RESIDENTIAL LEAD HAZARDS, NUTRITIONAL DEFICIENCIES, AND SOCIO-CULTURAL FACTORS RELATED TO HISPANIC CHILDREN WITH BLOOD LEAD LEVELS GREATER THAN OR EQUAL TO FIVE MICROGRAMS PER DECILITER

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ABSTRACT

Residential Lead Hazards, Nutritional Deficiencies, and Socio-cultural Factors Related to Hispanic Children with Blood Lead Levels Greater Than or Equal to Five Micrograms Per Deciliter

by

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One of the most significant public health successes during the late 20th century was the reduction of blood lead levels among children in the United States. However, lead continues to be a public health issue because it often affects minority children of lower socioeconomic status, who live in older homes. Young children are especially susceptible to the harmful affects of lead due to their vulnerable developmental state. According to research, the most common sources of lead exposure for U.S. children are lead-based paint and lead-contaminated dust in the home.

This study examined residential lead hazards, nutritional deficiencies, and socio-cultural factors related to children with blood lead levels $\geq 5\mu g/dL$ in Clark County, Nevada. The results demonstrated that lead-based paint residential hazards may not be the most common source for childhood lead exposure for children. While the results on nutritional deficiencies and socio-cultural factors related to Hispanic children were insignificant, evident trends were observed. These trends warrant the development for culturally appropriate lead prevention programs in Clark County, Nevada.

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CHAPTER 1

INTRODUCTION

Childhood lead poisoning is the most preventable, yet most prevalent environmental hazard among young children (CDC, 2005). It is classified as an injury that occurs as a result of environmental contamination which can be avoided entirely. Despite the advances in public health to reduce environmental lead exposure, thousands of children in the United States are exposed to lead every year. Once exposed to the toxic metal, which has no biological importance in the human body, children may endure lifelong consequences (ASTDR, 2005; Bellinger, 2004; CDC, 2005).

The toxic effects of lead have been known for nearly as long as it has been used. Lead poisoning even dates back to ancient civilizations. The fall of the Roman Empire has been attributed to their extensive use of lead (ATSDR, 2005; Hartman, 1988; Wigle, 2003). Today, lead is mined and mass manufactured for a variety of uses. In the recent past, lead was widely used in paint and as an additive in gasoline (ATSDR, 2005; EPA, 1992). Once the deleterious effects of lead pollution were discovered, the government prohibited the use of lead in residential paint and gasoline. The ban resulted in a remarkable decrease in environmental lead pollution. However, lead is ubiquitous in the environment due to the wide contamination from emissions (Bernard & McGeehin, 2003; CDC, 2005; EPA, 1992).

Many environmental components can affect a child's risk for lead exposure.

Household items, behaviors, and diet are common factors that have been examined in regards to childhood lead exposure (ATSDR, 2005; CD C, 2005; Urbanowicz, 1986). According to the Centers for Disease Control and Prevention (CDC) and the U.S. Environmental Protection Agency (EPA), lead-based paint and lead-contaminated dust and soil are the most common lead hazards in the home (CDC, 2005; EPA, 1992; Jacobs et al., 2002; Lynch, Boatright & Moss, 2000).

Children are at particular risk to the adverse effects of environmental lead. Lead is a known neurotoxicant, hepatotoxicant, and nephrotoxicant. Any damage to the brain, liver, or kidney as a result of lead exposure may be irreversible. Young children are more sensitive to the health effects of lead than adults because they are at a vulnerable developmental stage (ATSDR, 2005; Donkin et al., 1995; Finkelstein et al., 1998). Children have underdeveloped blood brain barriers and excretion mechanisms that may allow lead to remain in the body and enter the brain more readily than in an adult (Bellinger, 2004; Finkelstein, Markowitz& Rosen, 1998). In response to the harmful effects of lead, the Centers for Disease Control and Prevention (CDC) established the blood lead level of concern at $\geq$ 10 micrograms per deciliter (μg/dL) (CDC, 2005). However, researchers agree that blood lead levels below 10μg/dL may still cause negative cognitive and neurobehavioral impacts (Bernard, 2003; CDC, 2002b; CDC, 2005; Finkelstein et al., 1998; Lanphear, Dietrich, Auinger & Cox, 2000; Wigle, 2003).

Environmental lead exposure is a major public health concern due to the disparate distribution among populations of lower socioeconomic class. In comparison to their affluent counterparts, children from low-income families experience greater blood lead burdens due to poor housing conditions and deteriorating lead-based paint, poor parental supervision, coupled with nutritional deficiencies (CDC, 2002b; von Schimding, 2002). Studies demonstrate an inverse relationship between elevated blood lead levels and nutritional deficiencies in children (ATSDR, 2005; CDC, 2005; Wright, Shannon, Wright & Hu, 1999). Therefore, poor children are more likely to live in adverse environmental conditions and because of inadequate nutrition, may be more vulnerable to the deleterious effects of lead (CDC, 2005; von Schimding, 2002).

Recently, activities associated with socio-cultural practices have been implicated in elevated blood lead levels in children (Azarcona-Cruz et al. 2000; CDC, 2002a). Hispanic communities are at an increased risk for lead exposure by practicing traditional customs which may inadvertently contain lead. These socio-cultural activities include the consumption of Mexican-imported candies, cooking with lead-glazed pottery, wearing gold jewelry from Mexico, and using folk remedies (Baer, De Alba, Leal, Campos, & Goslin, 1998; CDC, 2002a; CDC, 2005). This is of particular concern in Nevada because of the large Hispanic population which may be at risk. Identifying these practices and associated lead hazards is critical to decreasing blood lead concentrations in children (Bose, Vashistha & O' Loughlin, 1983; Gersberg et al., 1997; Mohamed, Chin & Pok, 1995).

The widespread environmental contamination and ability to cause a wide spectrum of toxic effects makes lead a public health problem of global magnitude (Toscano & Guilarte, 2005; Wigle, 2003). Lead disproportionately affects children from lower income families. The deleterious effects on cognitive and behavioral functions are closely associated with factors such as socioeconomic status, maternal intelligence, and nutritional status (ATSDR, 2005; Myers et al., 1997; Wright el al., 1999).

The US Department of Health and Human Services has established a national health objective to eliminate BLLs ≥ 10 μg/dL in children by the year 2010 (CDC, 2005; Healthy People 2010). It is imperative to identify lead hazards and other contributing factors among various communities in order to educate them and successfully reduce childhood lead exposure. The goal of this study is to examine residential lead hazards, nutritional deficiencies, and cultural practices related to Hispanic children with blood lead levels ≥ 5μg/dL in Clark County, Nevada.

CHAPTER 2

LITERATURE REVIEW

Chemistry

Lead (Pb) is one of the most abundant and widely distributed trace elements in the environment. It can be found in small amounts within the earth's crust. Lead is a bluish-grayish metal which is comprised of a mixture of four stable isotopes, ^{208}Pb, ^{206}Pb, ^{207}Pb and ^{204}Pb. It has an atomic number of 82 and atomic mass of 207.2 grams/mole. Lead is a member of Group 14 on the periodic table and therefore possesses metallic properties that are highly desired in the metal industry. It is considered a stable element that can be combined with other metals to form alloys (ATSDR, 2005).

Chemical Properties

There are three oxidation states that lead may assume: Pb^0, Pb^{+2} and Pb^{+4}. In the environment, lead exists in the Pb^{+2} oxidation state. Lead is rarely found as a metal in its Pb^0 oxidation state and Pb^{+4} inorganic compounds are also not usually found under normal environmental conditions. Organic compounds are more prevalent in the tetravalent (+4) oxidation state rather than the organolead (+2) state (ATSDR, 2005).

Lead is usually found as a lead compound, often in galena ores (PbS), anglesite ($PbSO_4$), and cerussite ($PbCO_3$) (ATSDR, 2005). Lead is highly valued because of its low melting point, pliability and durability (Wigle, 2003).

