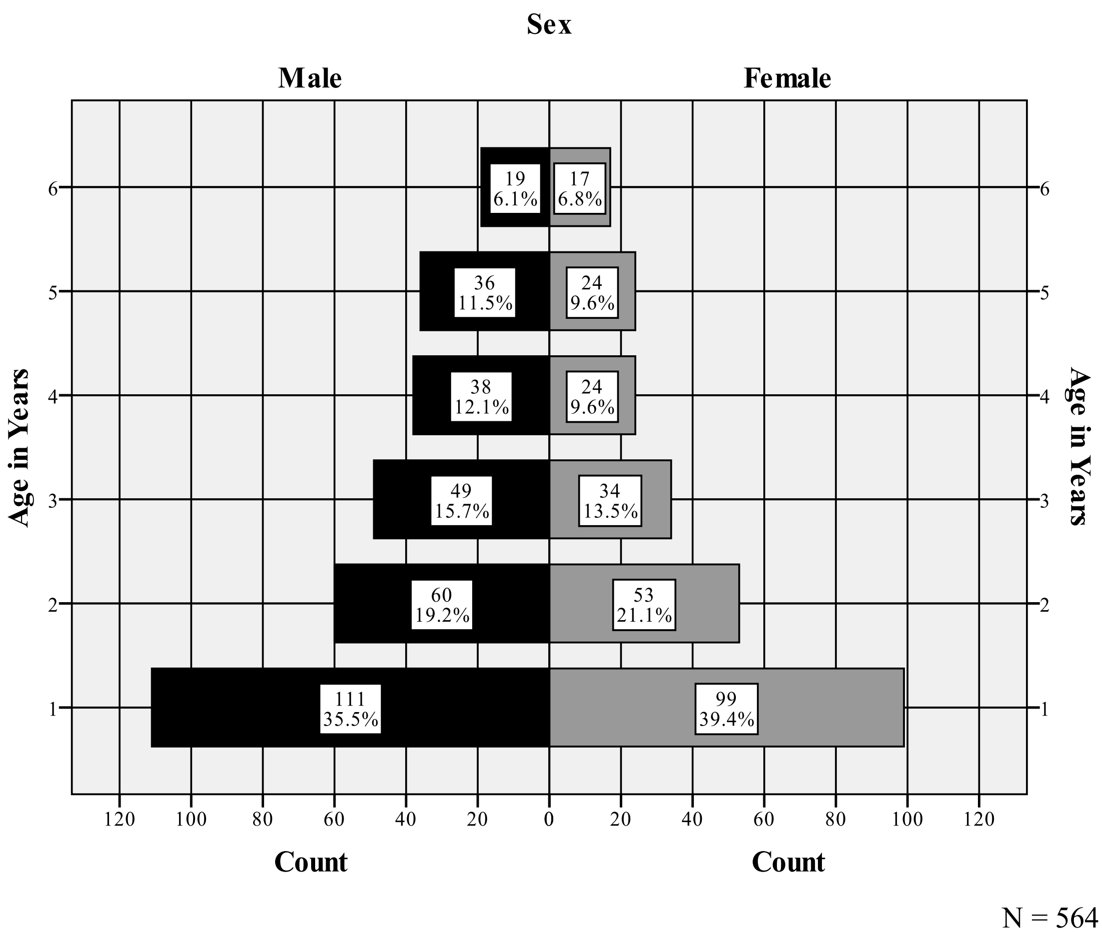


Figure 1: Age/Sex Distribution of Study Participants

The large majority of participants were of Hispanic race (75.9%, n = 428), the majority of whom further identified their ethnic background as Mexican, Mexican-American, Chicano, or Chicana (n = 286, 50.7% of the total population, 66.8% of the Hispanic population). Of the Hispanic participants, 27 (4.8% of the total population) identified their ethnic background as Central American, 5 (0.9% of the total population) identified some other Hispanic ethnicity, and 110 (19.5% of the total population) did not indicate a specific ethnic background. Only three non-Hispanic participants declined to provide additional information regarding their specific ethnicity. The ethnic distribution of the remaining 133 non-Hispanic study participants can be seen in Figure 2.

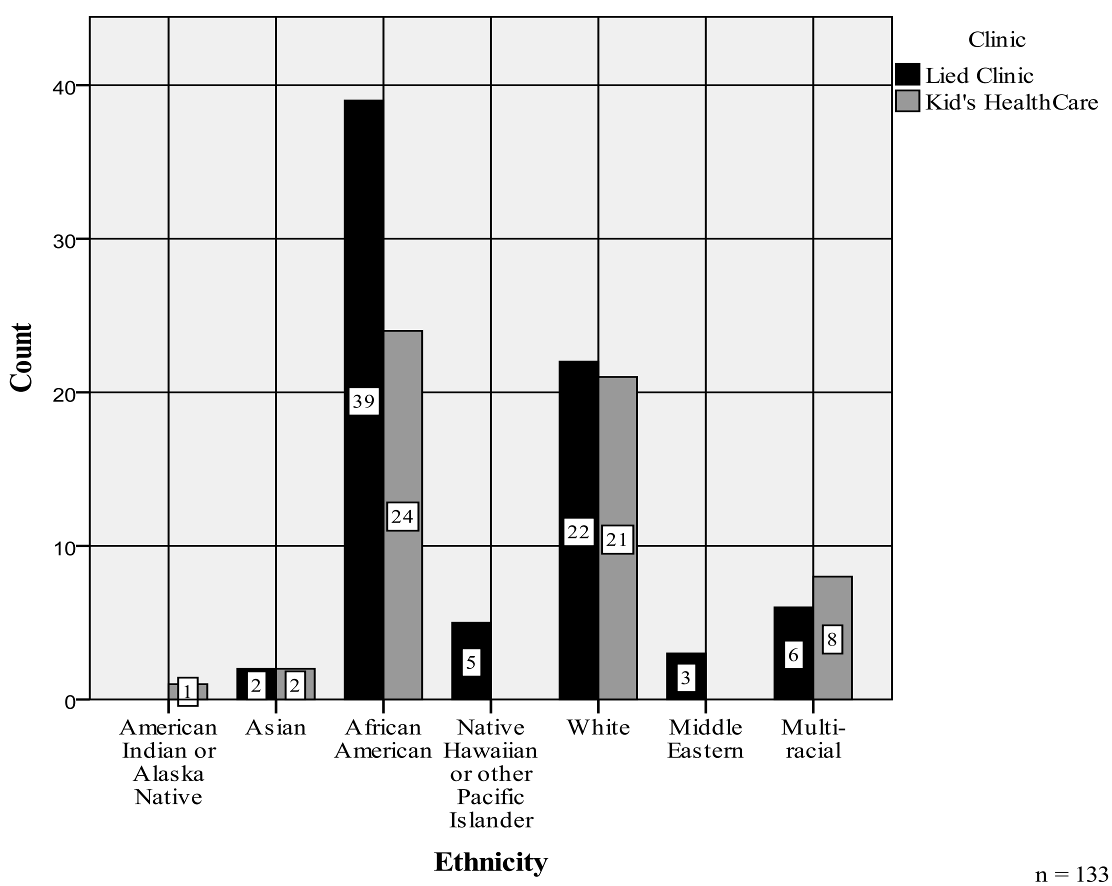


Figure 2: Distribution of Non-Hispanic Ethnicity by Recruiting Clinic

Nearly half of the participants (42.6%) were recruited from five local area codes. Area codes 89101, 89102, 89106, 89108, and 89110 had the highest representation of participating residents with 52 (9.2%), 47 (8.3%), 51 (9.0%), 49 (8.7%), and 42 (7.4%), respectively. Figure 3 depicts 37 zip codes, identified with stars, where recruited participants reside. Additional zip codes, which cannot be seen in Figure 3, also contributed study participants: two in Las Vegas (89112 and 89169), two in Henderson (89002 and 89044), and two in North Las Vegas (89036 and 89081), one in Moapa (89025), and one in Pahrump (89048). In total, study participants resided in 45 representative Southern Nevada zip codes.

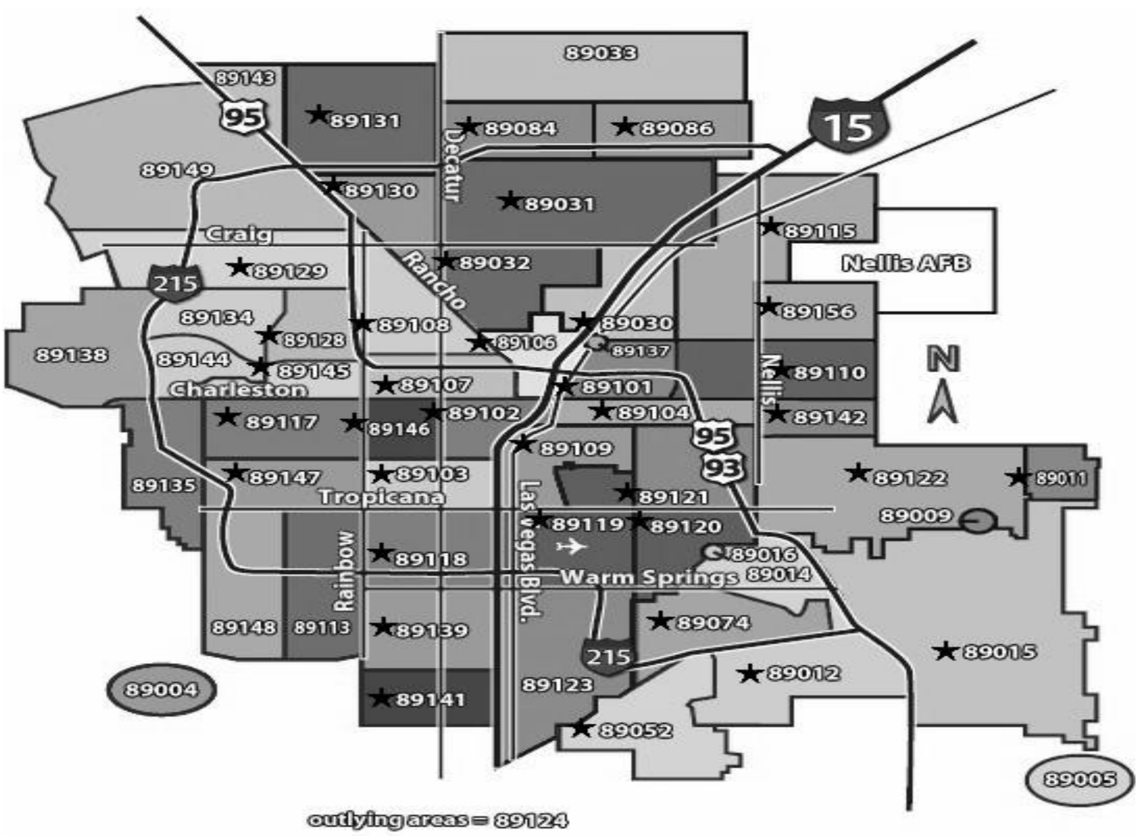


Figure 3: Resident Southern Nevada Zip Codes of Study Participants

(Map Source: http://www.lasvegas4us.com/greater_las_vegas_zip_code_map.htm)

The majority of participants were insured by Medicaid (*n* = 420, 74.5%), while another 79 participants (14.0%) had private medical insurance. Of the 564 participating children, 65 (11.5%) were uninsured. The majority of uninsured participants were recruited from Lied Clinic (*n* = 52, 80.0% of the uninsured population), while the majority of those with private insurance were recruited from Kid's HealthCare (*n* = 46, 58.2% of the privately insured population).

Questionnaire Data

Questionnaires were completed for all 564 children participating in the study. The questionnaire (APPENDIX 3) was comprised of five questions:

1. Does the child have a habit of eating, chewing, or sucking non-food items?
2. Does the child eat any imported candies?
3. Does the family use any of the following products?
4. Does the family use any home or ethnic remedies, condiments, spices or additives?
5. Does anyone in the child's household work with lead?

Question 1 (Does the child have a habit of eating, chewing or sucking non-food items?), hereby abbreviated Non-Food Items, listed nine optional applicable responses, of which, any and all affirmative responses could be checked. Additionally, an "Other" category could also be indicated, with a space for write-in responses. By far, the greatest number of participants answered affirmatively to this question. The frequency of responses to Non-Food Items can be seen in Table 4.

Table 4: Responses to Non-Food Items

Question 1: Does the child have a habit of eating, chewing, or sucking non-food items?							
	Response	**Frequency**	**Percent**		**Response**	**Frequency**	**Percent**
Paint Chips	No	536	95.0	**Soil**	No	503	89.2
	Yes	28	5.0		Yes	61	10.8
Jewelries	No	490	86.9	**Metallic Accessories**	No	493	87.4
	Yes	74	13.1		Yes	71	12.6
Pellets	No	509	90.2	**Chalk**	No	551	97.7
	Yes	55	9.8		Yes	13	2.3
Toys	No	239	42.4	**Fishing Sinkers**	No	558	98.9
	Yes	325	57.6		Yes	6	1.1
Bullets	No	560	99.3	**Other**	No	513	91.0
	Yes	4	0.7		Yes	51	9.0

n = 564

Of the 51 responses to "Other", the most commonly listed items were: fingers, thumbs, and hands; keys; books and paper; and pens, crayons, and markers. There were seven write-in responses for the first two aforementioned categories and six responses for each of the latter two categories. A number of questionnaires also indicated that children put rocks (five responses), crib rails (two responses), hair (one response), carpet, blankets, and stuffed animals (three responses), cans, plastic, straws, and strainers (one each, for a total of four responses), shoes and shoe strings (two responses), remote controls and batteries (one response), money (one response), and pacifiers (one response) into their mouths. Still others were more vague and indicated that children put "different objects into their mouth" (one response), "everything" (two responses), and "anything into their mouth" (one response). Only one respondent failed to identify what was indicated by their "Other" response.

Question 2 (Does the child eat any imported candies?), hereby abbreviated Imported Candies, listed eight brands or types of imported candy, which are shown in the literature to have been historically associated with lead contamination. Any and all affirmative responses could be checked. An "Other" category could also be indicated, with a space for write-in responses. The frequency of responses to Imported Candies can be seen in Table 5.

Table 5: Responses to Imported Candies

Question 2: Does the child eat any imported candies?

	Response	Frequency	Percent		Response	Frequency	Percent
Chaca Chaca	No	556	98.6	**Saladulces**	No	546	96.8
	Yes	8	1.4		Yes	18	3.2
Paleta	No	376	66.7	**Tamarindo**	No	479	84.9
	Yes	188	33.3		Yes	85	15.1
Tama Roca	No	554	98.2	**Vero**	No	531	94.1
	Yes	10	1.8		Yes	33	5.9
Vagabundo	No	562	99.6	**Other**	No	553	98.0
	Yes	2	0.4		Yes	11	2.0
Lucas	No	449	79.6				
	Yes	115	20.4				

n = 564

Eleven participants indicated that their child eats an imported candy of a type or brand which differed from the listed options. Two responses indicated that the candy eaten was not of Mexican origin; one response each was indicated for English toffee and Spanish/Portuguese chocolate. Eight responses identified candies or other treats imported from Mexico. Galletas (cookies) and "acordias - marshmallow cookies" were indicated once each, in two separate responses. The remaining questionnaires indicated

that children eat “rocka paleta” (two responses), “muelas” (one response), “Pica Gomas” (one response), “Ricolino and coronado” (one response), and “paleta caramelo and paleta coronado de cajeta” (one response). The final write-in response indicated that the child eats “lollipops”.

Question 3 (Does the family use any of the following products?), hereby abbreviated Home Goods, listed five varieties of home goods, which have been shown in the literature to be associated with lead. Any and all affirmative responses could be checked. There was no write-in response option for this question. The frequency of responses to Home Goods can be seen in Table 6. The complete optional responses for Question 3 are not listed in full in the column headings of Table 6. For reference: Q3: Glazed Pots = Glazed Pots or Ceramics, Q3: Cook/Dinnerware = Painted or Soldered Cooking and Dinnerware, and Q3: Lunch Boxes = Metallic or Vinyl-Lined Lunch Boxes.

Table 6: Responses to Home Goods

Question 3: Does the family use any of the following products?

	Response	Frequency	Percent
Glazed Pots	No	491	87.1
	Yes	73	12.9
Leaded Crystal	No	543	96.3
	Yes	21	3.7
Pewter	No	473	83.9
	Yes	91	16.1

	Response	Frequency	Percent
Cook/ Dinnerware	No	475	84.2
	Yes	89	15.8
Lunch Boxes	No	542	96.1
	Yes	22	3.9

n = 564

Question 4 (Does the family use any home or ethnic remedies, condiments, spices or additives?), hereby abbreviated Ethnic Remedies, listed twelve ethnic remedies and cosmetics which have been associated with lead poisoning according to the literature. Any and all affirmative responses could be checked. Here again, an "Other" category could also be indicated, with a space for write-in responses. The frequency of responses to Ethnic Remedies can be seen in Table 7.