Sources

<u>Natural</u>

Soil and Sediment

Lead is present in all types of soil in a wide range of concentrations. The weathering of rocks, dry and wet sedimentation of airborne particulates, and the decomposition of living matter are natural methods in which soil receives lead loads. Lead is mostly retained in the superficial layer of soil down to a depth of 5-10cm. Researchers have determined the average lead concentration in "unpolluted soils" to be approximately 17 parts per million (ppm) (Carelli, Sannolo, Lorenzo & Castellino, 1995; Moore, 1986). Lead cannot be destroyed; therefore it remains in the soil for many years (ATSDR, 2005).

Lead released from volcanic eruptions and erosion of underwater rocks and stones contributes to deposition into marine sediments. The deposition of lead from bodies of water onto aquatic sediments may be viewed as a process of detoxification of that particular ecosystem since a reduction of the lead concentration in the water results in deposition into the sediment (Carelli et al., 1995). Overall, lead released from natural sources into soil and sediment is minor compared to the lead deposited in soil and sediment from human sources (ATSDR, 2005).

Water

Lead is usually present in relatively low concentrations in natural surface and underground waters as a result of natural releases of lead from soil, sediment and air. Lead concentrations in surface waters are influenced by the hydrochemistry of these environments and the amount of lead in the sediments. The geochemical makeup of bedrock which embeds deep waters affects the lead concentrations in underground waters. Atmospheric deposition of lead onto water surfaces is a common pathway for lead to enter the aquatic system (ATSDR, 2005; Sannolo et al., 1995).

An important property of water that is relevant to lead is its pH level. The lower the pH of the water the greater ability it has to dissolve lead compounds. Higher concentrations of lead may be found in acidic water sources. Current input of lead into the water by anthropogenic sources is far greater than the natural input (ATSDR, 2005; Moore, 1986).

Air

Atmospheric lead is in the form of particulates which can exist primarily in dust and volcanic output. Because lead is in a particulate form, the half-life is extremely short. Smaller particles lower in the atmosphere may have a longer half-life and are much more dangerous as they are more likely to be inhaled. Organic leads are a result of industrial processes and are highly toxic to humans if inhaled. In fact, lead emissions from natural sources accounts for only a minute portion of global lead emissions (ATSDR, 2005; Moore, 1986).

Anthropogenic

Industrial

Human activities have increased the manufacturing and emissions of lead exponentially. Most of the lead found in the environment is due to industrial processes (ATSDR, 2005). Lead enters the environment as a result of mining for lead or through the manufacturing of lead. The properties of lead allow it to be used commercially as a metal, alloyed with other metals or as lead compounds. Table 1 illustrates the extensive use of industrial lead compounds. Primary lead is obtained from mined ore and can be recovered from lead, lead-zinc, zinc, and silver. Secondary lead is obtained from scrap lead, primarily from recycled lead-acid batteries. Burning coal, oil, or waste also releases lead into the atmosphere (ATSDR, 2005; Sannolo et al., 1995).

Using tetraethyl lead as an additive to gasoline resulted in the greatest lead contamination in history. The combustion of leaded gasoline has accounted for 90% of lead deposited in the atmosphere (ATSDR, 2005; Toscano& Guilarte, 2005). Environmental concentrations of lead increased the greatest between the years of 1950 and 2000 as a result of leaded-gasoline (ATSDR, 2005). Despite the fact that leaded gasoline was phased out in the mid-1980's, the environmental contamination released during the period of leaded gasoline is still present in the soil. Gasoline produced with lead additives continues to be used as fuel for aircrafts, race cars, and off-road engines (ATSDR, 2005; CDC, 2005; EPA, 1992).

Today, the major use of lead in the industrial business is for lead-acid storage batteries. The lead battery is preferred over other batteries such as the nickel-cadmium battery because it is inexpensive, rechargeable, and resistant to corrosion (ATSDR, 2005; Urbanowicz, 1986). Lead batteries provide a dependable source of electricity and are likely to remain in the industry for many years, despite the consequences that lead manufacturing has on the environment (Urbanowicz, 1986).

While the majority of lead production has been for the use in the automotive industry, it has a wide range of applications. It has been used in paint, solder, ammunition, and pesticides, all of which have been banned in the United States. The everlasting effects of lead from these uses still exist in the environment today (ATSDR, 2005; EPA, 1992).

Table 1. Current and former uses of selected lead compounds

Compound	Uses
Lead acetate	Dyeing of textiles, waterproofing, varnishes, lead driers, chrome pigments gold cyanidation process, insecticide, anti-fouling paints, analytical reagent, hair dye
Lead azide	Primary detonating compound for high explosives
Lead bromide	Photopolymerization catalyst, inorganic filler in fire-retardant plastics, general purpose welding flux
Lead chloride	Preparation of lead salts, lead chromate pigments, analytical reagent
Lead chromate	Pigment in industrial paints, rubber, plastics, ceramic coatings; organic analysis
Lead fluoborate	Salt for electroplating lead; can be mixed with stannous fluoroborate to electroplate any composition of tin and lead as an alloy
Lead iodide	Bronzing, printing, photography, cloud seeding
Lead molybdate	Analytical chemistry, pigments
Lead nitrate	Lead salts, mordant in dyeing and printing calico, matches, mordant for staining mother of pearl, oxidizer in the dye industry, sensitizer in photography, explosives, tanning, process engraving, and lithography
Lead oxide, black	Storage batteries, ceramic cements and fluxes, pottery and glazes, glass, chromium pigments, oil refining, varnishes, paints, enamels, assay of precious metal ores, manufacture of red lead, cement (with glycerol), acid-resisting compositions, match-head compositions, other lead compounds, rubber accelerator
Lead phosphate	Stabilizing agent in plastics
Lead styphnate	Primary explosive
Lead sulfate	Storage batteries, paints, ceramics, pigments, electrical and other vinyl compounds requiring high heat stability
Lead sulfide	Ceramics, infrared radiation detector, semi-conductor, ceramic glaze
Tetraethyl lead	Anti-knock agent in aviation gasoline

Source: ATSDR, 2005

Living Environment

After the discovery of the deleterious effects that lead may have on humans, policies were implemented to minimize the public's exposure. The 1978 ban of lead-based paint for the use of residences, household furniture, and children's toys, has produced a dramatic decrease in average blood lead levels among U.S. children (Bernard & McGeehin, 2003; EPA, 1992; Velsor-Friedrich, 2002). However, lead is ubiquitous in the environment due to the residual contamination resulting from the industrial and transportation emissions. Soil near roadways, older houses, old orchards, mining areas, industrial sites, near power plants, incinerators, landfills, and hazardous waste sites are known to contain the highest concentrations of lead (ATSDR, 2005; Bernard & McGeehin, 2003; CDC, 2005).

There are various hazards that exist in pre-1978 homes. Nationally, many older homes exist and may still contain lead-based paint (Bennefield & Bonnette, 2003; CDC, 2005; EPA, 1992). Contaminated paint and dust are the most common sources of exposure for children (CDC, 2005; EPA, 1992). The prevalence of lead-based hazards increases with the age of housing due to chipping, peeling or deteriorated paint on the interior or exterior of the home. Lead-contaminated dust created from lead-based paint can also accumulate in the home. Children that crawl around or hide in corners can become exposed to the lead-contaminated dust (Caravanos, Weiss & Jaeger, 2006; EPA, 1992). Older buildings may contain lead pipes which can contaminate drinking water (ATSDR, 2005). Children who live in these homes have a high risk of becoming exposed to lead (CDC, 2005; Clark et al., 2004).

Atypical lead sources include lead-glazed bathtubs, and tiles. While many old and new homes have these lead sources, they usually do not pose a serious threat unless renovation or remodeling releases lead dust into the air (Clark et al., 2004; EPA, 1992). Other sources which may be considered a hazard are leaded mini-blinds and metal objects which are made of lead. Children can place mini-blinds and metal objects in their mouths and ingest small lead particles or lead contaminated dust (Hugelmeyer, Moorhead, Horenblas, & Bayer, 1988; VanArsdale, Leiker, Kohn et al., 2004). The identification of such lead hazards in the home is important in order to minimize a child's exposure to lead (Blank & Howieson, 1983; EPA, 1992).

Socio-Cultural Environment

Various environmental sources related to socio-cultural activities have been implicated in lead poisoning cases. Recent data show that commonly used imported items which may be contaminated with lead are becoming a major source of lead exposure for children, specifically in Hispanic communities (ATSDR, 2005; CDC, 2005; Vallejos et al., 2006). Lead has been found in Mexican imported candies, folk remedies, imported pottery and ceramics, and imported jewelry (Baer, Garcia De Alba, Leal, Plascencia Campos, & Goslin 1998; CDC, 2002a; Hernandez-Avila, Romieu, Rios, Aracely, & Palazuelos, 1991; Mohammed, Chin & Pok, 1995).

Significant lead concentrations may be present in all components of Mexican imported candies from the tamarind or salt-based candy itself, sticks, straws, to associated wrappers and containers (CDC, 2002a). Mexico's long history of environmental lead contamination in addition to quality control issues in the manufacturing process may contribute to the candy contamination (Schnaas et al., 2004). Children's risk of lead exposure from candies is increased because they are the ones more likely to consume candies (CDC, 2000a; Lynch, Boatright, & Moss, 2000).

Immigrant Hispanic populations, like other immigrant populations continue cultural practices even after immigration into the United States. One practice that has raised concerns regarding lead includes treating children with lead contaminated powder remedies called “azarcon” or “greta” to cure illnesses such as “empacho” a stomach ailment (Baer et al., 1998; CDC, 2002b; Bose, Vashistha & O’Loughlin, 1983; Vallejos et al., 2006). Little is known about the origin and production of these powder remedies because it is often healers who sell them out of their homes to the parents of ill children. It is common in Hispanic communities to see a healer or “curandera” before seeking medical attention from a physician. Parents are reluctant to provide much information as to the exact source of the folk remedies to any health professional (Bose et al, 1983).

Hispanic women often use traditional bean pots from Mexico to soak, cook, and serve beans. These ceramic bean pots have a glaze on the interior which contains extremely high concentrations of lead that leach from the glaze at high temperatures (Azarcona-Cruz et al., 2000; Rojas-Lopez, Santos-Burgoa, Rios, Hernandez-Avila, & Romieu, 1994). Since beans are a staple food item in many Hispanic cultures, the leaching of lead from the bean pot into the beans can be a constant source of chronic exposure (Azarcona-Cruz, et al., 2000; Baer et al., 1983; Gersberg et al., 1997; Hernandez-Avila et al., 1991; Mohammed et al, 1995).

Many immigrant children already have an existing blood lead concentration prior to moving to America (Rothenberg et al., 1999). Mexico and other Latin countries did not ban the use of leaded gasoline for motor vehicles until the late 90’s. In addition, industrial and agricultural uses of lead for heavy machinery and pesticides are currently being utilized in some Latin countries (Romieu et al., 1994; Schnaas et al., 2004). A major source of lead in Mexico comes from the manufacturing and use of lead-glazed ceramics which can expose lead-glazing workers and families that use the ceramics for food preparation (Counter et al., 2005; Cowan et al., 2006; Schnaas et al., 2004). While the lead levels are decreasing, many studies demonstrate extremely high concentrations of lead still present in the soil, atmosphere, and other agricultural products from Mexico (Romieu et al., 1994). Hispanic families may visit Latin countries in Central and South America which are known to have major environmental lead contamination, thereby exposing their children to lead (Baer et al., 1998; Schnaas et al., 2004).

Lead and Humans

Adverse Health Effects

Biological Effects

Lead causes adverse effects on the renal, hepatic, hematopoietic, and the reproductive system. Many studies attempt to characterize exact symptoms that correspond to blood lead levels without success. There are simply too many variables that determine the effects of lead on each individual (ATSDR, 2005; Bellinger, 2004; Toscano et al., 2005). The most apparent effect is the damage caused to the central nervous system. Lead's primary mechanism of attack begins at the blood-brain barrier, which is of special relevance in children because of their underdeveloped brain. Lead-induced damage is concentrated in the prefrontal cerebral cortex, hippocampus, and cerebellum regions within the brain. (Donkin et al., 2000; Finkelstein et al., 1998). The hippocampus is essential for memory while the cerebral cortex is responsible for higher mental processes of language, memory and movement. The cerebellum is critically important for skilled movements, posture and also plays a role in motor learning and retaining memories of motor activities (Bellinger, 2004; Wood, Wood, & Boyd, 2000).

Biological activities and homeostasis are impaired at the cellular, intracellular and molecular levels. Table 2 lists the various effects, of cellular effects of lead toxicity, in no particular order. Regulatory actions and neurotransmitter systems in the brain are hindered by lead, even at blood lead levels below 10μg/dL. Cognitive impairments are common critical markers among children who experience long term exposure to low levels of lead (Bellinger, 2004; Bernard, 2003; CDC, 2002).

Table 2. Summary of the effects of lead toxicity

Apoptosis
Excitotoxicity
Decreased cellular energy metabolism
Impaired heme biosynthesis and anemia
Oxidative stress
Lipid peroxidation
Altered activity of second messenger systems
Altered neurotransmitter release
Altered neurotransmitter receptor density
Impaired development and function of oligodendrocytes
Abnormal myelin formation
Abnormal neurotrophic factor expression
Abnormal dendritic branching patterns
Disruption of the blood–brain barrier
Disruption of thyroid hormone transport into the brain
Altered regulation of gene transcription
Lowered IQ

Source: Wigle, 2003

Children

The toxicity of lead is of particular concern for children because they are more susceptible to the deleterious effects caused by lead. Children experience rapid brain development before the age of three. This development is controlled by many processes in the brain and is dependent on proper functioning of brain cells. Lead displays the ability to disrupt the sensitive cascade of events that occur during this stage of a child's life (ATSDR, 2005; Bellinger, 2004; Wigle, 2003). Lead causes central nervous system abnormalities in adults that seem to reverse with the cessation of exposure. Damages to the central nervous system of children do not seem to reduce nor reverse when exposures are no longer present (Bellinger, 2004; Pocock, Smith & Baghurst, 1994). Children with elevated blood lead levels often exhibit decreases in IQ, poor school performance, along with impulse control problems and attention deficits (Canfield, et al., 2003; Lidsky & Schneider, 2006; Myers et al., 1997).

Children also have riskier behaviors that increase their chances of being exposed to lead. Very young children explore the world around them with regular hand-to-mouth behavior. Ingesting lead particles from paint, dust or soil is common among children because they often crawl around the floor, hide and play outside (ATSDR, 2005: CDC, 2005). Another risk factor is a child with pica, a pathological disorder in which children eat non-food items. A child with pica may experience greater lead exposure by ingesting lead-based paint, contaminated soil or any other type of contaminated items (Wright et al., 1999). Acute poisoning has been recorded in the past with children who have pica and ingested metal objects (Hugelmeyer et al., 1988; VanArsdale et al., 2004).

Nutrition

Nutritional deficiencies of essential metals can exacerbate the toxic effects of lead exposure by enhancing absorption (CDC, 2002b; Goyer, 1997; Wright et al., 1999). Dietary iron, calcium, and zinc are the most important essential metals that influence lead toxicity because of their similar +2 charge (ATSDR, 2005; Goyer, 1997). It is common for children to be deficient in any of these three essential metals. In addition, children from low-socioeconomic class suffer nutritional deficiencies due to poor diet more often than middle to upper class children (Wright et al, 1999; Zambrana & Logie, 2000).

Calcium is important in many of the metabolic processes that occur within the body. Calcium homeostasis is important for the proper functioning of cells and nuero-development and neuro-function. Lead is metabolically similar to calcium and therefore has the ability to mimic and disrupt cellular pathways which involve calcium (Source; Goyer, 1997). Research shows that there is an inverse relationship between brain lead and dietary calcium, which can be detrimental to the developing organ in infants and children (Goyer, 1997).