Table 7: Responses to Ethnic Remedies

Question 4: Does the family use any home or ethnic remedies, condiments, spices or additives?

	Response	Frequency	Percent
Azarcon	No	564	100.0
	Yes	0	0.0
Litargirio	No	564	100.0
	Yes	0	0.0
Paylooah	No	564	100.0
	Yes	0	0.0
Ghasard	No	564	100.0
	Yes	0	0.0
Kandu	No	564	100.0
	Yes	0	0.0
Sindoor	No	560	99.3
	Yes	4	0.7
Greta	No	564	100.0
	Yes	0	0.0

	Response	Frequency	Percent
Moonshine	No	562	99.6
	Yes	2	0.4
Ceruse	No	564	100.0
	Yes	0	0.0
Bala Goli	No	564	100.0
	Yes	0	0.0
Surma/Kohl	No	564	100.0
	Yes	0	0.0
Kajal	No	563	99.8
	Yes	1	0.2
Other	No	557	98.8
	Yes	7	1.2

n = 564

Seven questionnaires also indicated that other ethnic remedies, condiments, spices or additives were used in the home. Of those, three responses indicated use of drinkable tea

or teas, and two indicated use of tea tree oil. One additional response indicated use of "spice mix" and the final response indicated home use of Knorr-brand products.

Question 5 (Does anyone in the child's household work with lead?), hereby abbreviated Household Occupation, offered the opportunity for a dichotomous No/Yes response. However, those who provided an affirmative response were given space to write-in the identified occupation. In total, 127 questionnaires indicated possible "take-home exposure" to lead through occupation. The majority of responses indicated that construction was the most common occupation identified for possible lead exposure. "Construction" and additional frequent write-in responses to Occupation can be seen in Table 8.

Table 8: Responses to Household Occupation

Question 5: Does anyone in the child's household work with lead?							
	Response	**Frequency**	**Percent**		**Response**	**Frequency**	**Percent**
Construction	No	489	86.7	**Electrician**	No	560	99.3
	Yes	75	13.3		Yes	4	0.7
Welding/ Iron Work	No	558	98.9	**Renovation/ Landscaping**	No	553	98.0
	Yes	6	1.1		Yes	11	2.0
Mechanic	No	555	98.4	**Other**	No	542	96.1
	Yes	9	1.6		Yes	22	3.9

n = 564

Six additional write-in responses simply indicated the personal relationship of the potentially lead-exposed worker to the child or listed the name of the worker, but did not indicate the occupational field. For the remaining sixteen affirmative responses, respondents failed to provide any additional information.

Blood Lead Level Data

All 564 study participants provided a suitable blood sample for the analysis of blood lead concentration (or blood lead level, BLL), 435 of which were recruited at Lied Clinic. The remaining 129 blood samples were collected from children recruited at Kid's HealthCare. Of the total blood samples, 448 were collected via venous blood draw, while the remaining 116 were collected via capillary finger stick. The method detection limit for venous blood draws was defined by Quest Diagnostic Laboratories to be 3µg/dL. The method detection limit for the LeadCare® II System used for capillary finger stick analysis was defined as 3.3µg/dL.

Of the 564 total blood samples, 529 had undetectable levels of lead, based on their respective collection method detection limits. Of the venous samples, 436 had levels of lead below 3µg/dL, while 93 of the capillary samples were below 3.3µg/dL. All BLL laboratory results, according to both blood draw type and clinic of recruitment, can be seen in Table 9.

Table 9: Blood Lead Level Results by Clinic and Draw Type

Clinic			Draw Type		Total Count	Percentage
			Venous	**Capillary**		
LIED	BLL Lab Results (µg/dL)	<3	317	0	317	56.2
		<3.3	0	87	87	15.4
		3	4	0	4	0.7
		3.4	0	4	4	0.7
		3.5	0	2	2	0.4
		3.6	0	1	1	0.2
		3.7	0	2	2	0.4
		3.9	0	1	1	0.2
		4	4	0	4	0.7
		4.1	0	1	1	0.2
		4.2	0	2	2	0.4
		4.8	0	1	1	0.2
		5	1	0	1	0.2
		5.2	0	3	3	0.5
		5.4	0	1	1	0.2
		5.8	0	2	2	0.4
		6.4	0	1	1	0.2
		7	1	0	1	0.2
	Sub Total Detectable		10	21	31	5.5
	LIED Total		327	108	435	77.1
KHC	BLL Lab Results (µg/dL)	<3	119	0	119	21.1
		<3.3	0	6	6	1.1
		3.3	0	1	1	0.2
		3.6	0	1	1	0.2
		4	2	0	2	0.4
	Sub Total Detectable		2	2	4	0.7
	KHC Total		121	8	129	22.9
	Total Detectable		12	23	35	6.2
	Grand Total		448	116	564	100.0

Detectable BLL Group – Demographic Data

There were only 35 participants (6.2% of the total population) placed into the Detectable BLL Group, based on collection method detection limits. The majority of members in this group were recruited from Lied Clinic (*n* = 31, 88.6% of the Detectable BLL Group). Of those 35, the majority of members were male (*n* = 27, 77.1% of the

Detectable BLL Group). The mean age of the group was 2.29 ± 1.487 years, and although not statistically significant, female members (*n* = 8, 22.9% of the Detectable BLL Group) tended to be younger (mean age for females = 1.63 ± 0.916 years).

The majority of detectable BLLs were reported for Hispanic participants (*n* = 29, 82.9% of the Detectable BLL Group). The ethnic distribution for the remaining members of this group was equal and included: African-American, white, and multi-racial participants (*n* = 2, representing 5.7% of the group, for each ethnicity). Of the 29 Hispanic members in the group, twenty (57.1% of the Detectable BLL Group) were further identified as Mexican, Mexican-American, Chicano, or Chicana. Another two members (5.7% of the Detectable BLL Group) were Central American and the remaining seven members did not specify their ethnic background. Most of the participants with detectable BLLs were insured by Medicaid (*n* = 28, 80.0% of the Detectable BLL Group), and almost equal numbers were either privately insured or did not have medical insurance coverage (*n* = 3 and *n* = 4, respectively).

<u>Detectable BLL Group - Questionnaire Data</u>

All 35 members of the Detectable BLL Group completed the required questionnaire. A summary of questionnaire responses for those with detectable BLLs, for each of the five questions, can be seen in Tables 10 - 14. Case-by-case responses for each question can be seen in APPENDIX 5.

Table 10: Detectable BLL Group Responses to Non-Food Items

Question 1: Does the child have a habit of eating, chewing, or sucking non-food items?							
	Response	**Frequency**	**Percent**		**Response**	**Frequency**	**Percent**
Paint Chips	No	34	97.1	**Soil**	No	30	85.7
	Yes	1	2.9		Yes	5	14.3
Jewelries	No	31	88.6	**Metallic Access.**	No	31	88.6
	Yes	4	11.4		Yes	4	11.4
Pellets	No	31	88.6	**Chalk**	No	35	100.0
	Yes	4	11.4		Yes	0	0.0
Toys	No	12	34.3	**Fishing Sinkers**	No	35	100.0
	Yes	23	65.7		Yes	0	0.0
Bullets	No	35	100.0	**Other**	No	34	97.1
	Yes	0	0.0		Yes	*1	2.9

n = 35

* The only write-in response in the Detectable BLL Group was "keys."

Table 11: Detectable BLL Group Responses to Imported Candies

Question 2: Does the child eat any imported candies?							
	Response	**Frequency**	**Percent**		**Response**	**Frequency**	**Percent**
Chaca Chaca	No	35	100.0	**Saladulces**	No	33	94.3
	Yes	0	0.0		Yes	2	5.7
Paleta	No	17	48.6	**Tamarindo**	No	30	85.7
	Yes	18	51.4		Yes	5	14.3
Tama Roca	No	34	97.1	**Vero**	No	33	94.3
	Yes	1	2.9		Yes	2	5.7
Vagabundo	No	35	100.0	**Other**	No	35	100.0
	Yes	0	0.0		Yes	0	0.0
Lucas	No	28	80.0				
	Yes	7	20.0				

n = 35

Table 12: Detectable BLL Group Responses to Home Goods

Question 3: Does the family use any of the following products?			
	Response	**Frequency**	**Percent**
Glazed Pots	No	29	82.9
	Yes	6	17.1
Leaded Crystal	No	33	94.3
	Yes	2	5.7
Pewter	No	26	74.3
	Yes	9	25.7
Cook/ Dinnerware	No	27	77.1
	Yes	8	22.9
Lunch Boxes	No	35	100.0
	Yes	0	0.0

n = 35

Table 13: Detectable BLL Group Responses to Ethnic Remedies

Question 4: Does the family use any home or ethnic remedies, condiments, spices or additives?			
	Response	**Frequency**	**Percent**
Azarcon	No	35	100.0
	Yes	0	0.0
Litargirio	No	35	100.0
	Yes	0	0.0
Paylooah	No	35	100.0
	Yes	0	0.0
Ghasard	No	35	100.0
	Yes	0	0.0
Kandu	No	35	100.0
	Yes	0	0.0
Sindoor	No	35	100.0
	Yes	0	0.0
Greta	No	35	100.0
	Yes	0	0.0
Moonshine	No	35	100.0
	Yes	0	0.0
Ceruse	No	35	100.0
	Yes	0	0.0
Bala Goli	No	35	100.0
	Yes	0	0.0
Surma/Kohl	No	35	100.0
	Yes	0	0.0
Kajal	No	35	100.0
	Yes	0	0.0
Other	No	35	100.0
	Yes	0	0.0

n = 35

Table 14: Detectable BLL Group Responses to Household Occupation

Question 5: Does anyone in the child's household work with lead?							
	Response	**Frequency**	**Percent**		**Response**	**Frequency**	**Percent**
Construction	No	29	82.9	**Renovation**	No	34	97.1
	Yes	6	17.1		Yes	1	2.9
Mechanic	No	33	94.3				
	Yes	2	5.7				

n = 35

Detectable BLL Group – Blood Lead Level Data

Only 35 of the 564 analyzed blood samples had detectable levels of lead, based on the respective method detection limits. The method detection limit identified for venous blood draw analysis was 3µg/dL, while the method detection limit for capillary finger stick analysis was slightly higher at 3.3µg/dL. Twelve detectable BLLs were collected via venous blood draw on site at the clinics or at a Quest Diagnostics Laboratory. The remaining 23 detectable BLLs were collected via capillary finger stick at the Southern Nevada Health District (SNHD). Detectable BLLs ranged from 3µg/dL to a high of 7µg/dL, with a mean BLL of 4.19 ± 1.013µg/dL. None of the detectable BLLs exceeded the Center for Disease Control and Prevention's "level of concern" for childhood lead poisoning, currently set at 10µg/dL. As such, no case management activities were initiated via the SNHD's Childhood Lead Poisoning Prevention Program (CLPPP) for any participants in the study. However, all detectable BLLs were reported to SNHD per 2006 Clark County mandate. The distribution of detectable BLLs by blood draw type can be seen in Figure 4.

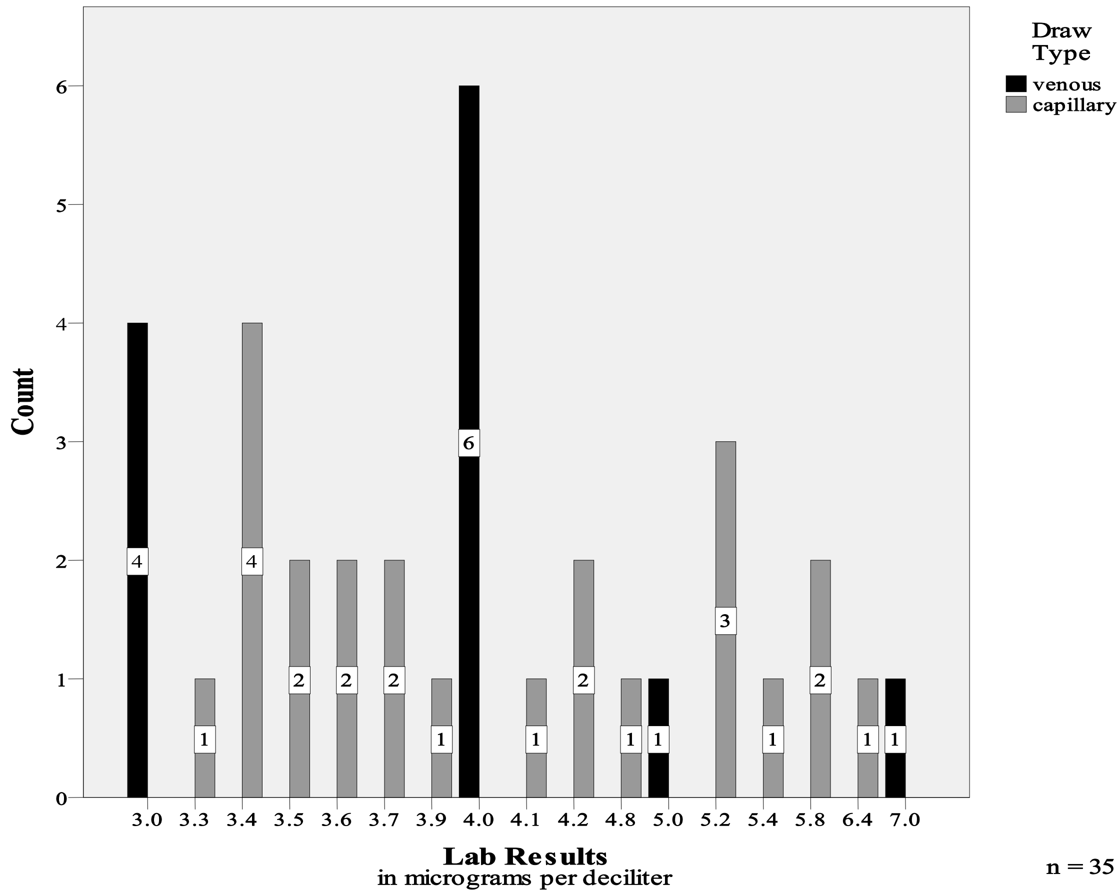


Figure 4: Detectable Blood Lead Levels by Draw Type

<u>Detectable BLL Group – Case Descriptions</u>

Case 001

Case 001 was a 4 year old Hispanic male, with no indicated specific ethnicity. He was recruited from Lied Clinic and was insured by Medicaid. Case 001 had a venous blood draw, with a reported BLL of 3μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4)

his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 002

Case 002 was a 2 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 002 had a venous blood draw, with a reported BLL of 3μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he had eaten Lucas and tamarindo imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 003

Case 003 was also a 2 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was also insured by Medicaid. Case 003 had a venous blood draw, with a reported BLL of 3μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 004

Case 004 was a 2 year old Hispanic female and was of Mexican, Mexican-American, or Chicana descent. She was recruited from Lied Clinic and was also insured by

Medicaid. Case 004 had a venous blood draw, also with a reported BLL of 3μg/dL. Responses to the questionnaire indicated that: 1) she had a habit of putting toys into her mouth, 2) she had eaten paleta and Lucas imported candies, 3) her household did not utilize any of the identified home goods, 4) her family did not use any ethnic remedies or cosmetics, and 5) none of her household members worked in an occupation which the respondent felt may expose them to lead.

Case 005

Case 005 was a 3 year old African-American male. He was recruited from Kid's HealthCare and was privately insured. Case 005 had a venous blood draw, with a reported BLL of 4μg/dL. Responses to the questionnaire indicated that: 1) he had a habit of putting toys into his mouth, 2) he did not eat imported candies, 3) his household did utilize painted or soldered cooking and dinnerware, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 006

Case 006 was a 1 year old Hispanic male, with no indicated specific ethnicity. He was recruited from Lied Clinic and was insured by Medicaid. Case 006 had a venous blood draw, with a reported BLL of 4μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he had eaten paleta imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 007

Case 007 was also a 1 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was uninsured. Case 007 had a venous blood draw, with a reported BLL of 4μg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting toys into his mouth, 2) he had eaten paleta and tamarindo imported candies, 3) his household utilized pewter home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) he had a household member who worked in an occupation which the respondent felt may expose them to lead, although the specific occupation was not indicated.