Iron deficiency is the most common nutritional deficiency among children in the United States. Iron deficiency substantially increases a child's susceptibility to lead poisoning. Both iron deficiency and lead poisoning disproportionately affect young children of lower socioeconomic status (Wright et al., 1999). However, the relationship with iron deficiency, lead exposure, and impaired cognitive and behavioral development seen in children is complex to investigate because iron deficiency alone can impair early mental development (Goyer, 1997).

While lead and zinc interactions are not as well defined as calcium and iron, it has been experimental shown that lead increases zinc excretion and zinc deficiency enhances lead absorption (Goyer, 1997). Zinc is also enzymatically involved with heme synthesis which is a biologically important function for the transport and storage of oxygen (Goyer, 1997; Nelson & Cox, 2005).

Overall, nutritional deficiency and lead poisoning disproportionately affects children minority children from low-income families. According to the CDC, NHANES III data found that the average calcium intake is lowest among Mexican Americans (CDC, 2002b; Wright et al., 1999). This is of particular importance for Clark County, as Hispanics account for the largest minority group. It is important to further assess the relationship between nutrition and lead poisoning in order to combat the problem. Many state prevention programs are now providing dietary supplements as a means of preventing not only nutritional deficiencies but reducing blood lead concentrations in children (Goyer, 1997).

Toxicology

Absorption

Lead may enter the body via inhalation, dermal exposure, fetal transmission and ingestion (Castellino & Castellino, 1995). The major route of lead exposure for children is by means of ingestion. Adults may be encounter dermal exposure or inhalation in occupational settings. Absorption is dependent on the characteristic of each individual, the environment and the lead compound itself. All routes allow for lead to enter the bloodstream, some are simply more efficient means of absorption than others (ATSDR, 2005; Castellino & Castellino, 1995).

Lead is not commonly airborne, unless industrial processes are occurring in the surrounding environment. Due to the size of lead particles, gravitational sedimentation often results before exposure can occur by means of inhalation. However, lead may become suspended in air for a short period of time as either vapors or aerosols (ATSDR, 2005; Castellino & Castellino, 1995). Vapors are free molecules which rapidly undergo condensation in the nuclei, reaction with oxygen or absorption on the surface of other dust particles found in the air. Inhaled vapors are deposited over the entire bronchial tree and may penetrate the alveoli. Due to the short life span of lead as vapors, there is no inherent risk of lead absorption by vapor inhalation (Castellino & Castellino, 1995).

Lead particles are most commonly found in aerosols as dust, smoke, or fog. Several factors affect how inhaled lead aerosols deposit in the respiratory tract and enter the bloodstream (Castellino & Castellino, 1995). Physiochemical properties of the particulates, anatomic properties of each individual respiratory tract, age-related factors that determine breathing patterns (i.e. nose breathing vs. mouth breathing) and ventilatory activity of the lung are among these factors that affect deposition and absorption of lead via inhalation (ATSDR, 2005; Castellino & Castellino, 1995). Lead particles greater than 2.5μm are deposited into the nasopharyngeal and tracheobroncial regions known as the ciliated airways. Smaller particles, less than 1μm in size are of greater concern as they may be deposited into the alveolar region and can be absorbed after extracellular dissolution (ATSDR, 2005).

Two physiologic processes are employed for the removal of inhaled particles that are deposited in the respiratory compartments. Mucociliary clearance removes large lead particles from the ciliated airways by cough reflex or by shifting particles from the upper respiratory tract to the gastrointestinal tract (ATSDR, 2005; Donkin et al., 2000). Alveolar clearance involves three pathways which occur deep within the lungs. Alveolar macrophages eliminate lead particles from the alveolar compartment by phagocytosis. The penetration of lead particles occurs through the junctions of the alveolar pneumocytes which move into interstitial spaces then into the lymph and blood. The third clearance pathway involves the passage of particles into the pulmonary tissue. Overall, inhalation is not the main route of lead absorption due to the intrinsic properties of lead and the clearance mechanisms utilized by the respiratory tract (ATSDR, 2005;

Castellino & Castellino, 1995; Donkin et al., 2000).

Dermal absorption of inorganic lead compounds is another route of absorption that is not considered hazardous because lead is not easily absorbed through the skin. However, lead absorption may occur with organic lead compounds such as alkyl lead or tetraethyl lead. The hydrophilic or lipophilic characteristic of an organic lead compound may promote the passage of lead through the thin lipid layer covering the skin (ATSDR, 2005; Donkin et al., 2000). The percent of lead absorption is influenced not only by the physiochemical properties of the lead compound, but also by the amount of skin surface in contact, the length of time of contact, and whether the skin is intact. The skin's first line of defense is the epidermal layer and if damaged, rapid lead absorption into the blood may occur. If percutaneous lead absorption occurs, it is by the passage of lead through epidermal cells, between epidermal cells or through hair follicles and sweat glands. Lead enters the bloodstream only after is reaches the dermal microcirculation (Castellino & Castellino, 1995).

Lead can also cross maternal blood and be absorbed into the fetal circulation during pregnancy (ATSDR, 2005). While the placenta serves as a protective barrier to the fetus, exchange of molecules does occur either by simple diffusion, enhance diffusion, active transport and pinocytosis. Little is known about the exact mechanisms of transport from maternal to fetal circulation, but studies demonstrate that if lead is present, it is exists in equal concentrations between the maternal and fetal blood. Lead may also be transferred from the mother to child via the mother's milk. Absorption of lead into the fetal circulation is a great danger as evidence demonstrates that lead can cause fetal damage, malformations and fetal death due to congenital plumbism (ATSDR, 2005; Castellino &

Castellino, 1995).

Children and pregnant women are at a particularly higher risk for lead absorption than a normal adult. They may absorb up to 50% of ingested lead in comparison to healthy adults who absorb less than 15% of ingested lead (ATSDR, 2005; Castellino & Castellino, 1995; Donkin et al., 2000). Ingestion is the most common route of absorption for children because they display frequent hand-to-mouth behavior (ATSDR, 2005; Bellinger, 2004; Toscano et al., 2005).

Several factors influence gastrointestinal absorption such as biological variability, subject's age, fasting conditions, gastrointestinal emptying, the chemical form of different lead compounds and nutritional deficiencies. Differences in absorption in respect to age may be due to postnatal physiological development of the intestine and to the shift from the neonatal diet to an adult diet (ATSDR, 2005). While all the factors are important, the most relevant and measurable factor that will be discussed in this research regarding absorption via ingestion is the affect of nutritional status (Castellino & Castellino, 1995).

Experimental studies in rats have shown that the majority of gastrointestinal lead absorption occurs in the small intestine, specifically in the duodenum (Castellino & Castellino, 1995). There are two types of interactions that occur between the metal and the intestinal epithelium. The first, tissue uptake of lead is extremely rapid and may serve as a protective measure because it removes lead available for transport. It is suspected that within the first ten minutes of contact between lead and the intestinal epithelium, lead binds with phosphate groups of the intestinal tissue to form covalent bonds. The phosphate-bound lead is not available for transport into the bloodstream and is excreted from the body (Castellino & Castellino, 1995).

The second type of interaction, involves a series of transepithelial mechanisms which are relatively slow but increase after interaction between lead and intestinal mucosa. The processes of transport here are active and passive transport. Active transport is energy dependent and requires a membrane carrier. Iron deficiency is particularly important in the active transport of lead (ASTDR, 2005; CDC, 2002b; Wright, Shannon, Wright, & Hu, 1999). The lack of iron enhances the binding of lead to membrane carriers, thereby allowing lead to cross the luminal membrane of epithelial cells and enter the cytoplasm. Passive transport of Pb^{2+} across the intestine occurs simultaneously with water absorption and is believed to utilize the same extracellular route through tight junctions as Ca^{2+} does. Insufficient calcium circulating in the bloodstream exponentially increases the passive absorption of lead (Castellino & Castellino, 1995; Goyer, 1997).

Lead is an active competitor with iron, zinc, and calcium binding sites; therefore a child deficient in any of these vital nutrients is more susceptible to lead uptake in various aspects of gastrointestinal absorption (Goyer, 1997). Studies show that iron and calcium can reduce intestinal lead absorption and retention of lead in the tissues (ATSDR, 2005; Wigle, 2003).

Distribution

The route of absorption and composition of the lead compound (i.e. organic or inorganic) influences the distribution of lead within the body and in turn affects its metabolism, potential toxic effects and excretion (Donkin et al., 2000). The ability of lead to pass through cell membranes determines the affect it will have on particular organs (ATSDR, 2005; Erickson & Thompson, 2005). While information on the distribution of organic lead is limited, studies demonstrate that both inorganic and organic lead compounds have the highest concentration in the liver followed by the kidneys then soft tissues (ATSDR, 2005; Castellino & Castellino, 1995).

Once lead enters the bloodstream, it rapidly moves from the intravascular space into the interstitial fluids to penetrate the cells (Castellino & Castellino, 1995). Approximately 99% of absorbed lead is bound to erythrocytes. Rather than binding to the outer membrane of erythrocytes, lead binds to proteins within the red blood cells (ATSDR, 2005; Lockitech, 1993).

For children, more than 70% of the total body burden of lead is found in the bone which can serve as a lead reservoir for decades. The release of lead from the bones can maintain blood lead levels after exposure has ended. Once lead moves from bone stores, it can be distributed into soft tissues and move on to excretion (ATSDR, 2005; Erickson & Thompson, 2005; Lockitech, 1993; Lidsky & Schneider, 2003).

Lead is widely but unevenly distributed in soft tissues. The highest lead concentration is in the liver (ASTDR, 2005; Castellino & Castellino, 1995; Donkin et al., 2000). After initial lead exposure the kidneys maintain the second highest lead concentration followed by skeletal muscles and the lungs. The smallest concentration is located within cerebral tissues however, this area is the most sensitive to lead (ASTDR, 2005; Castellino & Castellino). The data for lead distribution in soft tissues is based upon research conducted on autopsy samples and varies among individuals' physiological differences (ATSDR, 2005).

Metabolism

When inorganic lead is metabolized, it forms compounds with various nucleophilic functional groups (COOH, NH_2, and SH), proteins and non-protein ligands. The most stable complexes arise from the combination of inorganic lead with sulfhydryl groups (ATSDR, 2005; Castellino & Castellino, 1995). The formation of these groups within the body aids lead in disrupting an unlimited number of cellular functions. Organic lead compounds are actively metabolized in the liver by cytochrome p-450 and are more readily excreted (Castellino & Castellino, 1995).

Excretion

Since the majority of absorbed lead is widely distributed in the body fluids, the metal is present in bile and the secretions of salivary, pancreatic, sweat and mammary glands. Accordingly, the removal of absorbed lead is primarily by means of fecal and urinary excretion. Minor routes of excretion include sweat, saliva, hair, nails, and breast milk (ATSDR, 2005; Castellino & Castellino, 1995). Excretion is independent of route of exposure but is more efficient in adults compared to infants and children. As a result, higher levels of lead are found in infants and children than adults with the same exposure (ATSDR, 2005).

The majority of lead is excreted in the feces, which accounts for one-third of total absorbed lead excretion (ATSDR, 2005). Total fecal lead excretion is dependant on total dietary lead intake and total gastrointestinal lead secretion. The main passage for lead excretion through the feces is bile. Studies suggest that the liver has an active transport mechanism for the excretion of metals and lead forms a complex with certain biliary proteins. However, little is known about the chemical forms lead assumes in the bile or the exact mechanisms responsible for biliary excretion of lead (Castellino & Castellino, 1995).

Lead transfer from the plasma to the intestinal lumen involves three pathways: active secretion of the intestinal and pancreatic glands, passive passage through the epithelium of the intestinal cells into the lumen and incorporation into the intestinal cells, and loss in the intestinal cells into the lumen. The cooperation and contribution of each pathway to the total fecal lead excretion varies upon each individual (Castellino & Castellino, 1995).

Variability in urinary excretion is caused by the individual and their body's glomerular filtration rate (Donkin et al., 2000). Urinary excretion of lead begins promptly after absorption of the metal. Blood lead concentration is proportional to urinary output, suggesting that saturation does not occur. The two mechanisms responsible for renal excretion of lead are glomerular ultrafiltration and tubular function. There are two forms of lead found in the plasma, lead bound to plasma proteins and ionic lead, unbound and ultrafilterable (Castellino & Castellino, 1995).

The +2 charge of lead allows it to bind to free proteins which may typically bind to other vital nutrients with a +2 charge; therefore nutritional deficiencies play a role in the body's ability to excrete lead. Under normal conditions, approximately 40% of plasma lead is available for glomerular filtration. Only unbound ionic lead undergoes glomerular filtration which is dependent on the size and charge of the lead-protein complex (Castellino & Castellino).

The amount of lead excreted by means of sweat, saliva, hair, nails, and breast milk is minimal. Studies demonstrate a relationship between the amount of exposure to lead and the excreted amount by these particular glands (Castellino & Castellino, 1995). The most important pathway for lead into the oral fluids is by passive diffusion. Lead lines along the gums are a result of the body's attempt to excrete excess lead in the saliva (Donkin et al., 2000). Passive diffusion is also responsible for the transfer of blood from the maternal circulation into the mammary glands resulting in the excretion of lead via the breast milk (ATSDR, 2005).

Mechanisms of Action

Effects on Heme Synthesis

Many of the symptoms experienced from lead poisoning are a consequence of lead's disruptive actions on the cellular level. Heme is the prosthetic group of hemoglobin, myoglobin, and cytochromes (Nelson & Cox, 2005). Heme consists of an iron atom (Fe^{2+}) contained at the center porphyrin, a large heterocyclic organic ring (see Figure 1). Hemoglobin and myoglobin are important in the transport and storage of oxygen while cytochromes are proteins that aid in detoxification (Donkin et al., 2000, Nelson & Cox, 2005).

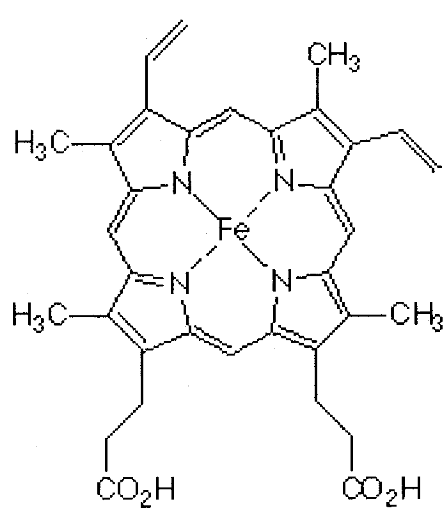


Figure 1. Heme Structure. Source: http://www.daviddarling.info/images/heme.gif

Initial disruption of heme synthesis presents as symptoms of fatigue and anemia due to the lack of oxygen uptake from the blood (CDC, 2002). Lead exerts its toxic effect on the last step of heme synthesis (see Figure 2). The enzyme ferrochelatase is inhibited by lead and the insertion of the iron into protoporphyrin to create heme fails to take place (Smith, 1989).