Case 008

Case 008 was a 1 year old African-American female. She was recruited from Lied Clinic and was uninsured. Case 008 had a venous blood draw, with a reported BLL of 4μg/dL. Responses to the questionnaire indicated that: 1) she had a habit of putting toys and keys into her mouth, 2) she did not eat imported candies, 3) her household did utilize painted or soldered cooking and dinnerware, 4) her family did not use any ethnic remedies or cosmetics, and 5) none of her household members worked in an occupation which the respondent felt may expose them to lead.

Case 009

Case 009 was a 4 year old white male. He was recruited from Lied Clinic and was insured by Medicaid. Case 009 had a venous blood draw, with a reported BLL of 4μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any

ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 010

Case 010 was a 2 year old multi-racial male. He was recruited from Kid's HealthCare and was insured by Medicaid. Case 010 had a venous blood draw, also with a reported BLL of 4µg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 011

Case 011 was a 1 year old Hispanic female and was of Mexican, Mexican-American, or Chicana descent. She was recruited from Lied Clinic and was insured by Medicaid. Case 011 had a venous blood draw, with a reported BLL of 5µg/dL. Responses to the questionnaire indicated that: 1) she did have a habit of putting toys and soil into her mouth, 2) she did not eat imported candies, 3) her household did not utilize any of the identified home goods, 4) her family did not use any ethnic remedies or cosmetics, and 5) she had a household member who worked in construction.

Case 012

Case 012 was a 1 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 012 had a venous blood draw, with a reported BLL of 7µg/dL – the highest BLL in this study. Responses to the questionnaire indicated that: 1) he did have a habit of putting

toys into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 013

Case 013 was a 2 year old Hispanic male and was of Central American descent. He was recruited from Kid's HealthCare and was privately insured. Case 013 had a capillary blood draw, with a reported BLL of 3.3μg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting toys into his mouth, 2) he did not eat imported candies, 3) his household did utilize pewter home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 014

Case 014 was a 1 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 014 had a capillary blood draw, with a reported BLL of 3.4μg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting jewelries, toys, and soil into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 015

Case 015 was a 2 year old Hispanic male, with no indicated specific ethnicity. He was recruited from Lied Clinic and was uninsured. Case 015 had a capillary blood draw, with a reported BLL of 3.4μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 016

Case 016 was a 1 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 016 had a capillary blood draw, with a reported BLL of 3.4μg/dL. Responses to the questionnaire indicated that: 1) he had a habit of putting pellets and toys into his mouth, 2) he did not eat imported candies, 3) his household did utilize glazed pottery or ceramics, pewter home goods, and painted or soldered cooking and dinnerware, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 017

Case 017 was a 2 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 017 had a capillary blood draw, also with a reported BLL of 3.4μg/dL. Responses to the questionnaire indicated that: 1) he had a habit of putting toys into his mouth, 2) he had eaten paleta imported candies, 3) his household did utilize painted or soldered cooking

and dinnerware, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 018

Case 018 was a 4 year old Hispanic male, with no indicated specific ethnicity. He was recruited from Lied Clinic and was insured by Medicaid. Case 018 had a capillary blood draw, with a reported BLL of 3.5µg/dL. Responses to the questionnaire indicated that: 1) he had a habit of putting toys and soil into his mouth, 2) he had eaten paleta, Tama Roca, Lucas, Saladulces, and tamarindo imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) he had a household member who worked as a mechanic.

Case 019

Case 019 was a 3 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 019 had a capillary blood draw, also with a reported BLL of 3.5µg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he had eaten paleta imported candies, 3) his household did utilize glazed pottery or ceramics, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 020

Case 020 was a 1 year old multi-racial male. He was recruited from Kid's HealthCare and was insured by Medicaid. Case 020 had a capillary blood draw, with a

reported BLL of 3.6μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 021

Case 021 was a 3 year old Hispanic female and was of Mexican, Mexican-American, or Chicana descent. She was recruited from Lied Clinic and was insured by Medicaid. Case 021 had a capillary blood draw, also with a reported BLL of 3.6μg/dL. Responses to the questionnaire indicated that: 1) she did have a habit of putting paint chips, jewelries, pellets, toys, and metallic accessories, pendants, or beads into her mouth, 2) she had eaten paleta, Lucas, and Saladulces imported candies, 3) her household did utilize glazed pottery or ceramics and pewter home goods, 4) her family did not use any ethnic remedies or cosmetics, and 5) none of her household members worked in an occupation which the respondent felt may expose them to lead.

Case 022

Case 022 was a 1 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 022 had a capillary blood draw, with a reported BLL of 3.7μg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting jewelries, toys, and metallic accessories, pendants, or beads into his mouth, 2) he had eaten paleta imported candies, 3) his household did utilize glazed pottery or ceramics, 4) his family did not use any

ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 023

Case 023 was also a 1 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was uninsured. Case 023 had a capillary blood draw, also with a reported BLL of 3.7μg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting toys into his mouth, 2) he had eaten paleta imported candies, 3) his household did utilize pewter home goods and painted or soldered cooking and dinnerware, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 024

Case 024 was a 3 year old Hispanic female and was of Mexican, Mexican-American, or Chicana descent. She was recruited from Lied Clinic and was insured by Medicaid. Case 024 had a capillary blood draw, with a reported BLL of 3.9μg/dL. Responses to the questionnaire indicated that: 1) she did have a habit of putting toys into her mouth, 2) she had eaten paleta imported candies, 3) her household did utilize pewter home goods, 4) her family did not use any ethnic remedies or cosmetics, and 5) none of her household members worked in an occupation which the respondent felt may expose them to lead.

Case 025

Case 025 was a 1 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 025 had a capillary blood draw, with a reported BLL of 4.1μg/dL. Responses to the

questionnaire indicated that: 1) he did have a habit of putting jewelries and toys into his mouth, 2) he had eaten paleta and Vero imported candies, 3) his household did utilize glazed pottery or ceramics, leaded crystal, pewter home goods, and painted or soldered cooking and dinnerware, 4) his family did not use any ethnic remedies or cosmetics, and 5) he had a household member who worked in construction.

Case 026

Case 026 was a 1 year old Hispanic female and was of Mexican, Mexican-American, or Chicana descent. She was recruited from Lied Clinic and was insured by Medicaid. Case 026 had a capillary blood draw, with a reported BLL of 4.2μg/dL. Responses to the questionnaire indicated that: 1) she did have a habit of putting toys into her mouth, 2) she had eaten paleta imported candies, 3) her household did not utilize any of the identified home goods, 4) her family did not use any ethnic remedies or cosmetics, and 5) none of her household members worked in an occupation which the respondent felt may expose them to lead.

Case 027

Case 027 was a 5 year old white male. He was recruited from Lied Clinic and was privately insured. Case 027 had a capillary blood draw, also with a reported BLL of 4.2μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he did not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, but 5) he had a household member who worked in flooring/maintenance.

Case 028

Case 028 was a 1 year old Hispanic female, with no indicated specific ethnicity. She was recruited from Lied Clinic and was insured by Medicaid. Case 028 had a capillary blood draw, with a reported BLL of 4.8µg/dL. Responses to the questionnaire indicated that: 1) she did have a habit of putting toys into her mouth, 2) she had eaten paleta and tamarindo imported candies, 3) her household did utilize painted or soldered cooking and dinnerware, 4) her family did not use any ethnic remedies or cosmetics, and 5) she had a household member who worked in construction.

Case 029

Case 029 was a 5 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 029 had a capillary blood draw, with a reported BLL of 5.2µg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting pellets, toys, and metallic accessories, pendants, or beads into his mouth, 2) he had eaten paleta, Lucas, and Vero imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 030

Case 030 was a 2 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 030 had a capillary blood draw, with a reported BLL of 5.2µg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting toys and soil into his mouth, 2) he had eaten paleta, Lucas, and tamarindo imported candies, 3) his household did

utilize glazed pottery or ceramics and leaded crystal, 4) his family did not use any ethnic remedies or cosmetics, and 5) he had a household member who worked in construction.

Case 031

Case 031 was a 6 year old Hispanic male, with no indicated specific ethnicity. He was recruited from Lied Clinic and was insured by Medicaid. Case 031 had a capillary blood draw, also with a reported BLL of 5.2μg/dL. Responses to the questionnaire indicated that: 1) he did have a habit of putting pellets and toys into his mouth, 2) he had eaten paleta imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) he had a household member who worked as a mechanic.

Case 032

Case 032 was a 1 year old Hispanic female and was of Mexican, Mexican-American, or Chicana descent. She was recruited from Lied Clinic and was insured by Medicaid. Case 032 had a capillary blood draw, with a reported BLL of 5.4μg/dL. Responses to the questionnaire indicated that: 1) she did have a habit of putting toys, soil, and metallic accessories, pendants, or beads into her mouth, 2) she did not eat imported candies, 3) her household did utilize pewter home goods and painted or soldered cooking and dinnerware, 4) her family did not use any ethnic remedies or cosmetics, and 5) she had a household member who worked in construction.

Case 033

Case 033 was a 1 year old Hispanic male and was of Central American descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 033 had a capillary blood draw, with a reported BLL of 5.8μg/dL. Responses to the questionnaire indicated

that: 1) he did have a habit of putting toys into his mouth, 2) he does not eat imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) he had a household member who worked in construction.

Case 034

Case 034 was a 5 year old Hispanic male and was of Mexican, Mexican-American, or Chicano descent. He was recruited from Lied Clinic and was insured by Medicaid. Case 034 had a capillary blood draw, also with a reported BLL of 5.8μg/dL. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he had eaten paleta and Lucas imported candies, 3) his household did utilize pewter home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Case 035

Case 035 was a 4 year old Hispanic male, with no indicated specific ethnicity. He was recruited from Lied Clinic and was insured by Medicaid. Case 035 had a capillary blood draw, with a reported BLL of 6.4μg/dL – the highest BLL for capillary draws in the study. Responses to the questionnaire indicated that: 1) he did not have a habit of putting any non-food items into his mouth, 2) he had eaten paleta imported candies, 3) his household did not utilize any of the identified home goods, 4) his family did not use any ethnic remedies or cosmetics, and 5) none of his household members worked in an occupation which the respondent felt may expose them to lead.

Statistical Analysis of Research Hypotheses

Statistical analysis was conducted on data from the Detectable BLL Group. A test for two proportions was conducted in Minitab 15 statistical software in order to identify differences between venous and capillary blood draws, in terms of proportion of detectable BLLs. The proportion (venous detectable BLLs = 12/448 = 2.7% and capillary detectable BLLs = 23/116 = 19.8%) was significantly different ($p < 0.001$). Despite this, and due to small sample size, venous and capillary detectable BLLs remained combined for analysis.

Questionnaire Data

Data from the questionnaire were entered directly into SPSS Statistics 18 software. Questions 1 through Question 4 (Non-Food Items, Imported Candies, Home Goods, and Ethnic Remedies) each had multiple response opportunities. For subsequent analysis, these responses were transformed into categorical variables. Responses were transformed to be dichotomous as either “No response” or “At least one response”. As such, any number of affirmative responses was collectively considered “At least one response”. Question 5 (Household Occupation) had “No”/ “Yes” responses which were categorical and did not require transformation. Table 15 shows the case-by-case categorization of the data.

Table 15: Categorical Responses for the Detectable BLL Group

	Question 1*		Question 2		Question 3		Question 4		Question 5	
	Response		**Response**		**Response**		**Response**		**Response**	
Case Number	**No**	**At least one**	**No**	**At least one**	**No**	**At least one**	**No**	**At least one**	**No**	**Yes**
001	X		X		X		X		X	
002	X			X	X		X		X	
003	X		X		X		X		X	
004		X		X	X		X		X	
005		X	X			X	X		X	
006	X			X	X		X		X	
007		X		X		X	X			X
008		X	X			X	X		X	
009	X		X		X		X		X	
010	X		X		X		X		X	
011		X	X		X		X			X
012		X	X		X		X		X	
013		X	X			X	X		X	
014		X	X		X		X		X	
015	X		X		X		X		X	
016		X	X			X	X		X	
017		X		X		X	X		X	
018		X		X	X		X			X
019	X			X		X	X		X	
020	X		X		X		X		X	
021		X		X		X	X		X	
022		X		X		X	X		X	
023		X		X		X	X		X	
024		X		X		X	X		X	
025		X		X		X	X			X
026		X		X	X		X		X	
027	X		X		X		X			X
028		X		X		X	X			X
029		X		X	X		X		X	
030		X		X		X	X			X
031		X		X	X		X			X
032		X	X			X	X			X
033		X	X		X		X			X
034	X			X		X	X		X	
035	X			X	X		X		X	
Total Count	**12**	**23**	**16**	**19**	**19**	**16**	**35**	**0**	**25**	**10**

n = 35

* Question1: Non-Food Items
Question 2: Imported Candies
Question 3: Home Goods
Question 4: Ethnic Remedies
Question 5: Household Occupation

Blood Lead Level Data

Based on the research hypotheses, statistical analysis in this study was limited to analysis of the data for the Detectable BLL Group (n = 35). As such, original continuous BLL data were also transformed into categorical variables. All reported BLLs below their respective method detection limits were considered "Undetectable BLLs", while all values in excess of the detection limits were considered "Detectable BLLs" and were used for analysis.

Research Hypotheses

In order to analyze the study's research hypotheses, five separate tests for two proportions were conducted in Minitab 15 statistical software. Data were entered into Fisher's exact tests based on the response frequencies for Non-Food Items, Imported Candies, Home Goods, Ethnic Remedies, and Household Occupation, after data were transformed into categorical variables.

Non-Food Items

H_{01}: $p_1 = p_2$

H_{A1}: $p_1 \neq p_2$

This hypothesis attempted to analyze the difference in the proportion of children with detectable blood lead concentrations who have the habit of eating, chewing, or sucking non-food items and those who do not have the same habit. The result of the analysis for Non-Food Items can be seen in Table 16.

Table 16: Fisher's Exact Test Results for Non-Food Items

Test and CI for Two Proportions - Non-Food Items			
	Frequency	**n**	**Sample p**
No responses	12	35	0.657143
At least one response	23	35	0.342857

Difference = p (1) - p (2)
Estimate for difference: -0.314286
95% CI for difference: (-0.536676, -0.0918956)
Z = 2.77; Fisher's exact test: p-value = 0.016

Results indicate that there was a statistically significant difference ($p = 0.016$) between the proportion of children with detectable blood lead concentrations who have the habit of eating, chewing, or sucking non-food items and those who do not have the same habit.

Imported Candies

H_{02}: $p_1 = p_2$

H_{A2}: $p_1 \neq p_2$

This hypothesis attempted to analyze the difference in the proportion of children with detectable blood lead concentrations who ingest imported candies and those who do not ingest imported candies. The result of the analysis for Imported Candies can be seen in Table 17.

Table 17: Fisher's Exact Test Results for Imported Candies

Test and CI for Two Proportions - Imported Candies			
	Frequency	**n**	**Sample p**
No responses	16	35	0.457143
At least one response	19	35	0.542857

Difference = p (1) - p (2)
Estimate for difference: -0.0857143
95% CI for difference: (-0.319113, 0.147684)
Z = -0.72; Fisher's exact test: p-value = 0.633

Results indicate that there was no significant difference ($p = 0.633$) between the proportion of children with detectable blood lead concentrations who ingest imported candies and those who do not.

Home Goods

$H_{03:}$ $p_1 = p_2$

H_{A3}: $p_1 \neq p_2$

This hypothesis attempted to analyze the difference in the proportion of children with detectable blood lead concentrations whose families use certain home goods, associated with lead contamination, and those whose families do not use the same home goods. The result of the analysis for Home Goods can be seen in Table 18.

Table 18: Fisher's Exact Test Results for Home Goods

Test and CI for Two Proportions - Home Goods			
	Frequency	**n**	**Sample p**
No responses	19	35	0.542857
At least one response	16	35	0.457143

Difference = p (1) - p (2)
Estimate for difference: 0.0857143
95% CI for difference: (-0.147684, 0.319113)
Z = 0.72; Fisher's exact test: p-value = 0.633

The frequencies used for analysis of Home Goods were reverse of the frequencies used for analysis of Imported Candies. Therefore, the results of the analysis were the same. There was no significant difference ($p = 0.633$) between the proportion of children with detectable blood lead concentrations whose families use home goods, associated with lead contamination, and those whose families do not use the same home goods.

Ethnic Remedies

H_{04}: $p_1 = p_2$

H_{A4}: $p_1 \neq p_2$

This hypothesis attempted to analyze the difference in the proportion of children with detectable blood lead concentrations whose families use ethnic remedies or cosmetics and those whose families do not use ethnic remedies or cosmetics. The result of the analysis for Ethnic Remedies can be seen in Table 19.