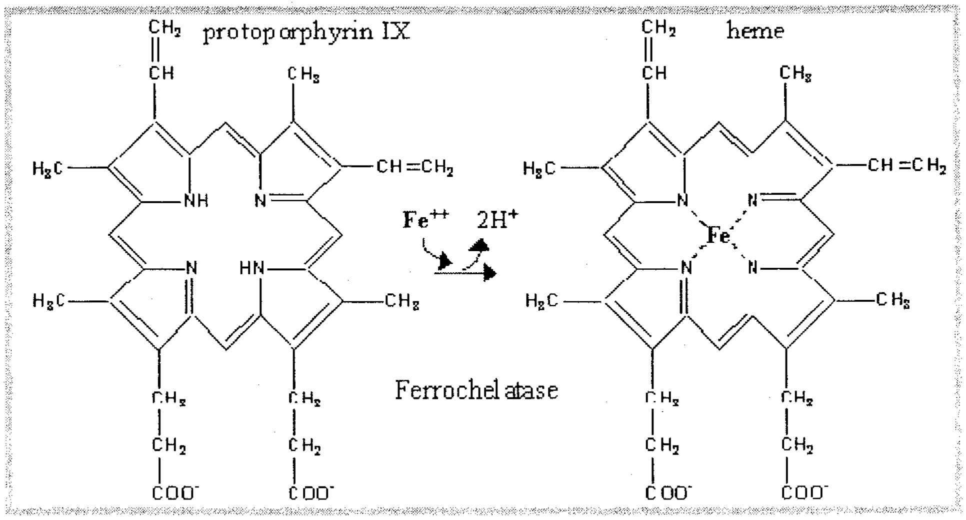


Figure 2. Heme synthesis. Source:http://www.rpi.edu/dept/bcbp/molbiochem/MBWeb/mb2/part1/images/protoporph.gif

Lead also reduces the production of heme and heme-dependent proteins by irreversibly binding to and inhibiting δ-Aminolevulinic acid dehydratase (ALAD), a zinc-dependent protein (Nelson & Cox, 2005; Wigle, 2003). This causes an accumulation of ALAD which impairs oxygen transport and storage, mitochondrial energy production, and P450 detoxification systems (Smith, 1989; Wigle, 2003).

Competition with Calcium

Many human physiological processes either require or are regulated by calcium.

Calcium has an influence on every system with in the body from the central nervous system, circulatory system, skeletal system, to the endocrine system. On the molecular level, calcium is necessary for normal cell function and cellular homeostasis (Goyer, 1997; Nelson & Cox, 2005).

Within the body, Pb^{+2} is nearly undistinguishable from Ca^{+2} and therefore can disrupt many calcium-mediated functions throughout the entire body (Finkelstein et al., 1998; Lidsky & Schneider, 2003). While all of lead's toxic effects are completed by various mechanisms, the common factor involved with each mechanism is lead's ability to interfere with the regulatory action of calcium in cellular functions (ATSDR, 2005; Finkelstein et al., 1998; Goldstein, 1990; Lidsky et al., 2003; Masci & Bongarzone, 1995). Lead negatively impacts many biological activities at various intracellular levels from the voltage-gated channels to the first, second, and third messengers (Finkelstein, Marowitz & Rosen, 1998). Lead has profound effects on the intracellular calcium homeostasis which results in acute calcium-mediated cell death within the nervous system and impairment in neuronal differentiation and synaptogenesis (Masci & Bongarzone, 1995).

Blood Brain Barrier Disruption

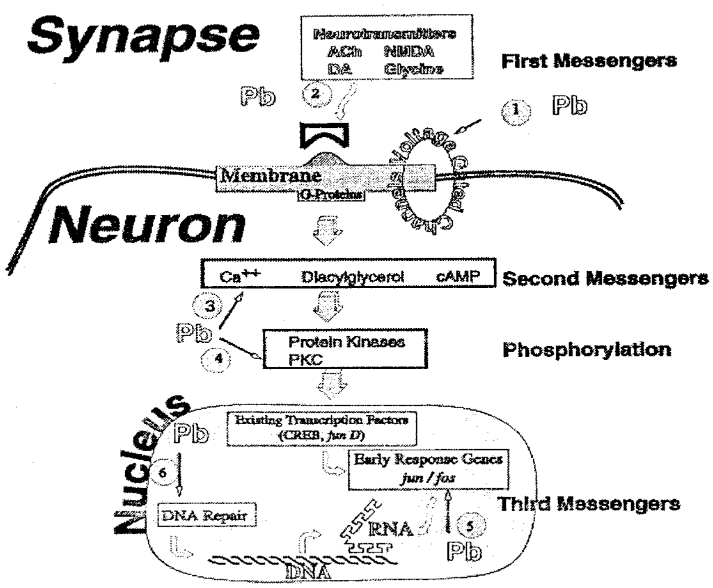
Endothelial cells packed tightly in brain capillaries form the blood brain barrier. Astroycytes are a type of non-neuronal cells that aid in homeostasis, the formation of myelin, and provide support and nutrition to endothelial cells. The blood brain barrier protects the brain by restricting the passage of many substances from the bloodstream to the brain (Finkelstein et al., 1998, Risau & Wolburg, 1990).

The blood brain barrier is particularly vulnerable to the toxic actions of lead due primarily to lead's ability to substitute for calcium ions and readily cross the protective barrier (Finkelstein et al., 1998; Lidsky & Schneider, 2003). Lead is thought to be transported in the brain with the aid of the Ca-ATPase pump. The pump uses ATP as the source of energy and transports calcium from the extracellular or interstitial fluid into the intracellular space (Finkelstein et al., 1998; Risau & Wolburg, 1990). Lead can imitate calcium and enter the most critical organ for development, the brain. As lead passes through the blood brain barrier, it causes damage to endothelial cells and astrocytes. Once lead enters the brain, the effects of lead are detrimental to the proper functioning of the brain (Finkelstein et al., 1998; Goyer, 1997; Lidsky & Schneider, 2003).

Effects on Neurotransmission

Neurons are cells in the nervous system that process and transmit internal as well as external signals to all parts of the body. They communicate with one another via chemical or electrical synapses. Action potentials initiate a synaptic transmission which begins as an electrical signal at a pre-synaptic neuron and travels to a neighboring neuron to become a chemical signal that is diffused into the synaptic cleft (Donkin et al., 2000). The chemical signal, also known as a neurotransmitter acts on the post-synaptic neuron and produces an electrical signal in that neuron. Neuronal signaling occurs very rapidly and is sensitive to changes in ions (Risau & Wolburg, 1990).

Lead has the ability to act as a chemical stressor on the neurotransmitter system by altering neurotransmission storage, release and neurotransmitter receptors. Dendrite formation and branching are essential steps in synapse formation which are inhibited by lead (Wigle, 2003). Many calcium dependent activities which include acetylcholine, dopamine, protein kinase C (PKC) and amino acid neurotransmitters are suppressed or heightened in the presence of lead. Lead initially mimics calcium at the blood-brain barrier ([1]Figure 3, point 1) and blocks the voltage-dependent calcium channels. In response, the release of inhibition of various enzymes occurs which disrupts the entire synapse. Many neuronal processes and cell types that are essential for synaptic plasticity, learning, and memory are adversely affected by Pb^{+2}. (Goldstein, 1990; Finklestein, 1998; Toscano & Guilarte, 2005).



Biomarkers

Various indicators may be utilized to determine if a child has been exposed to lead. A biomarker is a biochemical feature or a facet that can be used to measure the effects or progress of a disease (Donkin et al., 2000). Table 3 demonstrates the related health effects at various blood lead levels. In the case of measuring body lead, hair and urine

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[1] Figure 3. Neuron: 1) voltage-gated channels; 2) neurotransmitters (first messenger systems); 3) second messengers; 4) protein kinases; 5) third messenger systems; 6) DNA repair Source: Finkelstein et al., 1998.

analysis, IQ scores and blood lead levels have been used in the past. X-ray techniques can measure lead in teeth or bones, but are not widely available. Hair analyses are no longer commonly used because of possible errors due to environmental contamination (ATSDR, 2005; Smith, 1989). While IQ scores do not assess exposure, they are valuable indicator of the effects of lead exposure on neurocognitive development (Canfield et al., 2003; Schwartz, 1994). Blood lead concentrations prove to be the most precise and accurate measure of body lead and are most commonly used (CDC, 2005).