Table 19: Fisher's Exact Test Results for Ethnic Remedies

Test and CI for Two Proportions - Ethnic Remedies			
	Frequency	**n**	**Sample p**
No responses	35	35	1.000000
At least one response	0	35	0.000000

Difference = p (1) - p (2)
Estimate for difference: 1
95% CI for difference: (*, *)
Z = *; Fisher's exact test: p-value = 0.000

Results indicate a statistically significant difference ($p = 0.000$) existed between the proportion of children with detectable blood lead concentrations whose families use ethnic remedies or cosmetics and those whose families do not. However, these results cannot be considered accurate due to inadequate sample size (no responders answered affirmatively).

Household Occupation

H_{05}: $p_1 = p_2$

H_{A5}: $p_1 \neq p_2$

This hypothesis attempted to analyze the difference in the proportion of children with detectable blood lead concentrations whose household members are exposed to lead in their occupation and those whose household members do not have lead exposure in their occupations. The result of the analysis for Household Occupation can be seen in Table 20.

Table 20: Fisher's Exact Test Results for Household Occupation

Test and CI for Two Proportions - Household Occupation			
	Frequency	**n**	**Sample p**
No	25	35	0.714286
Yes	10	35	0.285714

Difference = p (1) - p (2)
Estimate for difference: 0.428571
95% CI for difference: (0.216915, 0.640228)
Z = 3.97; Fisher's exact test: p-value = 0.001

Results indicate that there was a statistically significant difference ($p = 0.001$) between the proportion of children with detectable blood lead concentrations whose household members are exposed to lead in their occupation and those whose household members are not occupationally-exposed.

CHAPTER 5

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion of Results

Throughout the recruitment period, a total of 1,048 families were approached for participation in this study. At that time, the families were provided educational materials regarding the dangers of childhood lead exposure and the need for screening to decrease the prevalence of childhood lead poisoning (APPENDIX 4). A total of 811 children were originally enrolled in the study, of which 247 were ultimately excluded for failure to provide an adequate blood sample for analysis. The 564 participating children did provide the necessary blood sample via venous draw or capillary finger stick and were screened for exposure to lead.

A questionnaire was also completed for each participant, which attempted to measure the children's possible exposure to lead through their unique behaviors, their individual or household use of potentially lead-contaminated products, and "take-home exposures" from occupationally-exposed household members. Recruitment for the study was conducted at two local pediatric outpatient clinics (Lied Clinic and Kid's HealthCare), which serve residents from high-risk zip codes (89030, 89101, 89110, 89115, 89121, 89156, and 89169), as identified by the Southern Nevada Health District (SNHD, 2007). The majority of patients served by the clinics were also Medicaid recipients, a group considered to be at particularly high risk for elevated blood lead levels (CDC, 2000).

However, of the 564 enrolled participants, only 35 had detectable blood lead levels (BLLs) based on method detection limits. The BLLs ranged from 3µg/dL to a high of 7µg/dL. None of the study participants had BLLs in excess of CDC's current 10µg/dL

level of concern. The majority of participants in the Detectable BLL Group were male (*n* = 27), and the group had a mean age of 2.29 ± 1.487 years. The majority of detectable BLLs were reported for Hispanic participants (*n* = 29), twenty of whom were further identified as Mexican, Mexican-American, Chicano, or Chicana. Most of the participants with detectable BLLs were insured by Medicaid (*n* = 28) although four participants did not have any medical insurance coverage.

The questionnaires from the 35 cases with detectable BLLs were analyzed in an attempt to find associations between possible exposures to lead and detectable BLLs. For this sample, a greater proportion of children with detectable BLLs had the habit of eating, chewing, or sucking non-food items. These results suggest that there may be a positive association between the habit of putting non-food items into the mouth and a resulting detectable BLL for the sampled population. These results are consistent with the literature which identifies a number of products associated with oral exposure to lead and the knowledge that children have an increased frequency of hand-to-mouth behaviors (EPA, 2004). Not surprisingly, the questionnaire data indicated that this habit was common among children in the study and also indicated that a number of children have multiple exposure opportunities. Twelve of the 23 detectable BLL children with a habit of putting non-food items into their mouth were identified as doing so with more than one item.

In contrast, there was no significant difference between the proportion of children with detectable BLLs who did eat imported candies and those who did not. At first look, these results may seem to conflict with the literature, which implicates imported candies in a number of childhood lead poisoning cases. However, not all imported candies are

contaminated with lead. Additionally, the lead contamination of imported candies may vary considerably even between items of the same type, brand, batch, or serving. Further, a dose-response relationship for the ingestion of lead-contaminated imported candies has not been established, making an association between ingestion and subsequent BLL difficult to ascertain. This study did not provide adequate information to determine if an association exists between a child's ingestion of imported candies and the likelihood of obtaining a detectable BLL.

However, questionnaire data did indicate that ten of the nineteen detectable BLL children, who eat imported candies, eat more than one variety. The data indicated that one child ate as many as five different imported candy brands or types. Therefore, despite few detectable BLLs, it seems as though the possibility for exposure to lead through contaminated imported candies remains high for participants in this study.

In addition, there was no significant difference between the proportion of children with detectable BLLs whose families' either did or did not use the identified home goods, shown to be associated with lead contamination. Hereto, the literature identifies a number of home goods associated with lead exposure and subsequent childhood lead poisoning. Yet again, not all home goods of the identified types are contaminated with lead. Further, the contact that the child may have had with these particular items was not assessed in this study. Consequently, this study was not able to determine if an association exists between a families' use of certain home goods and their child's achievement of a detectable BLL.

Further, data from this study were inconclusive in determining if an association exists between a families' use of ethnic remedies or cosmetics and their child's subsequent

detectable BLL. Statistical analysis did identify a significant difference in the proportion of children with detectable BLLs whose families did not use ethnic remedies and cosmetics and those who did. However, this data should be considered inaccurate, due to the lack of any affirmative responses for this question. With an inadequate sample size, this study cannot determine if an association exists between a families' use of ethnic remedies or cosmetics and detectable BLLs for children in this group.

Additionally, data from this study indicated that there was a significant difference in the proportion of children in the study with detectable BLLs who had household members that were potentially occupationally-exposed to lead and those who did not. Interestingly, the proportion of children with detectable BLLs was higher for those children who did not have identified household members working in occupations which may expose them to lead. These results are in contrast to the literature, which suggests that occupationally-exposed individuals provide a greater opportunity for “take-home exposures" to their children (Chiaradia et al., 1997). These results may be indicative of an inconsistency between the perceived threat of occupational lead exposure and actual threats. This apparent inconsistency identifies the need for further education of adults regarding true occupational risks of lead exposure.

Finally, it is possible that any and all of the children with undetectable BLLs, particularly those with affirmative responses to the questionnaire, may actually have been exposed to lead. It remains feasible that these children could have had lead exposures but simply not to extent necessary to obtain a detectable BLL based on current method detection limits. As no threshold for the toxic effects of lead in children has yet to be

identified, it becomes all the more important to ensure screening methods have the lowest detection limits possible (ATSDR, 2007b).

Discussion of Research Questions

This study attempted to answer two research questions. First, the study attempted to determine the blood lead levels of children in Southern Nevada and assess the children's risk for lead poisoning. The results for this study suggest that the BLLs in Southern Nevada children may be relatively low. The results are similar to current Clark County estimates, which suggest that the prevalence of children with BLLs between 1 - 9µg/dL is 29.5% and the prevalence of children with BLLs ≥ 10µg/dL is only 0.4% (SNHD, 2007). None of the participants in the study were considered to have BLLs which categorized them as being lead poisoned, at the time of analysis. However, 35 detectable BLLs were identified, indicating the presence of some exposure. Moreover, while all of the detectable BLLs in the study were below 10µg/dL, there is a growing body of research which suggests that BLLs below this action level may still adversely affect neurobehavioral development in children (Gilbert & Weiss, 2006). Further, according to current CDC guidelines, it is recommended that all of the children with detectable BLLs below 10µg/dL be rescreened within 1 year, in order to sufficiently assess any changes to or continued threats of exposure (Bernard, 2003).

Second, the study attempted to determine what factors, particularly in the area of atypical exposure sources, may be associated with Southern Nevada children's BLLs. The study identified a number of potential exposure sources, which were fairly common in the study population. The questionnaire results indicated that Southern Nevada

children may be at risk for detectable BLLs through putting toys in their mouths (a statistically significant association), their ingestion of paleta imported candies, their families' use of pewter in the home, and their household members' "take-home exposure" from working in construction.

Further, those children with non-detectable BLLs at the time of analysis did not display a complete absence of risk for lead exposure. Questionnaires for the entire study population indicated that large numbers of Southern Nevada children frequently put toys in their mouths, eat paleta imported candies, have painted or soldered cooking and dinnerware used in their homes, and have household members working in construction. Based on the literature, which identifies these behaviors and products in connection to childhood lead poisoning, it is reasonable to assume that Southern Nevada children could continue to be at risk for lead exposure from these prevalent atypical sources.

Study Limitations

This study had a number of limitations, which suggest that the data and results should not be generalized to the entire population of Southern Nevada children. The recruiting method was one of convenience and was limited to patients seen at only two of Southern Nevada's many pediatric clinics. Although, the recruiting locations provided service to children considered to be at high-risk for elevated BLLs, due to either residential zip code or Medicaid-eligibility status, the children in the study may not be representative of Southern Nevada children as a whole. In addition, the final sample size of 564 participants is small when compared to the estimated number of young children currently

residing in Southern Nevada, approximately 128,000 children by 2005 projections (SNHD, 2007).

Further, the small sample size of detectable BLLs (*n* = 35) also limited the statistical power of any analyses. A statistically significant difference was found between the proportion of detectable BLLs identified through the methods of venous and capillary blood draws. Despite this difference, the small sample size necessitated the combination of the results from these two methods for analysis and likely introduced some error into the results. In an ideal sample, all BLLs would have been obtained via the same collection method or sample sizes would have been relatively equal between the two methods to truly ascertain significant differences. As such, the drastic difference in sample size between the Detectable and Undetectable BLL Groups also made comparisons between these groups impractical. Any results would likely have been masked by the significantly greater number of undetectable cases (*n* = 529, versus detectable cases, *n* = 35).

The questionnaire utilized for the assessment of potential lead exposures was also not without limitations. The questionnaire was developed by a group of experts in the field of childhood lead poisoning from the University of Nevada, Las Vegas. It was originally designed to be utilized by busy medical professionals as a quick assessment tool to identify potentially at-risk children, who should then receive a blood lead test. It was further designed to assist in the identification of possible atypical sources of exposure for subsequent environmental lead inspections, which would be conducted for children with elevated BLLs. The questionnaire was not a validated research tool. As such, a number of inadequacies limited its use during statistical analysis.

First, only those who agreed to participate in the study completed the questionnaire. This design had the potential for response bias. No information was collected from the families which declined participation in the study and it is possible that those children were somehow systematically different from those who enrolled in the study. It is possible that some of the children at highest risk for elevated BLLs would have had parents or guardians who were less likely to be concerned about health matters of this nature. As such, the results from the study participants may not be truly representative of the population of interest.

Also, the questionnaire data was obtained on behalf of the child from a parent or legal guardian. Essentially, the data from the questionnaire was "self-reported" and was privy to the same recall biases as any self-reported data. It is also possible that parents and legal guardians did not completely understand the questions (i.e. identifying domestic "lollipops" as imported candies and citing the use of commonly available "Knorr-brand products" as an ethnic spice). It may also be true that parents or guardians were not comfortable associating their children with the items on the questionnaire identified as possible sources of lead exposure. There is often a reluctance to report the use of such items often out of fear of punishment, particularly surrounding the use of ethnic remedies (CDC, 1993).

Additionally, the questions themselves were limited in their ability to determine the association between affirmative responses and the achievement of a detectable BLL. Question 1 (Does the child have a habit of eating, chewing, or sucking non-food items?) provided no information regarding the frequency or duration of the identified behavior. Question 2 (Does the child eat any imported candies?) also did not address the frequency

or duration of imported candy ingestion, nor did it assess the amount of candy eaten. Question 3 (Does the family use any of the following products?) identified the presence of certain home goods in the household, but did not supply any additional information about the child's contact with said items. Question 4 (Does the family use any home or ethnic remedies, condiments, spices or additives?) was controversial by nature, and, even if participants had answered affirmatively, frequency, duration, and direct exposure to the child were again not assessed. Further, Question 5 (Does anyone in the child’s household work with lead?) depended heavily on the respondent's knowledge about the occupational exposures to lead for their household members. It is not uncommon for employees to be unaware of the lead risks present in their occupation. Without a list, similar to those provided for other questions, it is possible that occupations which may be associated with lead exposure were present in the study population, but simply were not recognized.

Finally, because the questionnaire only provided data which was cross-sectional in nature, even with a larger sample size or more clearly defined questions, it would have been difficult to establish the causality of the exposure and the resulting detectable BLL. Further, even if this type of association would have been plausible, additional challenges would have presented themselves, particularly in the area of confounding variables. As such, all results from this study are considered solely representative of the unique study sample and are limited in scope.

Study Contributions

Childhood lead poisoning was not a reportable condition in Nevada until funding from the Centers for Disease Control and Prevention was received for a Clark County

Childhood Lead Poisoning Prevention Program (CLPPP) in late 2006. Prior to that time, screening and reporting were voluntary procedures; therefore, lead screening numbers were largely unknown (SNHD, 2007). The Southern Nevada Health District (SNHD) reported that in 2000 they received only one voluntary blood lead test report for a child under 6 years old. In 2001, only two reports were received and, in 2002 and 2003, a mere three blood lead test reports were received each year (SNHD, 2008). In late 2004, the SNHD began an awareness campaign to increase blood lead screening and voluntary reporting which did result in improved screening numbers. From August 2004 through March 2007 (reporting became mandatory in January 2007), the SNHD received 7,137 reports for blood lead tests in children under 6 years old (SNHD, 2007).

This study effectively contributed to SNHD's continued lead screening awareness campaign by providing more than 1,000 families with educational materials about the dangers of childhood lead poisoning. While not a measurable outcome, the study likely raised awareness in a number of other families, simply through their contact with newly enlightened study participants. In fact, a number of potential recruits informed the study investigators during their first encounter that they were already aware of and interested in lead testing, due to communication with friends or family already recruited into the study.

In addition, this study successfully screened 564 Southern Nevada children under age 6 for exposure to lead, representing a greater than 6000% increase over screening numbers from the years 2000 through 2003. This number further represents approximately 8% of the total screening numbers for the years 2004 through 2007 alone. By contributing significantly to the total number of children screened, this study served to further clarify the current status of childhood lead poisoning in Southern Nevada.

Finally, this study was the first and only project of its kind in Nevada. This study effectively engaged a number of healthcare practitioners at two of the county's busiest pediatric outpatient clinics. As a direct result of the study, a greater number of local pediatricians actively encouraged screening young children for exposure to lead than had in the past. Only through the continued, multifaceted support of prevention efforts can the goal of childhood lead poisoning elimination be obtained. Consequently, it seems as though Nevada may have significantly lower prevalence rates of childhood lead poisoning to begin with - making the goal of elimination all the more feasible.

Conclusions and Recommendations for Further Study

Lead poisoning continues to be considered the most significant and preventable environmental health issue for children in the United States (CDC, 2000). The Centers for Disease Control and Prevention (CDC) report that approximately 250,000 children currently have blood lead levels (BLLs) above 10µg/dL, the level at which intervention is recommended. Unfortunately, evidence is building which suggests that adverse health effects are measurable in children with BLLs well below this arbitrary level and supports the assertion that there is no threshold for lead toxicity in children (Gilbert & Weiss, 2006). This knowledge suggests that an even greater number of children may be at-risk.

In 1997, the CDC developed guidelines for the targeted screening of young children for exposure to lead in order to enhance prevention efforts. The CDC recommended that all children receive a blood lead test at the ages of 1 and 2 years. The CDC further recommended screening for children between the ages of 3 and 6 years old, if they had not been previously screened, if they lived in a high risk zip code, if they received public

assistance (i.e. Medicaid), or were otherwise considered to be at-risk (CDC, 1997). This study served to supplement the CDC-guided screening activities conducted by the Southern Nevada Health District's Childhood Lead Poisoning Prevention Program (CLPPP) and to contribute to the ultimate goal of childhood lead poisoning elimination.

This study identified 35 children under the age of 6 years old with detectable BLLs. These children have been exposed to lead and it is unclear what irreversible adverse health outcomes they may experience over their life-course as a result of this acute or on-going exposure. The study also identified a positive association between a child's habit of putting non-food items into their mouth and the proportion of children with a detectable BLL. This result, as well as, the identification by the questionnaire of a number of potential exposure sources present in the population, stresses the need for continued educational and screening efforts within Southern Nevada.