Table 3. Health Effects of Lead in Children by Blood Lead Level

Blood Lead Level (μg/dL)	Health Effects
> 125	Acute encephalopathy, death
>80	Encephalopathy, coma, renal toxicity
>60	Colic
>20	Anemia, peripheral neuropathy, reduced nerve conduction velocity
>15	Increased zinc protoporphyrin, impaired vitamin D activation
>10	Growth deficits
<10	IQ and hearing deficits

Source: Wigle, 2003

I.Q. Scores

Epidemiological studies demonstrate an inverse relationship between blood lead levels and IQ scores. On average, research shows a 4-6 point decrease in IQ with each increase of 10 μg per deciliter in 3-5 year olds (Canfield et al, 2003). Declines in IQ are greater as blood lead concentrations increase. However, this correlation is still present in children at blood lead levels below 10 μg/dL (Canfield et al., 2003; Schwartz, 1994). Many researchers agree that blood lead levels below 10 μg/dL may cause adverse cognitive and neurobehavioral impacts (Bernard, 2003; Beranard & McGeehin, 2003;

The actual lead poisoning blood lead level is ≥ 20 μg/dL and levels above 40 μg/dL may require chelation therapy to remove lead from the body. Medical assessments, mandatory home investigations and more rigorous prevention methods to bring the blood lead levels down are initiated at BLLs of 20 μg/dL (CDC, 2005). The CDC (2005) recommends that "children are tested:

- At ages 1 and 2 years
- At ages 3-6 years if they have never been tested for lead
- If they receive federal assistance from programs such as Medicaid or the Supplemental Food Program for Women, Infants, and children
- If they live in a building or frequently visit a house built prior to 1950
- If they visit a home built prior to 1978 that has been recently remodeled
- If they have a sibling or playmate who has had lead poisoning."

EPA Regulations

In order to minimize childhood lead poisoning, the Environmental Protection Agency established the "Residential Lead-Based Paint Hazard Reduction Act of 1992", also known as Title X (EPA, 1992). The main purpose of Title X is to educate the public and prevent childhood lead poisoning by developing a national strategic plan to eliminate lead-based paint hazards in any federally assisted/owned or child occupied housing. In addition, the EPA developed regulations to enforce Title X which include definitions of lead-based paint, clearance standards and necessary certification of individuals assessing properties (See Appendix 1). Target-housing is a term defined by Title X, which prioritizes the investigation of pre-1978 housing where children reside and may be at risk for lead exposure (EPA, 1992).

A risk assessment of a home by an EPA certified risk assessor is required in the case of a lead poisoned child under age six. The risk assessor is to identify any possible lead hazards in the home by means of sampling and analyzing paint soil, dust, water and any other suspect objects (EPA, 1992). Following the home investigation, the risk assessor completes a report that summarizes all the results and concludes the investigation in a follow-up meeting with the guardian of the child.

Southern Nevada Health District

The CDC provides technical and financial assistance to state and local childhood lead poisoning prevention programs (CLPPP). The goals of the CLPPP programs are to prevent lead poisoning in children by implementing partnerships, developing strategic programming processes, developing ongoing surveillance programs, identifying at risk populations, providing community education and promoting blood lead screenings (CDC, 2002b; CDC, 2005). The Clark County Childhood Lead Poisoning Prevention Program (CCCLPPP) was launched in spring of 2006 by the Southern Nevada Health District (SNHD) in collaboration with the University of Nevada, Las Vegas.

Clark County, Nevada

Nevada experienced a dramatic population increase in the past decade. A major portion of Nevada's population growth comes from immigration, primarily from Mexico. The Hispanic population comprises 26% of the total population in Clark County (Guzman, 2001; Rothweiler, Cabb, Gerstenberger, 2007). The population of children under six which are most at risk to lead poisoning is also on the rise. According to 2004 U.S. Census data, there were over 124,000 children under the age of five years in Clark County, and the population is projected to increase to over 180,000 by 2010 (Census

Bureau, 2006; Hardcastle, 2004). Minority groups often live in low-income housing and occupy older homes which may have lead-based paint and thereby increase their risk for lead exposure (Rothweiler et al., 2007).

In 2000, Clark County had almost 600,000 total housing units. Of the total housing units, approximately 27% of the housing units were built prior to 1979 and over 27,000 housing units were built before 1960 (Bennefield & Bonnette, 2003; Hardcastle, 2004). Many of these homes have never been checked for lead-based paint.

Due to limited resources, lead screening, reporting, home investigations, training and lead outreach has not occurred at significant levels. However, there are likely to be many Hispanic children of lower socioeconomic status who live in older homes or practice socio-cultural traditions and are exposed to lead on a daily basis. The severity of lead exposure is unknown in Nevada and may be a great threat to the young population.

CHAPTER 3

QUESTIONS, OBJECTIVES AND HYPOTHESES

Questions

- What are the most common lead hazards found during lead home investigations?
- Does blood lead level increase as more lead hazards are identified in the home?
- Will children with BLL $\geq$ 5μg/dL also have Iron, Calcium or Zinc deficiencies?
- Does blood lead level increase as the number of socio-cultural traditions increase?

Objectives

- To determine if the most common lead hazards found in investigated homes are lead-based paint or non-paint sources.
- To investigate the relationship between blood lead concentration and the number of lead hazards found in each home.
- To evaluate the distribution of nutritional deficiencies (i.e. Iron, Calcium, Zinc) among children with BLL $\geq$ 5μg/dL.
- To examine the correlation between blood lead levels and various socio-cultural practices, including home remedies, wearing gold jewelry from Mexico, Mexican candy consumption, and traditional cookware.

Hypotheses

Most Common Lead Residential Lead Hazard

- The most common lead hazards found during home investigations will be non-paint sources.

A home investigation will be conducted in which all interior and exterior paint surfaces were tested for lead. Additional miscellaneous samples will also be analyzed for the presence of lead. All tested samples will be evaluated according to the standards set by the U.S. EPA.

Dust, mini-blinds, bathtub, pottery (non-food), folk remedy, bean pot, Mexican-imported candy, and Mexican-imported jewelry will all be categorized as non-paint hazards.

A Chi-squared goodness of fit test will be used to evaluate the distribution of positive lead sources found in investigated homes. The Chi-square goodness-of-fit test will be performed with an $n = 22$, d.f. = 1, and an $\alpha = 0.05$

Blood Lead Level and Number of Lead Hazards

- There will be a direct relationship with the number of lead hazards identified in the home and the blood lead level of each child.

The number of hazards identified in each home will be examined against the blood lead level of that particular case. Each case will be compared to all cases.

In order to visually examine the total number of lead hazards in each home vs. blood lead levels a scatter plot will be constructed.

To determine the measure of agreement between the lead hazards and blood lead levels, a Spearman's Rho correlation will be conducted.

Nutritional Deficiencies

- Iron, Calcium or Zinc deficiencies will be present in most of the investigated lead cases.

The risk assessor will gather information regarding the child's health, habits and behaviors from a questionnaire. Guardians will be asked "has a doctor told you that your child has an Iron, Calcium, or Zinc deficiency in the past six months?" If any deficiency is present the answer will be recorded as a yes and no for no type of deficiency will be recorded.

A Chi-squared goodness of fit test will be used to evaluate the distribution of nutritional status among children with BLL $\geq 5\mu g/dL$. The chi-square goodness-of-fit test will be performed with an $n = 22$, d.f. = 1, and a p value = 0.05.

Blood Lead Levels and Number of Socio-Cultural Practices

- There is a direct relationship between the number of socio-cultural traditions practiced (i.e. eating Mexican candies, eating food prepared in lead-glazed bean pots, wearing gold jewelry from Mexico or using traditional folk remedies) and blood lead levels among Hispanics.

Data for this part of the study will be gathered from the questionnaire. The questionnaire includes questions about cultural practices. The cultural practices that will be examined are use of traditional bean pots, folk remedies, gold jewelry from Mexico, and Mexican candy consumption.

In order to examine the BLL vs. the total number of socio-cultural practices in each home, scatter plots will be constructed. To determine the measure of agreement between the number of cultural practices and blood lead levels, a Spearman's Rho correlation will be conducted.