Educational and screening efforts will require the participation of medical professionals, public health professionals, and academia alike. Pediatricians should continue to be educated on and engaged in the CDC guidelines for lead screening, particularly those who deal with a high volume of Medicaid-eligible children, and should ensure that the guidelines are being consistently followed in their practice. Public health professionals must continue to expand the knowledge of childhood lead poisoning universally. Increasing knowledge and awareness surrounding the dangers of lead poisoning may convince more parents and guardians of at-risk children to seek out resources and permit the necessary blood analyses. It may also convince more practitioners to adhere to the screening guidelines. Further, academia should be

responsible for continued research and the development of useful tools to improve the risk-assessment process for medical and public health professionals in the field.

Additionally, while screening children for their BLLs is an invaluable tool, it is essentially a secondary effort. Ideally, a lead poisoned child should not be the trigger for prevention efforts. In order to eliminate childhood lead poisoning in Southern Nevada, and elsewhere, a continued move towards greater primary prevention efforts is recommended. Whenever possible, environmental interventions should precede medical interventions. Current activities being conducted by the Southern Nevada CLPPP (i.e. residential and child-care facility lead risk assessments) need to be sustained. In addition, the collective move towards multidimensional healthy homes initiatives will ensure that public health professionals capture a wider population of at-risk children.

Finally, continued research is needed to more accurately assess the current status of BLLs in Southern Nevada children and children statewide. Additional research is also needed to identify the true risk posed by atypical sources of exposure, particularly those identified by the questionnaire as being present in the community. Research activities, such as those conducted at the University of Nevada, Las Vegas (i.e. assessing the presence of lead contamination in imported candies, toys, and pottery; the development of an IEUBK model for the ingestion of imported candies; examining children's teeth for lead biomarkers), call for support in the areas of continued funding and organizational encouragement. In order to one day realize the goal of childhood lead poisoning elimination, it remains essential that the next generation of public health professionals contributes to the current body of knowledge on the subject and encourages public health practice and policy to become aligned with the research.

APPENDIX 1

INSTITUTIONAL REVIEW BOARD APPROVAL

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Biomedical IRB – Full Board Review Approval Notice

NOTICE TO ALL RESEARCHERS:

Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: November 26, 2008

TO: **Dr. Shawn Gerstenberger**, School of Public Health

FROM: Office for the Protection of Research Subjects

RE: Notification of IRB Action
Protocol Title: **Clark County's Children Lead Screening**
Protocol #: 0808-2830

This memorandum is notification that the project referenced above has been reviewed by the UNLV Biomedical Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45CFR46. The protocol has been reviewed and approved.

The protocol is approved for a period of one year from the date of IRB approval. The expiration date of this protocol is October 20, 2009. Work on the project may begin as soon as you receive written notification from the Office for the Protection of Research Subjects (OPRS).

PLEASE NOTE:
Attached to this approval notice is the **official Informed Consent/Assent (IC/IA) Form** for this study. The IC/IA contains an official approval stamp. Only copies of this official IC/IA form may be used when obtaining consent. Please keep the original for your records.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through OPRS. No changes may be made to the existing protocol until modifications have been approved by the IRB.

Should the use of human subjects described in this protocol continue beyond October 20, 2009, it would be necessary to submit a **Continuing Review Request Form** *60 days* before the expiration date.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@unlv.edu or call 895-2794.

Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047
(702) 895-2794 • FAX: (702) 895-0805

APPENDIX 2

INFORMED CONSENT FORMS

RECEIVED

FEB 2 6 2009

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

UNLV IRB Approved MAR 2 6 2009 Expires OCT 2 0 2009

PARENTAL PERMISSION TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: CLARK COUNTY CHILDREN'S LEAD SCREENING

INVESTIGATOR(S): Lopa Shah, MD (702-671-2231), Shawn L.Gerstenberger, PhD (702-895-1565), Erika R. Torres, Mackenzie Burns & Diana Vereschzagin (702-895-5449), Scott Denton, MD (702-671-2231), Beverly Neyland, MD (702-671-2231)

SPONSOR: Trust Fund for Public Health

REMOVED: protocol #, IRB approval and expiration date, IRB from title and centered UNLV logo

Name of Minor: ______________________________

Case Number: ______________________________

Purpose
- The purpose of our study is to better understand which children have lead in their blood.
- We are asking you if you would like to have your child be in the study because he/she is 1 – 6 years old and you are visiting the LIED or Kids Health Care Well Child Check.

Why is testing your child for lead important?
- We are testing children for lead because it is known to cause health problems in children.

Procedures
- If you decide to be in the study, we will ask you some questions about things in your house that might have lead in them.
- Also, your child will have a small amount of blood drawn – about a teaspoon-sized amount.
    - You may have your blood drawn at the clinic or go to Quest lab to have the blood drawn. Blood is drawn from the arm or blood can be drawn by a finger prick.
    - This is free, but, you may have to pay for transportation cost to get to the lab.

What happens if your child has a high blood lead level?
- If lead is found in your child's blood, your child's name will be sent to the Southern Nevada Health District (SNHD).
    - If there is a lot of lead in your child's blood, people from SNHD will contact you to see if you want to use a free service offered by the Childhood Lead Poising Prevention Program (CLPPP).
    - The CLPPP will provide nursing case management and in most cases will come to your home to identify how lead may have gotten into your child's blood. In many cases, children get lead in their blood by using or holding things that have lead in

Page | 1 of 2

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

them.
- The CLPPP will work with you to make your home safe from lead.
- If lead is found in your child's blood, your doctor will also be contacted so he/she can follow up with you.
- We will not use your name in any research report.

Risks
- If you decide to be in the study, there is the risk that you child will be sore or have some pain and bruising as he/she has blood drawn.
    - To help keep this risk small, we will only allow your child to have blood drawn by people who are certified to do this.

Other important things to know:
- You don't need to be in this study if you don't want to.
- Your child's health care will not be any different if you choose to be in the study or if you don't want to be in the study.
- There are no costs to you if you are in the study.
    - However, for those who participate from LIED clinic there may be cost in travel to Quest laboratories which is less than a mile away from the clinic.
- You will not be paid if you are in the study.
- You can ask any questions that you have about the study.
- If you have a question later that you didn't think of now, you can call Dr. Shawn Gerstenberger 702-895-1565 or Dr. Lopa Shah702-671-2231.
- If I have not answered your questions or you do not feel comfortable talking to me about your question, you can call the UNLV Office for the Protection of Research Subjects at 702-895-2794.

Signing your name at the bottom means that you agree to be in this study.

☐ The check indicates that the above consent was read to the participant by a research team member.	
Signature of Parent	Date
Signature of Person Obtaining Parental Permission	Date

Participant Note: Please do not sign this document if the Approval stamp is missing or is expired.

UNIVERSITY MEDICAL CENTER OF SOUTHERN NEVADA
INSTITUTIONAL REVIEW BOARD (IRB)

PARENTAL PERMISSION TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: CLARK COUNTY CHILDREN'S LEAD SCREENING.
INVESTIGATOR(S): Lopa Shah, MD (702-671-2231), Shawn L.Gerstenberger, PhD (702-895-1565), Erika R. Torres (702-895-5449), Scott Denton, MD (702-671-2231), Beverly Neyland, MD (702-671-2231)
PROTOCOL #: B07/08-034
SPONSOR: Trust Fund for Public Health.

PURPOSE

You are being asked to allow your dependent/child to participate in a research study where we will check blood lead level in children. The purpose of this study is to find lead levels in children between the ages of 12 and 72 months so as to detect high levels and prevent future complications of lead poisoning which can cause speech delay, anemia or affect neurodevelopment of your child. The study will also aim to identify possible sources of lead exposure.

PARTICIPANTS

You are being asked to allow your dependent/child participate because he/she is between the ages of 12 and 72 months when screening for lead levels is recommended but not mandatory. And many of children with high lead level may not have symptoms, and blood lead level will be able to detect it. In this study, we expect to screen about 4,500 children between the ages of 12 and 72 months.

PROCEDURES

If you agree to allow your dependent/child participate in this study, after the study is verbally explained to you, and all your questions and concerns have been addressed, you will be required to sign a permission form. After this, you will be given a brief questionnaire to answer questions on possible sources of lead exposure which your dependent/child might have come in contact with. This can take 10-15 minutes of your time. Where your answers indicate possible lead exposure and your dependent/child had not previously been screened for lead, a blood sample will then be drawn from your dependent/child . This blood will be then be tested to check the level of lead in it.

If your dependent/child blood lead level is more than 10 ug/dl, the Clark County Lead Poisoning Prevention Program will be notified. Then environmental testing for risk factors will be carried. In addition to finding high lead levels and thus preventing future complications, the results of this study will also help the area of promotion of public health leading to up to date recommendations for lead poisoning in our local community.

DISCOMFORTS, INCONVENIENCES, AND/OR RISKS

The study will involve the collection of a blood sample from your dependent/child. This might cause some discomfort, pain, bruising and very rarely, fainting or infection. To minimize this discomfort, blood samples will only be taken by physician or professionals in the lab, or by finger prick, unnecessary pricking will be avoided. Needles and syringes will not be reused. Another inconvenience might be the time it

DO NOT SIGN THE INFORMED CONSENT IF THE EXPIRATION STAMP IS MISSING OR CONSENT HAS EXPIRED.

UNIVERSITY MEDICAL CENTER
IRB ANNUAL REVIEW
EXPIRATION DATE: MAY 19 2010

Patient Initials

would take to fill out the questionnaires – about 10 -15 minutes. These will be administered in a private room, and will protect your dependent/child's confidentiality. There may be risks currently unknown.

ALTERNATIVES
The alternative is not to allow your dependent/child to participate in this study.

BENEFITS
There may be no direct benefits of the study to your dependent/child as a participant in this study. A benefit might be in the case where lead levels above 10 ug/dl are detected in your child, allowing for follow up preventing future complications. Benefits to the society and science would be: 1) Increased access to lead testing for Clark County Children and their families. 2) Increased knowledge to actual causes of children's lead poisoning in Clark County. 3) Research based evidence to guide children's lead poisoning testing policies in Clark County.
Benefits do not include payments/incentives given to participants.

CONFIDENTIALITY
Your identity will be protected to the extent allowed by law. You will not be personally identified in any reports or publications that may result from this study. All documents will be kept in a locked filing cabinet. Data will be stored on one computer which will be kept in a locked room. The principal investigator and co-investigators will be the only individuals with access to the data. You will not be identified by name, initials or date of birth in any reports of the completed study. Your confidentiality will be respected. No information that discloses your identity will be released or published.
However, the Department of Health and Human Service (HHS), other federal agencies; the University of Nevada, Reno and University Medical Center Institutional Review Boards will have access may inspect your study records.

COSTS/COMPENSATION
There will be no cost to you nor will you be compensated for participating in this research study. A prepaid blood lead request will be given to you, so it does not cost you any thing to get your child blood lead level tested.
In the event that this research activity results in an injury, treatment will be available, including first aid, emergency treatment, and follow-up care as needed. Care for such injuries will be billed in the ordinary manner to you or your insurance company. UMC has no financial responsibility for patients enrolled in research projects. Your dependent/child's study doctor will not receive any significant payments for their participation in this study.

If you think you have suffered a research related injury, you should immediately contact the Principal Investigator, Dr Lopa Shah (702-671-2231).

If I have any questions concerning my rights as a research subject in this study, I may contact the:

DO NOT SIGN THE INFORMED CONSENT IF THE EXPIRATION STAMP IS MISSING OR CONSENT HAS EXPIRED.

UNIVERSITY MEDICAL CENTER
IRB ANNUAL REVIEW
EXPIRATION DATE: MAY 19 2010

Patient Initials

UNIVERSITY MEDICAL CENTER OF SOUTHERN NEVADA
INSTITUTIONAL REVIEW BOARD (IRB)

University Medical Center of Southern Nevada
IRB Coordinator
1800 W. Charleston Boulevard
Las Vegas, NV 89102
Phone: (702) 383-7336
Fax: (702) 383-2479
Email: Jill.Teixeira@umcsn.com

RIGHT TO REFUSE OR WITHDRAW

Participation is voluntary. You may refuse your dependent/child to participate or withdraw from the study at any time and still receive the care you would normally receive if you were not in the study. If the study design or use of the data is to be changed, you will be informed and your permission will re-obtained. You will be told of any significant new findings developed during the course of this study, which may relate to your willingness to continue participation. Your dependent/child's participation in this study may be terminated at any time for any reason without regard to their consent.

QUESTIONS

If you have questions about this study or wish to report a research-related injury, please contact Dr. Lopa Shah (702)-671-2231.

You may ask about your rights as a research subject or you may report (anonymously if you choose so) any comments, concern, or complaints to the University Medical Center of Southern Nevada Institutional Review Board, telephone number (702) 383-7336, or by addressing a letter to the IRB Chair/IRB Coordinator Attn: Institutional Review Board, 1800 W. Charleston Blvd., Las Vegas, NV 89102.

CLOSING STATEMENT

I have read (   ) this parental permission form or have had it read to me (   ). [Check one.]

_________has explained the study to me and all of my questions have been answered. I have been told of the risks or discomforts and possible benefits of the study. (I have been told if I choose not to participate in this study, will not affect my child's health care)

If I do not take part in this study, my refusal to participate will involve no penalty or loss of rights to which I am entitled. I may withdraw from this study at any time without penalty [or loss of other benefits to which I am entitled].

I have been told my rights as a research subject, and I voluntarily give permission to my child/dependant to participate in this study. I have been told what the study is about and how and why it is being done. All my questions have been answered.

DO NOT SIGN THE INFORMED CONSENT IF THE EXPIRATION STAMP IS MISSING OR CONSENT HAS EXPIRED.

UNIVERSITY MEDICAL CENTER
IRB ANNUAL REVIEW
EXPIRATION DATE: MAY 19 2010

____
Patient Initials

I will receive a signed and dated copy of this Parental Permission form.

Signature of Participant (<u>or</u> *Legally Authorized Representative**) Date

Signature of Person Obtaining Parental Permission Date

Signature of Investigator Date

*(*only if subject is not competent;**only if required by sponsor or IRB)*

DO NOT SIGN THE INFORMED CONSENT IF THE EXPIRATION STAMP IS MISSING OR CONSENT HAS EXPIRED.

UNIVERSITY MEDICAL CENTER
IRB ANNUAL REVIEW
EXPIRATION DATE: MAY 19 2010

Patient Initials

UNIVERSITY OF NEVADA, RENO, BIOMEDICAL INSTITUTIONAL REVIEW BOARD
PARENTAL PERMISSION TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: CLARK COUNTY CHILDREN'S LEAD SCREENING.
INVESTIGATOR(S): Lopa Shah, MD (702-671-2231), Shawn L.Gerstenberger, PhD (702-895-1565), Erika R. Torres (702-895-5449), Scott Denton, MD (702-671-2231), Beverly Neyland, MD (702-671-2231)
PROTOCOL #: B07/08-034
SPONSOR: Trust Fund for Public Health.

UNR Biomedical IRB Approval 05/20/09
EXPIRATION DATE 06/12/10

PURPOSE

You parents or guardians are being asked to allow your child/ward to participate in a research study where we will check blood lead level in children. The purpose of this study is to find lead levels in children between the ages of 12 and 72 months so as to detect high levels and prevent future complications of lead poisoning which can cause speech delay, anemia or affect neurodevelopment of your child. Many children with high lead levels may not have symptoms, and a blood lead level will be able to detect it. The study will also aim to identify possible sources of lead exposure.

PARTICIPANTS

You are being asked to allow your child/ward participate because he/she is between the ages of 12 and 72 months when screening for lead levels is recommended but not mandatory. In this study, we expect to screen about 4,500 children between the ages of 12 and 72 months.

PROCEDURES

If you agree to allow your child/ward to participate in this study, after the study is verbally explained to you, and all your questions and concerns have been addressed, you will be required to sign a permission form. After this, you will be given a brief questionnaire to answer questions on possible sources of lead exposure which your child/ward might have come in contact with. This can take 10-15 minutes of your time for filling out the questionnaire, where your answers indicate possible lead exposure and your child/ward had not previously been screened for lead, a blood sample, capillary (finger prick) or blood draw, will then be taken from your child/ward. This will also require extra time for you to bring your child to get his blood drawn for lead test, as well as wait time for blood drawing. This blood will be then be tested to check the level of lead in it.
If your child/ward blood lead level is more than 10 ug/dl, the Clark County Lead Poisoning Prevention Program will be notified. Then environmental testing for risk factors will be performed.

DISCOMFORTS, INCONVENIENCES, AND/OR RISKS

The study will involve the collection of a blood sample from your child/ward. This might cause some discomfort, pain, bruising and very rarely, fainting or infection. To minimize this discomfort, blood samples will only be taken by professionals in the lab, unnecessary pricking will be avoided. Needles and syringes will not be reused. Another inconvenience might be the time it would take to fill out the questionnaires, about 15-20 minutes, time to bring child/ward for blood drawing as well as wait time for blood drawing. These will be administered in a private room, and will protect your child/ward confidentiality.

TITLE OF STUDY: CLARK COUNTY CHILDREN'S LEAD SCREENING
INVESTIGATORS: Lopa Shah, MD (702-671-2231), Shawn L. Gerstenberger, PhD (702-895-1565), Erika R. Torres (702-895-5449), Scott Denton, MD (702-671-2231), Beverly Neyland, MD (702-671-2231)
PROTOCOL #: B07/08-034
SPONSOR: Trust Fund for Public Health.

BENEFITS

There may be no direct benefits of the study to your child/ward as a participant in this study. A benefit might be in the case where lead levels above10 ug/dl are detected in your child/ward, allowing for follow up preventing future complications. Benefits to the society and science would be: 1) Increased access to lead testing for Clark County children and their families. 2) Increased knowledge to actual causes of children's lead poisoning in Clark County. 3) Research based evidence to guide children's lead poisoning testing policies in Clark County. Benefits do not include payments/incentives given to participants.

CONFIDENTIALITY

Your identity will be protected to the extent allowed by law. You will not be personally identified in any reports or publications that may result from this study. All documents will be kept in a locked filing cabinet. Data will be stored on one computer which will be kept in a locked room. The principal investigator and co-investigators will be the only individuals with access to the data. You will not be identified by name, initials or date of birth in any reports of the completed study. Your confidentiality will be respected. No information that discloses your identity will be released or published.

However, the Department of Health and Human Service (HHS), other federal agencies; the University of Nevada, Reno and University Medical Center Institutional Review Boards will have access and may inspect your study records.

In addition, the University Medical Center requires that the investigators provide a copy of this permission form to them for their auditing purposes once you have signed it.

UNR Biomedical IRB Approval **05/20/09**
EXPIRATION DATE **06/12/10**

COSTS/COMPENSATION

There are no fees to refer to CLPPP (Childhood Lead Poisoning Prevention Program) of Clark County. Once lead level is 10 ug/dl or above, CLPPP program will be directly notified from the laboratory since notification of the Clark County Health Department is mandatory.

There will be no cost to you nor will you be compensated for participating in this research study. A prepaid blood lead request will be given to you, so it does not cost you any thing to get your child/ward blood lead level tested.

In the event that this research activity results in an injury, treatment will be available, including first aid, emergency treatment, and follow-up care as needed. Care for such injuries will be billed in the ordinary manner to you or your insurance company.

If you think you have suffered a research related injury, you should immediately contact the Principal Investigator, Dr Lopa Shah (702-671-2231)

RIGHT TO REFUSE OR WITHDRAW

You may refuse your child/ward to participate or withdraw from the study at any time and still receive the care you would normally receive if you were not in the study. If the study design or use of the data is to be changed, you will be so informed and your permission re-obtained. You will be

told of any significant new findings developed during the course of this study, which may relate to your willingness to continue participation.

QUESTIONS

If you have questions about this study or wish to report a research-related injury, please contact Dr. Lopa Shah (702)-671-2231.

You may ask about your rights as a research subject or you may report (anonymously if you choose so) any comments, concern, or complaints to the University of Nevada, Reno Biomedical Institutional Review Board, telephone number (775) 327-2368, or by addressing a letter to the Chair of the Board, c/o UNR Office of Human Research Protection, 205 Ross Hall / 331, University of Nevada, Reno, Reno, Nevada, 89557.

CLOSING STATEMENT

I have read (   ) this parental permission form or have had it read to me (   ). [Check one.]

_________has explained the study to me and all of my questions have been answered. I have been told of the risks or discomforts and possible benefits of the study. (I have been told if I choose not to participate in this study, will not affect my child's health care)

If I do not take part in this study, my refusal to participate will involve no penalty or loss of rights to which I am entitled. I may withdraw from this study at any time without penalty or loss of other benefits to which I am entitled.

I have been told my rights as a research subject, and I voluntarily give permission to my child to participate in this study. I have been told what the study is about and how and why it is being done. All my questions have been answered.

I will receive a signed and dated copy of this Parental Permission form.

UNR Biomedical IRB Approval **05/20/09**
EXPIRATION DATE **06/12/10**

Signature *Legally Authorized Representative* Date

Signature of Person Obtaining Parental Permission Date

Signature of Investigator Date

UNIVERSITY MEDICAL CENTER

AUTHORIZATION to USE and DISCLOSE PROTECTED HEALTH INFORMATION FOR RESEARCH PURPOSES

Participant Name:		**Medical Record #:**	
Principal Investigator:	Dr. Lopa shah	**Protocol #:**	08.06.007
Principal Investigator's Contact Information:	702 672 2231		
Title of Study:	Clark County Children's Lead Screening study		

What is the purpose of this form?

The health-related information that we gather about you in this study is personal. In this form, we describe who will be working with this information and ask for your permission to use the information in the research study.

Please read this form carefully. If you have any questions, please ask the Principal Investigator listed above before signing this form. By signing this form you agree that researchers may use your personal health information.

Why do the researchers want my personal health information?

Dr. Lopa shah will collect your health information and share it with CDC, UNR, UNLV and UMC to use in the research study that is described in the Informed Consent form.

What personal health information do the researchers want to use?

The researchers want to copy and use the portions of your medical record that they will need for their research. Some of the information that will be used and/or shared may include the following:

- The diagnosis and history of your disease or condition;
- Information about your treatment or previous treatment you may have had;
- Information about other medical conditions you may have;
- Information on side effects (adverse events) you may experience, and how these were treated;
- Long-term information about your general health status and the status of your disease;
- Data that may be related to tissue and/or blood samples that may be collected from you;
- Numbers or codes that will identify you, such as your medical record number and social security number.
- Blood Lead level

- Zip Code

Who will be able to use my personal health information?

The investigators involved in this study will use your health information for research. As part of this research, they may give your information to the following groups taking part in the research. The investigators may also permit these groups to come in to review your original records so that they can monitor their research study.

- University of Nevada School of Medicine, CDC, UNR, UNLV and UMC
- The health care providers at UMC who provide services to you in connection with this study
- Laboratories and other individuals and organizations that analyze your health information, in accordance with the study's protocol
- Public Health agencies and other government agencies (including non-U.S.) as authorized or required by law
- The United States Food and Drug Administration
- The research sponsors, and/or their designees, subcontractors
- Data and Safety Monitoring Boards and others authorized to monitor the conduct of the study

How will information about me be kept private?

The investigators will keep all patient information private to the extent possible. Only researchers working with Dr. Lopa Shah & Erika Torres will have access to your information and will not release personal health information about you to others except as authorized or required by law. However, once your information is given to other organizations that are not required to follow federal privacy laws, we cannot assure that the information will remain protected.

If I sign this form, will I automatically be entered into the research study?

No, you cannot be entered into any research study without further discussion and a separate informed consent. After discussion, you may decide to take part in the research study. At that time, you will be asked to sign a specific research consent form.

What happens if I do not sign this form?

You have a right to refuse to sign this form. Your health care outside the study, the payment for your health care, and your health care benefits will not be affected if you do not sign this form.

If you do not sign this form, you will not be able to enter this research study and will not receive treatment as a study participant.

What happens if I want to withdraw my permission?

If you sign this form, you may change your mind at any time. If this happens, you must withdraw your permission in writing. Beginning on the date you withdraw your permission, no new personal health information will be used for research but the researchers may still use the information collected before you changed your mind in order to complete the research.

If you sign this form and enter the research study, but later change your mind and withdraw your permission, you will be removed from the research study at that time.

To withdraw your permission, please contact the person below. She will make sure your written request to withdraw is processed correctly.

How long will this permission last?

This form will never expire unless you change your mind and withdraw it.

How long will my information be kept for research? The study results will be retained in your research record for at least six years after the study is completed, however the sponsor of the study may define a longer timeframe. Ask your Principal Investigator if you have any questions about how long the information will be kept. At the end of that time either the research information not already in your medical record will be destroyed or information identifying you will be removed from such study results at [UNSOM, Department of Pediatrics]. Any research information in your medical record will be kept indefinitely.

What are my rights regarding access to my personal health information?

Some information collected about you only for this research study may be kept in a research study record separate from your medical record, and some research information may also be part of your medical record. Your physician will receive blood lead level report.

May I have a copy of this form?

Yes, you have a right to receive a copy of this form after you have signed it. If after you have signed this form you have any questions about your rights, please contact the UMC Privacy Officer at (702) 383-3854.

SIGNATURE

I have read this form and all of my questions about this form have been answered. By signing below, I give permission for the described uses and sharing of information.

____ ______________________________
Signature of Participant or Personal Representative Date

____
Print Name of Participant or Personal Representative

____
Description of Personal Representative's Authority

CONTACT INFORMATION

The contact information of the participant or personal representative who signed this form should be filled in below.

Address:
____
____
____
____

Telephone:
____________________ (daytime)
____________________ (evening)

Email Address (optional):
____

THE PARTICIPANT OR HIS OR HER PERSONAL REPRESENTATIVE MUST BE PROVIDED WITH A COPY OF THIS FORM AFTER IT HAS BEEN SIGNED.

UNIVERSITY OF NEVADA, RENO

AUTHORIZATION TO USE, CREATE AND SHARE HEALTH INFORMATION FOR RESEARCH PURPOSES

Researchers: Lopa Shah, MD, Shawn L. Gerstenberger, PhD, Erika R. Torres, Scott Denton, MD, and Beverly Neyland, MD

Title of Study: CLARK COUNTY CHILDREN'S LEAD SCREENING

IRB Protocol #: B07/08-034

By law, researchers must protect the privacy of health information about you. In this form the word "you" means both the person who takes part in the research and the person who gives permission for another person to be in the research. Researchers may use, create, or share your health information for research **only if you let them**. This form describes what researchers will do with your health information. Please read it carefully. If you agree with it, please sign your name at the bottom. You will get a copy of this form after you have signed it.

If you sign this form, information will be shared with the people who conduct the research. In this form, all these people together are called "researchers." Their names will also appear on the research consent form that you sign.

The researchers will use the health information only for the purposes named in this form.

1. **My health information that may be used, created, or shared includes:**

   - Name, age, sex, address, questionnaire survey about possible lead exposure, blood sample to Lead testing, Laboratory result of Lead level, referral information to Health department in case of Lead level > 10 ug/dl, Medical record number.

2. **My health information will be used for:**

   - To participate_in this research study where they will check blood lead level in my child/ward. This is to find lead levels in children between the ages of 12 and 36 months to detect high lead levels and prevent future complications of lead poisoning, to identify possible sources of lead exposure in the local community, and
   - One reason to share the information is to be able to conduct research, another reason is to ensure that the research meets legal, institutional or accreditation requirements.

3. **What the researchers may do with my health information:**

   The researchers may use and create health information about you for the study. They may also share your health information with certain people and groups. These may include:

- The University of Nevada, Reno Biomedical Institutional Review Board/Office of Human Research Protection
- The sponsor of the study, Trust Fund for Public Health and its representatives.
- The Department of Health and Human Service (HHS), other federal agencies; University Medical Center Institutional Review Board and others who watch over the safety, effectiveness, and conduct of the research, when required by law.
- Kids Health Care center
- Quest Laboratory
- UNLV
- If your child's blood lead level is high, your primary care clinician will be contacted and Health department will be informed.

4. **Removing your name from health information**

The researchers may remove your name (and other information that could identify you) from your health information. No one would know the information was yours.
If your name is removed, the information may be used, created, and shared by the researchers and sponsor as the law allows. (This includes other research purposes.) This form would no longer limit the way the researchers use, create, and share the information.

5. **How the researchers protect health information**

The researchers and the Trust Fund for Public Health will follow the limits in this form. If they publish the research, they will not identify you unless you allow it in writing. These limitations continue even if you take back this permission.

6. **After the researchers learn health information**

The limits in this form come from a federal law called the Health Insurance Portability and Accountability Act (HIPAA). This law applies to your doctors and other health care providers.
Once the researchers get your health information, this law may no longer apply. But other privacy protections will still apply.

7. **Storing your health information**

Your health information may be added to a database or data repository. This permission will end when the database or data repository is destroyed.

8. **You do not have to sign this permission (authorization) form. If I decide not to sign the authorization form:**

- It will not affect your child's treatment, payment or enrollment in any health plans or affect your eligibility for benefits.
- You may not be allowed to participate in the research study.

9. After signing the authorization form, you can change your mind and:

- Not let the researcher disclose or use your protected health information (revoke the authorization).
- If you revoke the authorization, you will send a written letter to: *Dr.Lopa Shah, 2040 W. Charleston suite 402, Las Vegas, Nevada, 89102* to inform her of your decision.
- If you revoke this Authorization, researchers may only use and disclose the protected health information **already** collected for this research study.
- If you revoke this Authorization your protected health information may still be used and disclosed should you have an adverse event.
- If you change your mind and withdraw the authorization, you may not be allowed to continue to participate in the study.

10. Please note

Unless you take back your permission (authorization), this form does not have an ending date.

11. Your signature

I agree to the use, creation, and sharing of my health information for purposes of this research study

Signature of research subject or participant's legal representative	Date
Printed name of research subject or participant's legal representative	Representative's relationship to participant

Southern Nevada Health District

UNIVERSITY OF NEVADA SCHOOL OF MEDICINE

Consent to Conduct a Blood Lead Level Test on a Minor

Child's Name ____
Last First Middle

Address ____

City________________________ State__________ ZIP Code____________

County____________________ Phone Number ____________________

Gender
❑ Male ❑ Female

Date of Birth____________________

Ethnicity
❑ Hispanic ❑ Non-Hispanic

Racial Background
❑ African American ❑ Native Hawaiian
❑ Asian ❑ White
❑ Other ❑ Unknown

Insurance Type
❑ Medicaid ❑ Nevada CheckUp
❑ Other____________________

Name of Provider ____________________

I want my child tested for lead. I understand the test involves a finger stick blood specimen drawn from my child.

Signature of Parent/Guardian______________________________________

Date ____

DO NOT WRITE BELOW THIS LINE. SNHD USE ONLY.

Sample Type ____

❑ Capillary ❑ Venous

Results of Testing____

APPENDIX 3

QUESTIONNAIRE

LEAD SCREENING QUESTIONNAIRE

STUDY TITLE: Clark County Children's Lead Screening

Name: ______________________________ **Age:** ____ **Sex:** ____ **Race:** ______________

Contact Phone #: ______________ **Medical Record #:** ___________ **Zip code:** _________

Insurance Coverage: **None** **Medicaid** **Private** _______________

1. Does the child have a habit of eating, chewing, or sucking non-food items?

- ☐ Paint Chips
- ☐ Jewelries
- ☐ Pellets
- ☐ Toys
- ☐ Bullets
- ☐ Soil
- ☐ Metallic Accessories, Pendants, Beads
- ☐ Chalk
- ☐ Fishing sinkers
- ☐ Other ____________________

2. Does the child eat any imported candies? For example:

- ☐ Chaca Chaca
- ☐ Paleta
- ☐ Tama Roca
- ☐ Vagabundo
- ☐ Other ______________________
- ☐ Lucas
- ☐ Saldulces
- ☐ Tamarindo
- ☐ Vero

3. Does the family use any of the following products?

- ☐ Glazed Pots/Ceramics
- ☐ Leaded Crystal
- ☐ Pewter
- ☐ Painted/Soldered Cooking & Dinnerware
- ☐ Metallic or Vinyl-lined Lunch Boxes

4 Does the family use any home or ethnic remedies, condiments, spices or additives?

- ☐ Azarcon
- ☐ Litagirio
- ☐ Paylooah
- ☐ Ghasard
- ☐ Kandu
- ☐ Sindoor
- ☐ Other ______________________
- ☐ Greta
- ☐ Moonshine
- ☐ Ceruse
- ☐ Bala Goli
- ☐ Surma/Kohl
- ☐ Kajal

5. Does anyone in the child's household work with lead (electronics assembly, construction, etc.)?

☐ No ☐ Yes ____________________

(08/29/2008 ver

APPENDIX 4

SNHD EDUCATIONAL MATERIALS

LEAD is dangerous for children and pregnant women.

Could there be lead in your home?

Free In-Home Lead Inspections

For a limited time, the Southern Nevada Health District will provide FREE lead inspections of Clark County homes built before 1978, such as the ones in your neighborhood. During a simple visit, you will learn about the lead sources in your home and the ways you can fix them.

Call today to schedule a free visit.

(702) 759-1283

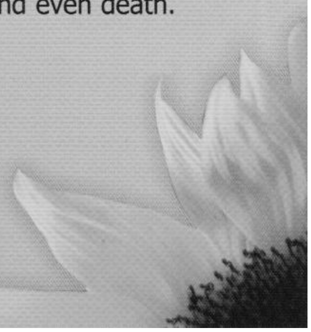
Keep Your Family Safe from Lead Exposure

Lead can be found in many things in your home:

- Paint in houses built before 1978
- Toys
- Candy imported from other countries
- Pottery and ceramics
- Folk remedies
- Dust and dirt

Lead can hurt your family:

- Lead can enter your child's body very fast.
- Lead makes it hard for children to properly grow and learn because it affects their brains.
- Lead affects pregnant women and their unborn babies.
- Lead exposure can cause permanent brain damage and even death.



SNHD
Southern Nevada Health District

www.SouthernNevadaHealthDistrict.org

In Clark County, one in four kids 6 years or younger is exposed to lead.

Your child may be exposed to lead from many sources:

- imported products such as candy, jewelry and toys
- some imported pots, dishes and ceramics
- home remedies used to treat upset stomach or "empacho"
- soil
- chipped or peeling paint from homes built before 1978
- dust created from remodeling homes built before 1978

Ask your doctor to test your child at 12 and 24 months or before the age of 6 years if he/she has never been tested.

Supported by Grant/Cooperative Agreement Number 5H64-EH000145-02 from the Centers for Disease Control and Prevention (CDC). The contents are solely the responsibility of the authors and do not necessarily represent the official view of the CDC.

(Insert)

Keep Your Child Safe from Lead

SOUTHERN NEVADA HEALTH DISTRICT

(Front)

How can I protect my child?

- Make sure your child gets tested at 12 and 24 months or before the age of 6 years.
- Keep your child away from peeling or damaged paint.
- Clean floors, window sills and dusty places often with wet mops and wet cloths.
- Wash toys, pacifiers and other items your child puts into his or her mouth.
- Wash your child's hands often, especially before eating, sleeping and after playing.
- Avoid giving your child folk remedies or medication not recommended by his or her doctor.
- Do not give your child imported candy.
- Give your child healthy meals and snacks that are high in iron and calcium, such as lean meat, chicken, tuna, turkey, peas, cereals, peanut butter, potatoes with skin, milk, cheese and yogurt. Also feed your child foods high in vitamin C, such as oranges, fruit juice, tomatoes, strawberries, kiwi, grapefruit, cantaloupe, broccoli and cauliflower.

How does the health district help prevent lead exposure?

The Childhood Lead Poisoning Prevention Program (CLPPP) combines the efforts of the Southern Nevada Health District and many community organizations. CLPPP helps families, health care providers and community organizations locally and statewide by:

- Providing information on lead exposure prevention
- Tracking children who have high levels of lead in their blood, investigating to find out how they may have been exposed to lead, and providing case management
- Working with families and doctors of children who are affected
- Inspecting houses built before 1978
- Testing potential lead sources

For more information, call 759-1283 or go to www.SouthernNevadaHealthDistrict.org/clppp

SNHD
Southern Nevada Health District

Southern Nevada Health District
625 Shadow Lane • P.O. Box 3902
Las Vegas, NV 89127
(702) 759-1283

This brochure was supported by Grant/Cooperative Agreement Number 5 H64 EH000145-02 from the Centers for Disease Control and Prevention (CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the CDC.

(Back)

What is lead exposure?

When a person is exposed to lead, it can enter the body and may cause health problems. Lead exposure is especially dangerous to young children and unborn babies because even small amounts of lead can cause permanent damage, resulting in:

- learning and behavior problems
- delayed growth and development

How can lead get into my child?

Lead can get into a child when he or she swallows something that contains lead particles. It can also enter an unborn baby if the mother has been exposed to lead.

Where is lead found?

Your child may be exposed to lead from many sources:

- chipped or peeling lead-based paint (usually in homes built before 1978)
- clay pots, dishes and ceramics
- dust and dirt
- sites where houses or buildings built before 1978 are being remodeled
- home remedies
- imported candies and other foods
- toys
- jewelry and keys

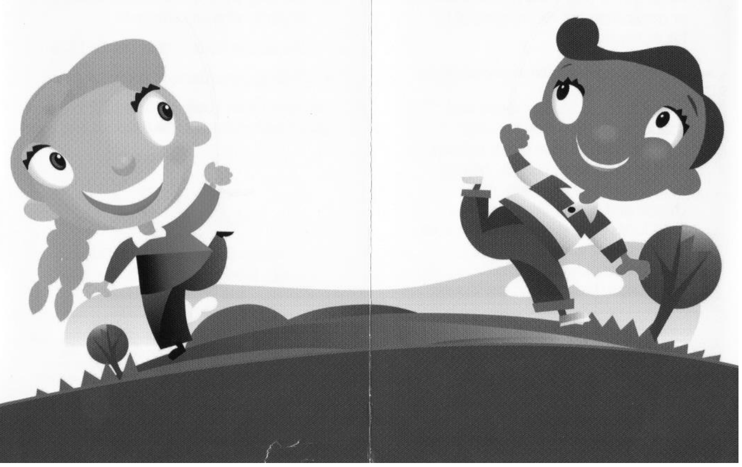
How can I find out if my child has been exposed to lead?

Many children who have been exposed to lead do not look or act sick. A blood test is the only way to find out if your child has been exposed to lead.

All children should get tested at 12 and 24 months or before the age of 6 years. If your child has never been tested, make sure to tell your child's doctor during the next visit.

What do the results mean?

The results of the blood test indicate the amount of lead in your child represented by a number. The lower the number, the better.



(Interior)

APPENDIX 5

DETECTABLE BLL QUESTIONNAIRE RESULTS

Question 1: Does the child have a habit of eating, chewing, or sucking non-food items?											
Case #	**Paint Chip**	**Jewelry**	**Pellets**	**Toys**	**Bullets**	**Soil**	**Metal. Access.**	**Chalk**	**Fishing Sinkers**	**Other**	**Detail**
001	0	0	0	0	0	0	0	0	0	0	
002	0	0	0	0	0	0	0	0	0	0	
003	0	0	0	0	0	0	0	0	0	0	
004	0	0	0	1	0	0	0	0	0	0	
005	0	0	0	1	0	0	0	0	0	0	
006	0	0	0	0	0	0	0	0	0	0	
007	0	0	0	1	0	0	0	0	0	0	
008	0	0	0	1	0	0	0	0	0	1	keys
009	0	0	0	0	0	0	0	0	0	0	
010	0	0	0	0	0	0	0	0	0	0	
011	0	0	0	1	0	1	0	0	0	0	
012	0	0	0	1	0	0	0	0	0	0	
013	0	0	0	1	0	0	0	0	0	0	
014	0	1	0	1	0	1	0	0	0	0	
015	0	0	0	0	0	0	0	0	0	0	
016	0	0	1	1	0	0	0	0	0	0	
017	0	0	0	1	0	0	0	0	0	0	
018	0	0	0	1	0	1	0	0	0	0	
019	0	0	0	0	0	0	0	0	0	0	
020	0	0	0	0	0	0	0	0	0	0	
021	1	1	1	1	0	0	1	0	0	0	
022	0	1	0	1	0	0	1	0	0	0	
023	0	0	0	1	0	0	0	0	0	0	
024	0	0	0	1	0	0	0	0	0	0	
025	0	1	0	1	0	0	0	0	0	0	
026	0	0	0	1	0	0	0	0	0	0	
027	0	0	0	0	0	0	0	0	0	0	
028	0	0	0	1	0	0	0	0	0	0	
029	0	0	1	1	0	0	1	0	0	0	
030	0	0	0	1	0	1	0	0	0	0	
031	0	0	1	1	0	0	0	0	0	0	
032	0	0	0	1	0	1	1	0	0	0	
033	0	0	0	1	0	0	0	0	0	0	
034	0	0	0	0	0	0	0	0	0	0	
035	0	0	0	0	0	0	0	0	0	0	

Question 2: Does the child eat any imported candies?									
Case #	**Chaca Chaca**	**Paleta**	**Tama Roca**	**Vagabundo**	**Lucas**	**Saladulces**	**Tamarindo**	**Vero**	**Other**
001	0	0	0	0	0	0	0	0	0
002	0	0	0	0	1	0	1	0	0
003	0	0	0	0	0	0	0	0	0
004	0	1	0	0	1	0	0	0	0
005	0	0	0	0	0	0	0	0	0
006	0	1	0	0	0	0	0	0	0
007	0	1	0	0	0	0	1	0	0
008	0	0	0	0	0	0	0	0	0
009	0	0	0	0	0	0	0	0	0
010	0	0	0	0	0	0	0	0	0
011	0	0	0	0	0	0	0	0	0
012	0	0	0	0	0	0	0	0	0
013	0	0	0	0	0	0	0	0	0
014	0	0	0	0	0	0	0	0	0
015	0	0	0	0	0	0	0	0	0
016	0	0	0	0	0	0	0	0	0
017	0	1	0	0	0	0	0	0	0
018	0	1	1	0	1	1	1	0	0
019	0	1	0	0	0	0	0	0	0
020	0	0	0	0	0	0	0	0	0
021	0	1	0	0	1	1	0	0	0
022	0	1	0	0	0	0	0	0	0
023	0	1	0	0	0	0	0	0	0
024	0	1	0	0	0	0	0	0	0
025	0	1	0	0	0	0	0	1	0
026	0	1	0	0	0	0	0	0	0
027	0	0	0	0	0	0	0	0	0
028	0	1	0	0	0	0	1	0	0
029	0	1	0	0	1	0	0	1	0
030	0	1	0	0	1	0	1	0	0
031	0	1	0	0	0	0	0	0	0
032	0	0	0	0	0	0	0	0	0
033	0	0	0	0	0	0	0	0	0
034	0	1	0	0	1	0	0	0	0
035	0	1	0	0	0	0	0	0	0

Question 3: Does the family use any of the following products?					
Case #	**Glazed Pottery**	**Leaded Crystal**	**Pewter**	**Cook/ Dinnerware**	**Lunch Boxes**
001	0	0	0	0	0
002	0	0	0	0	0
003	0	0	0	0	0
004	0	0	0	0	0
005	0	0	0	1	0
006	0	0	0	0	0
007	0	0	1	0	0
008	0	0	0	1	0
009	0	0	0	0	0
010	0	0	0	0	0
011	0	0	0	0	0
012	0	0	0	0	0
013	0	0	1	0	0
014	0	0	0	0	0
015	0	0	0	0	0
016	1	0	1	1	0
017	0	0	0	1	0
018	0	0	0	0	0
019	1	0	0	0	0
020	0	0	0	0	0
021	1	0	1	0	0
022	1	0	0	0	0
023	0	0	1	1	0
024	0	0	1	0	0
025	1	1	1	1	0
026	0	0	0	0	0
027	0	0	0	0	0
028	0	0	0	1	0
029	0	0	0	0	0
030	1	1	0	0	0
031	0	0	0	0	0
032	0	0	1	1	0
033	0	0	0	0	0
034	0	0	1	0	0
035	0	0	0	0	0

* Question 4 data is omitted (responses were negative for all options, for all cases)

Question 5: Does anyone in the child's household work with lead?			
Case #	**No**	**Yes**	**Yes - Details**
001	1	0	
002	1	0	
003	1	0	
004	1	0	
005	1	0	
006	1	0	
007	0	1	
008	1	0	
009	1	0	
010	1	0	
011	0	1	Construction
012	1	0	
013	1	0	
014	1	0	
015	1	0	
016	1	0	
017	1	0	
018	0	1	Mechanic
019	1	0	
020	1	0	
021	1	0	
022	1	0	
023	1	0	
024	1	0	
025	0	1	Construction
026	1	0	
027	0	1	Flooring
028	0	1	Construction
029	1	0	
030	0	1	Construction
031	0	1	Mechanic
032	0	1	Construction
033	0	1	Construction
034	1	0	
035	1	0	

REFERENCES

Agency for Toxic Substances and Disease Registry (2007a). Case studies in environmental medicine: lead toxicity. Retrieved October 25, 2009 from: http://www.atsdr.cdc.gov/csem/lead/docs/lead.pdf

Agency for Toxic Substances and Disease Registry (2007b). *Toxicological profile for lead*. Georgia: U.S. Department of Health and Human Services.

Alexander, F.W., Clayton, B.E., and Delves, H.T. (1974). Mineral and trace-metal balances in children receiving normal and synthetic diets. *QJM: An International Journal of Medicine 43*, 89-111.

Al-Modhefer, A.J.A., Bradbury, M.W.B., and Simmons, T.J.B. (1991). Observations on the chemical nature of lead in human blood serum. *Clinical Science 81*:823-829.

Aufderheide, A.C., and Wittmers L.E. (1992). Selected aspects of the spatial distribution of lead in bone. *Neurotoxicology* 13:809-820.

Azcona-Cruz, M.I., Rothenberg, S.J., Zamora-Munoz, J.S., and Romero-Placeres, M. (2000). Lead-glazed ceramic ware and blood lead levels of children in the city of oaxaca, mexico. *Archives of Environmental Health 55*(3), 217-222.

Baer, R.D., Garcia de Alba, J., Cueto, L.M., Ackerman, A., and Davison, S. (1989). Lead based remedies for empacho: patterns and consequences. *Social Science and Medicine 29*(12), 1373-1379.

Baer, R.D., Garcia de Alba, J., Mares Leal, R., Plascencia Campos, R., and Goslin, N. (1998). Mexican use of lead in the treatment of empacho: community, clinic, and longitudinal patterns. *Social Science and Medicine 47*(9), 1263-1266.

Barbee, S.J., and Constantine, L.A. (1994). Release of lead from crystal decanters under conditions of normal use. *Food and Chemical Toxicology 32*(3), 285-288.

Barry, P.S.I. (1975). A comparison of concentrations of lead in human tissue. *British Journal of Industrial Medicine 32*:119-139.

Bergdahl, I.A., Grubb, A., Schutz, A., Desnick, R.J., Wetmur, J.G., Sassa, S., et al. (1997). Lead binding to δ-aminolevulinic acid dehydratase (ALAD) in human erythrocytes. *Pharmacology and Toxicology 81*:153-158.

Bernard, S.M. (2003). Should the centers for disease control and prevention's childhood lead poisoning intervention level be lowered? *American journal of Public Health 93*(8), 1253-1260.

Blake, K.C.H., and Mann, M. (1983). Effect of calcium and phosphorus on the gastrointestinal absorption of 203Pb in man. *Environmental Research 30*:188-194.

Bose, A., Vashistha, K., and O'Loughlin, B.J. (1983). Azarcon por empacho – another cause of lead toxicity. *Pediatrics 72*(1), 106-108.

Bress, W.C., and Bidanset, J.H. (1991). Percutaneous in vivo and in vitro absorption of lead. *Veterinary and Human Toxicology 33*:212-214.

Center for Environmental Health (2008). Lead in lunchboxes. Retrieved October 24, 2009, from: http://www.ceh.org

Centers for Disease Control and Prevention (1984). Lead poisoning-associated death from asian indian folk remedies – florida. *Morbidity Mortality Weekly Report 33*(45), 638, 643-645.

Centers for Disease Control and Prevention (1992). Case studies in environmental medicine: lead toxicity. *CDC Wonder*. Retrieved October 24, 2009 from: http://wonder.cdc.gov/wonder/prevguid/p0000017/p0000017.asp

Centers for Disease Control and Prevention (1993). Lead poisoning associated with use of traditional ethnic remedies – california, 1991-1992. *Morbidity Mortality Weekly Report 42*(27), 521-524.

Centers for Disease Control and Prevention (1997). Screening young children for lead poisoning: guidance for state and local public health officials. Retrieved March 14, 2010 from: http://www.cdc.gov/nceh/lead/publications/screening.htm

Centers for Disease Control and Prevention (2000). Recommendations for blood lead screening of young children enrolled in medicaid: targeting a group at high risk. *Morbidity Mortality Weekly Report 49*(RR14), 1-13.

Centers for Disease Control and Prevention (2002). Childhood lead poisoning associated with tamarind candy and folk remedies – california, 1999-2000. *Morbidity Mortality Weekly Report 51*(31), 684-686.

Centers for Disease Control and Prevention (2003a). Lead and drinking water from private wells. *Healthy Water*. Retrieved December 13, 2009 from: http://www.cdc.gov/ncidod/dpd/healthywater/factsheets/pdf/lead.pdf

Centers for Disease Control and Prevention (2003b). Surveillance for elevated blood lead levels among children—united states, 1997-2001. *Morbidity Mortality Weekly Report 52*(ss10), 1-21.

Centers for Disease Control and Prevention (2004a). Childhood lead poisoning from commercially manufactured french ceramic dinnerware – new york city, 2003. *Morbidity Mortality Weekly Report 53*(26), 584-586.

Centers for Disease Control and Prevention (2004b). Lead poisoning from ingestion of a toy necklace – oregon, 2003. *Morbidity Mortality Weekly Report 53*(23), 509-511.

Centers for Disease Control and Prevention (2005). Lead poisoning associated with use of litargirio – rhode island, 2003. *Morbidity Mortality Weekly Report 54*(9), 227-229.

Centers for Disease Control and Prevention (2006). Death of a child after ingestion of a metallic charm – minnesota, 2006. *Morbidity Mortality Weekly Report 55*(12), 340-341.

Centers for Disease Control and Prevention (2009a). Number of children tested and confirmed eblls by state, year, and bll group, children < 72 months old. CDC's National Surveillance Data (1997-2006). Retrieved September 18, 2009 from http://www.cdc.gov/nceh/lead/data/national.htm

Centers for Disease Control and Prevention (2009b). Folk medicine. *Lead – Tips – Sources of Lead*. Retrieved October 24, 2009 from: http://www.cdc.gov/nceh/lead/tips/folkmedicine.htm

Chamberlain, A., Heard, C., Little, M.J., Newton, D., Wells, A.C., and Wiffin, R.D. (1978). Investigations into lead from motor vehicles. Harwell, united kingdom: united kingdom atomic energy authority. Report no. AERE-9198.

Chiaradia, M., Gulson, B.L., and MacDonald, K. (1997). Contamination of houses by workers occupationally exposed in a lead-zinc-copper mine and impact on blood lead concentrations in the families. *Occupational and Environmental Medicine 54,* 117-124.

Daluga, M., and Miller, K. (2007). Lead in your child's lunch box. *Clinical Pediatrics 46*(2), 151-153.

Dargan, P.I., Evans, P.H., House, I.M., and Jones, A.L. (2000). A case of lead poisoning due to snooker chalk. *Archives of Disease in Childhood 83*, 519-520.

Davis, A., Ruby, M.V., and Bergstrom, P.D. (1994). Factors controlling lead bioavailability in the butte mining district, montana, usa. *Environmental Geochemistry and Health 16*:147-157.

Dolcourt, J.L., Hamrick, H.J., O'Tuama, L.A., Wooten, J., and Barker Jr., E.L. (1978). Increased lead burden in children of battery workers: asymptomatic exposure resulting from contaminated work clothing. *Pediatrics 62*, 563-566.

Frazer, L. (2008). Soil in the city: a prime source of lead. *Environmental Health Perspectives 116*(12), A 522.

Gerson, M., Van Den Eeden, S.K., and Gahagan, P. (1996). Take-home lead poisoning in a child from his father's occupational exposure. *American Journal of Industrial Medicine 29*, 507-508.

Gilbert, S.G. and Weiss, B. (2006). A rationale for lowering the blood lead action level from 10 to 2µg/dL. *Neurotoxicology 27*(5), 693-701.

Gorospe, E.C. and Gerstenberger, S.L. (2008). Atypical sources of childhood lead poisoning in the united states: a systematic review from 1966-2006. *Clinical Toxicology 46*(8), 728-737.

Graziano, J.H. and Blum, C. (1991). Lead exposure from lead crystal. *Lancet 337*(8734), 141-142.

Gulson, B.L., Mahaffey, K.R., Jameson, C.W., Mizon, K.J., Korsch, M.J., Cameron, M.A., et al. (1998). Mobilization of lead from the skeleton during the postnatal period is larger than during pregnancy. *Journal of Laboratory and Clinical Medicine 131*:324-329.

Gulson, B.L., Mizon, K.J., Korsch, M.J., Palmer, J.M., and Donnelly, J.B. (2003). Mobilization of lead from human bone tissue during pregnancy and lactation - a summary of long-term research. *Science of the Total Environment 303*:79-104.

Haar, G.T. and Aronow, R. (1974). New information on lead in dirt and dust related to the childhood lead problem. *Environmental Health Perspectives*, 83-89.

Health Canada (1994). Lead intoxication in a child related to the ingestion of playground paint chips – quebec. *Canada Communicable Disease Report 21*(2), F-1 – F-3.

Healy, M.A., Harrison, P.G., Aslam, M., Davis, S.S., and Wilson, C.G. (1982). Lead sulfide and traditional preparations: routes for ingestion, and solubility and reactions in gastric fluid. *Journal of Clinical Pharmacology 7*, 169-173.

Heard, M.J. and Chamberlain, A.C. (1982). Effect of minerals and food on uptake of lead from the gastrointestinal tract in humans. *Human Toxicology 1*, 411-416.

Heard, M.J., Wells, A.C., Newton, D., and Chamberlain, A.C. (1979). Human uptake and metabolism of tetra ethyl and tetramethyl lead vapour labelled with ^{203}Pb. *International Conference on Management and Control of Heavy Metals in the Environment, London, England, September*. Edinburgh, United Kingdom: CEP Consultants, Ltd., 103-108.

Hipkins, K.L., Materna, B.L., Payne, S.F., and Kirsch, L.C. (2004). Family lead poisoning associated with occupational exposure. *Clinical Pediatrics 43*, 845-849.

Holstege, C.P., Ferguson, J.D., Wolf, C.E., Baer, A.B., and Poklis, A. (2004). Analysis of moonshine for contaminants. *Clinical Toxicology 42*(5), 597-601.

Hull, C. (2005). *Pewter*. Buckinghamshire, UK: Shire Publications, Ltd..

Hursh, J.B., Schraub, A., Sattler, E.L., and Hofmann, H.P. (1969). Fate of 212Pb inhaled by human subjects. *Health Physics 16*:257-267.

Illinois Department of Public Health (2008). Sources of childhood lead poisoning. Retrieved October 24, 2009 from: http://idph.state.il.us/HealthWellness/leadfs_sources.pdf

James, A.C., Stahlhofen, W., Rudolf, G., Köbrich, R., Briant, J.K., Egan, M.J., et al. (1994). Deposition of inhaled particles. *Annals of the International Commission on Radiological Protection, 24*(13), 231-299.

Jones, T.F., Moore, W.L., Craig, A.S., Reasons, R.L., and Schaffner, W. (1999). Hidden threats: lead poisoning from unusual sources. *Pediatrics 104*(5), 1223-1225.

Karri, S.K., Saper, R.B., and Kales, S.N. (2008). Lead encephalopathy due to traditional medicines. *Current Drug Safety 3*(1), 54-59.

Katagiri, Y., Toriumi, H. and Kawai, M. (1983). Lead exposure among 3-year-old children and their mothers living in a pottery-producing area. *International Archives of Occupational and Environmental Health 52*, 223-229.

Kehoe, R.A. (1987). Studies of lead administration and elimination in adult volunteers under natural and experimentally induced conditions over extended periods of time. *Food and Chemical Toxicology 25*:425-493.

Los Alamos National Labs (2003). Lead. Retrieved October 25, 2009 from: http://periodic.lanl.gov/elements/82.html

Lynch, R., Elledge, B., and Peters, C. (2008). An assessment of lead leachability from lead-glazed ceramic cooking vessels. *Journal of Environmental Health 70*(9), 36-39.

Lynch, R.A., Boatright, D.T., and Moss, S.K. (2000). Lead-contaminated imported tamarind candy and children's blood lead levels. *Public Health Reports 115*, 537-543.

Magellan Biosciences (2009). LeadCare II waived. Retrieved March 6, 2010 from: http://www.waivedleadcare.com/download/70-7054_Public_health_9_30_09RevC.pdf

Mahaffey, K.R. and Annest, J.L. (1986). Association of erythrocyte protoporphyrin with blood lead level and iron status in the second national health and nutrition examination survey, 1976-1980. *Environmental Research 41*, 327-338.

McKinney, P.E. (2000). Acute elevation of blood lead levels within hours of ingestion of large quantities of lead shot. *Clinical Toxicology 38*(4), 435-440.

McQuirter, J.L., Rothenburg, S.J., Dinkins, G.A., Kondrashov, V., Manalo, M., and Todd, A.C. (2004). Change in blood lead concentration up to 1 year after a gunshot wound with a retained bullet. *American Journal of Epidemiology 159*(7), 683-692.

Medlin, J. (2004). Sweet candy, bitter poison. *Environmental Health Perspectives 112*(14), A 803.

Mielke, H.W., Gonzales, C.R., Powell, E., Jartun, M., and Mielke Jr., P.W. (2007). Nonlinear association between soil lead and blood lead of children in metropolitan new orleans, louisiana: 2000-2005. *Science of the Total Environment 388*, 43-53.

Mielke, H.W., Powell, E.T., Shah, A., Gonzales, C.R., and Mielke, P.W. (2001). Multiple metal contamination from house paints: consequences of power sanding and paint scraping in new orleans. *Environmental Health Perspectives 109*(9), 973-978.

Miller, M.B., Curry, S.C., Kunkel, D.B., Arreola, P., Arvizu, E., Schaller, K., and Salmen, D. (1996). Pool cue chalk: a source of environmental lead. *Pediatrics 97*(6), 916-917.

Mojdehi, G.M., and Gurtner, J. (1996). Childhood lead poisoning through kohl. *American Journal of Public Health 86*(4), 587-588.

Moore, M.R., Meredith, P.A., Watson, W.S., Sumner, D.J., Taylor, M.K., and Goldberg, A. (1980). The percutaneous absorption of lead-203 in humans from cosmetic preparations containing lead acetate, as assessed by whole-body counting and other techniques. *Food and Cosmetics Toxicology 18*:399-405.

Mowad MD, E., Haddad MD, I., and Gemmel, D.J. (1998). Management of lead poisoning from ingested fishing sinkers. *Archives of Pediatric and Adolescent Medicine 152*, 485-488.

National Resources Defense Council v. Environmental Protection Agency, 545 F.2d 320 (2nd Cir. 1976).

Nriagu, J.O. (1990). The rise and fall of leaded gasoline. *The Science of the Total Environment*, 92: 13-28.

Petrucci, R.H., Harwood, W.S., and Herring, F.G. (Eds.) (2002). *General Chemistry: Principles and Modern Applications* (8th ed.). Upper Saddle River, NJ: Prentice-Hall, Inc..

Pocock, S.J., Shaper, A.G., Walker, M., Wale, C.J., Clayton, B., Delves, T., et al. (1983). Effects of tap water lead, water hardness, alcohol, and cigarettes on blood lead concentrations. *Journal of Epidemiology and Community Health 37*, 1-7.

Rabinowitz, M.B., Wetherill, G.W., and Kopple, J.D. (1976). Kinetic analysis of lead metabolism in healthy humans. *Journal of Clinical Investigation 58*:260-270.

Schmidt, C.W. (2008). Face to face with toy safety: understanding an unexpected threat. *Environmental Health Perspectives 116*(2), A71-A76.

Schroeder, H.A., and Tipton, I.H. (1968). The human body burden of lead. *Archives of Environmental Health 17*:965-978.

Shannon, M. (1998). Lead poisoning from an unexpected source in a 4-month-old infant. *Environmental Health Perspectives 106*(6), 313-316

Southern Nevada Health District (2007). *Southern Nevada Health District Childhood Lead Poisoning prevention Program Lead Poisoning Elimination Plan*. Retrieved March 6, 2010 from: www.cchd.org/download/epi/clppp-elimination-plan.pdf

Southern Nevada Health District, Office of Epidemiology (2008). Number of first-time blood lead test reports received. [*Morbidity Database*]. Unpublished data. Received March 19, 2010.

Su, M., Barrueto Jr., F., and Hoffman, R.S. (2002). Childhood lead poisoning from paint chips: a continuing problem. *Journal of Urban Health: Bulletin of the New York Academy of Medicine 79*(4), 491-501.

The Orange County Register (2004). Toxic treats. *OCRegister.com Investigations*. Retrieved October 23, 2009 from: http://www.ocregister.com/investigations/2004/lead/part2_sidebar1.shtml

Trotter II, R.T. (1985). Greta and azarcon: a survey of episodic lead poisoning from a folk remedy. *Human Organization 44*(1), 64-71.

U.S. Consumer Product Safety Commission (2003). Target corporation announce recall of multicolored sidewalk chalk. *NEWS from CPSC*. Retrieved October 16, 2009 from: http://www.cpsc.gov/cpscpub/prerel/prhtml04/04032.html

U.S. Department of Health and Human Services (2000). Healthy people objectives. *Healthy People 2010*. Retrieved September 18, 2009 from: http://healthypeople.gov/

U.S. Environmental Protection Agency (1973). EPA requires phase-out of lead in all grades of gasoline. *EPA Press Release*. Retrieved November 22, 2008, from http://www.EPA.gov/history/topics/lead/03.htm

U.S. Environmental Protection Agency (1986). Air quality criteria for lead (final). Volumes I and IV of IV.

U.S. Environmental Protection Agency (1993). Actions you can take to reduce lead in drinking water. *Lead in Drinking Water*. Retrieved December 13, 2009 from: http://www.EPA.gov/OGWDW/lead/lead1.html

U.S. Environmental Protection Agency (2004). Residential lead-based paint abatement. EPA Model Worker Course: Residential Lead-Based Paint Abatement. Retrieved October 20, 2009 from: http://www.EPA.gov/oppt/lead/pubs/abateworker.htm

U.S. Environmental Protection Agency (2006). Air quality criteria for lead. Volume I of II.

U.S. Environmental Protection Agency (2007). Humans and lead fishing sinkers. *Anglers and Aquatic Resource Protection*. Retrieved October 16, 2009 from: http://www.EPA.gov/owow/fish/humans.html

U.S. Environmental Protection Agency (2008). 40 CFR Parts 50, 51, 53 and 58. National ambient air quality standards for lead; Final rule. *Federal Register*, 73(219): 66964.

U.S. Food and Drug Administration (2006). Lead in candy likely to be consumed by small children. *Guidance for Industry: Lead in Candy Likely to be Consumed Frequently by Small Children: Recommended Maximum Level and Enforcement Policy*. Retrieved October 23, 2009 from: http://www.cfsan.fda.gov/guidance.html

U.S. Food and Drug Administration (2007). FDA warns consumers not to use swad brand sindoor: product contains high levels of lead. *FDA News Release*. Retrieved October 24, 2009 from: http://fda.gov

Vassilev, Z.P., Marcus, S.M., Ayyanathan, K., Ciuffo, V., Bogden, J.D., Kemp, F.W., et al. (2005). Case of elevated blood lead in a south asian family that has used sindoor for food coloring. *Clinical Toxicology 43*(4), 301-303.

Wallace, D.M., Kalman, D.A., and Bird, T.D. (1985). Hazardous lead release from glazed dinnerware: a cautionary note. *The Science of the Total Environment 44*, 289-292.

Wigle, D.T. (2003). *Child Health and the Environment*. Oxford: Oxford University Press, Inc..

Williams, P. L., James, R. C. & Roberts, S. M. (Eds.). (2000). *Principles of Toxicology: Environmental and Industrial Applications* (2nd ed.). New York: John Wiley & Sons, Inc..

Witkowski, J.A., and Parish, L.C. (2001). You've come a long way baby: a history of cosmetic lead toxicity. *Clinics in Dermatology 19*, 367-370.

Zhang, W., Zhang, G.G., He, H.Z., and Bolt, H.M. (1994). Early health effects and biological monitoring in persons occupationally exposed to tetraethyllead. *International Archives of Occupational and Environmental Health 65*:395-399.

VITA

Graduate College
University of Nevada, Las Vegas

Mackenzie Suzanne Burns

Degrees:
Bachelor of Arts, Sport Sciences, 2003
University of the Pacific

Special Honors:
2009 - 2010 School of Community Health Sciences, Master of Public Health,
Outstanding Graduate Student Award - Environmental and Occupational Health

Poster Presentation:
Nevada Public Health Association, September 2009,
Efforts to Increase Lead Screening Rates in Southern Nevada:
The Clark County Children's Lead Screening Study

Thesis Title: Factors Associated with Blood Lead Levels of Children in Southern Nevada

Thesis Examination Committee:
Chairperson, Shawn Gerstenberger, Ph.D.
Committee Member, Linda Stetzenbach, Ph.D.
Committee Member, Chad Cross, Ph.D.
Graduate Faculty Representative, Jennifer Keene, Ph.D.