CHAPTER 4

METHODOLOGY

Participants

Participants for this study were gathered from the Clark County Childhood Lead Poisoning Prevention Program. An Internal Review Board exemption was filed and approved in order to conduct research with the data obtained. Local physicians recommended blood analyses for select children. All blood lead results of these children were reported to the Southern Nevada Health Department (SNHD). Typically, the homes of children whose blood lead levels are ≥ 10μg/dL are assessed for residential lead hazards. Due to the unknown severity of lead poisoning in Clark County, the SNHD investigated any home with a child under six whose BLL was ≥ 5μg/dL. Upon receiving a test result for a child under age six whose blood lead level is ≥ 5μg/dL, the UNLV School of Public Health was notified. The risk assessor and at least one representative from the SNHD visited the child's home to conduct a home investigation and complete the questionnaire with the guardian's permission.

Since Nevada has a large Hispanic community who may be exposed to different lead sources, only Hispanic children were considered for this study.

Data Collection

All the data for this study were collected from the home risk assessments and questionnaires which were conducted at the home for each child whose BLL was $\geq$ 5μg/dL. The risk assessment was conducted according to the guidelines set by the EPA and HUD. Residential paint, dust, soil, water, and miscellaneous object were tested for the presence of lead.

Paint Samples

During the home investigation, interior and exterior paint surfaces were tested using a Niton XLp 300A/700A Series X-ray fluorescence device (XRF) with a ^{109}Cadmium radioactive isotope source. The XRF has the ability to identify the presence of lead in several layers of paint. The criterion for lead-based paint was 1mg/cm^2, in accordance with the EPA standard. Table 4 lists the EPA standards used for all tested items during the home investigation.

Table 4. EPA standards used to establish residential lead hazards for risk assessments

EPA Standards for Residential Dwellings	
XRF Assays	1 mg/cm^2 Wet Weight = 600 ug/g or 600 ppm or 0.06% Dry Weight = 500 ug/g or 500 ppm or 0.05%
Dust Sampling	Interior Floors (carpeted and uncarpeted) = 40 ug/ft^2 Interior Window Sills = 250 ug/ft^2 Window Troughs = 400 ug/ft^2 Concrete = 800 ug/ft^2
Soil Sampling	Bare Play Area = 400 ppm Bare Soil in Non-Play Areas = 1,200 ppm Abatement Required = 5,000 ppm
Water Sampling	15 ug/L or 15 ppb or 0.015 mg/L

Source: EPA, 1992

Before beginning the risk assessment the XRF was calibrated using a 1mg/cm^2 paint standard. A map of the house was drawn to identify rooms in the house consistently. Every wall in each room, furniture and various objects in the rooms were tested for lead-based paint with the XRF. Toys with chipping paint, mini-blinds, tile floors, any jewelry, and ceramic tableware were also tested with the XRF. In addition, the exterior of the residence was also tested for the presence of lead-based paint. Photographs were taken of any items with lead-based paint. All XRF results were hand-written as well as electronically stored in a file for each home investigation.

Dust

A minimum of six dust wipe samples were collected from the home in various locations such as front entry, back entry, window troughs, child's bedroom, child's play room and any other area where the child spends a considerable amount of time. Templates were used to obtain lead concentration results in ug/ft^2. A $0.5ft^2$ area was used for floor areas. The dust sample was collected using an EPA dust technician technique. The technique consists of three total wipes per area and begins with S-shape wipe horizontally, then and S-shape wipe vertically followed by a wipe on the inside perimeter of the template. The dust technician wore gloves and folded the dust wipe after each wipe. Dust samples were collected with individually sealed pre-moistened, OSHA approved wipes. For quality control a blank was included. All collected samples were labeled with date, case number and description of the sample. The dust samples were sent to an analytical laboratory for Graphite Furnace Atomic Absorption Spectroscopy (GFAAS) analysis for lead concentration. The results were evaluated according to the guidelines established by the EPA for dust samples.

Soil

Soil samples were collected from the home when bare areas were present. A soil sampling tool was used to penetrate the ground approximately two inches deep. Only the deepest inch was placed in the sample tube. The soil was collected as a composite of any bare play area surrounding the home or separate samples from areas along the drip-line, play area, or non-play area. All collected samples were labeled with date, case number and description of the sample area. The soil samples were tested for lead concentration with GFAAS. The results were compared to EPA soil standards.

Water

Water samples were obtained when there was a child with a BLL $\geq$ 10 µg/dL or a child with a BLL $\geq$ 5 µg/dL and lived in a pre-78 home. One liter of water was collected from the kitchen as a first draw after an 8 hour stand time. The water bottle was left with the parent at the time of the home investigation. The Environmental Health Specialist from the SNHD returned the next morning to collect the water bottle. Water samples were analyzed for lead concentration using the GFAAS method. The water results were compared to the 5ppm standard for residential water which was established by the EPA.

Miscellaneous Items

Items that could not be appropriately tested using the XRF or by the dust wipe method were collected with the family's permission and analyzed with the GFAAS method. Miscellaneous items such as Mexican-imported candy, metal objects, cosmetics, and home remedies fell into this category. All items were place in a tube, labeled with date, case number and item name. In addition, the items were photographed.

Questionnaire

The risk assessor gathered information regarding the child's health, habits and behaviors using a questionnaire (See Appendix 2). In most cases, the questionnaire was conducted in Spanish. The in-home questionnaire included questions which assessed the cleanliness of the home, child's diet, and observed hand-to-mouth behavior of the child. Questions about foreign travel, parent occupation, hobbies and cultural practices also provided insight as to the source of lead exposure for the child. All the information from the questionnaire was recorded into an access database maintained by UNLV.

Risk Assessment Report

Once all the samples were analyzed, the risk assessor wrote a report summarizing all the results and hazards found in the home. The photographs of hazards were included along with the electronic and hand-written version of XRF readings. The risk assessor gave recommendations as to how to minimize exposure to lead. The completed report was sent to the SNHD who added a cover letter and scheduled a follow up visit.

Data Analysis Program

SPSS for Windows® Version 14.0 was used to perform statistical tests on the data. The following tests were performed: Shapiro-Wilk's test for normality, Chi-square goodness-of-fit test, and Spearman's Rho correlation coefficient, as detailed in the hypotheses section.

CHAPTER 5

STUDY RESULTS

General

Risk assessments were conducted for 23 Hispanic children in Clark County Nevada. Although there were 23 cases reported to SNHD, two children lived in the same home so risk assessments were only conducted on 22 homes. One case that was included was reported as black by the SNHD. The child was of African descent and spoke English. However, the family emigrated from Belize, which is a small country in Central America that has great Spanish influences from surrounding countries such as Mexico and Guatemala. In addition, the family reported practicing two of the four socio-cultural traditions.

The range of blood lead levels among these 23 cases was 5μg/dL to 19μg/dL . The mean blood lead level was 8.4 μg/dL with a standard deviation of 3.8. A potential lead hazard was identified in every home, with two homes having five potential lead hazards. The total number of lead hazards identified for all 23 cases was 59. Information gathered from the questionnaire provided nutritional data as well as data on socio-cultural factors that may have contributed to lead exposure.

Most Common Residential Lead Hazard

All lead residential lead hazards are listed in a frequency distribution in Table 5. The frequency distribution was used to identify the number of times a specific hazard was identified during home investigations. Soil, water, and metal objects were excluded from the table as these were never identified as hazards during home investigations.

Table 5. Frequency distribution of lead hazards found during risk assessments

Lead Hazards	Hazards Observed	Relative Frequency
Mexican-Imported Candy	15	0.254
Tile	9	0.152
Mexican-Imported Jewelry	8	0.135
Traditional Bean Pot	7	0.119
Pottery (non-food)	6	0.102
Bathtub	5	0.084
Pb paint	4	0.068
Folk Remedy	2	0.034
Dust	2	0.034
Mini-blinds	1	0.017
TOTAL	59	1.000

The most common lead hazard identified in investigated homes was Mexican-imported candy, which was found in 15 of the 23 cases that were investigated. Tile was the second most common lead hazard followed by gold jewelry from Mexico. Soil, water, and metal objects were never found to contain lead that exceeded EPA standards in any of the risk assessments. Figure 4 is a histogram that provides a visual comparison of types of lead hazards found during home investigations for the 23 children with BLL $\geq$ 5μg/dL.

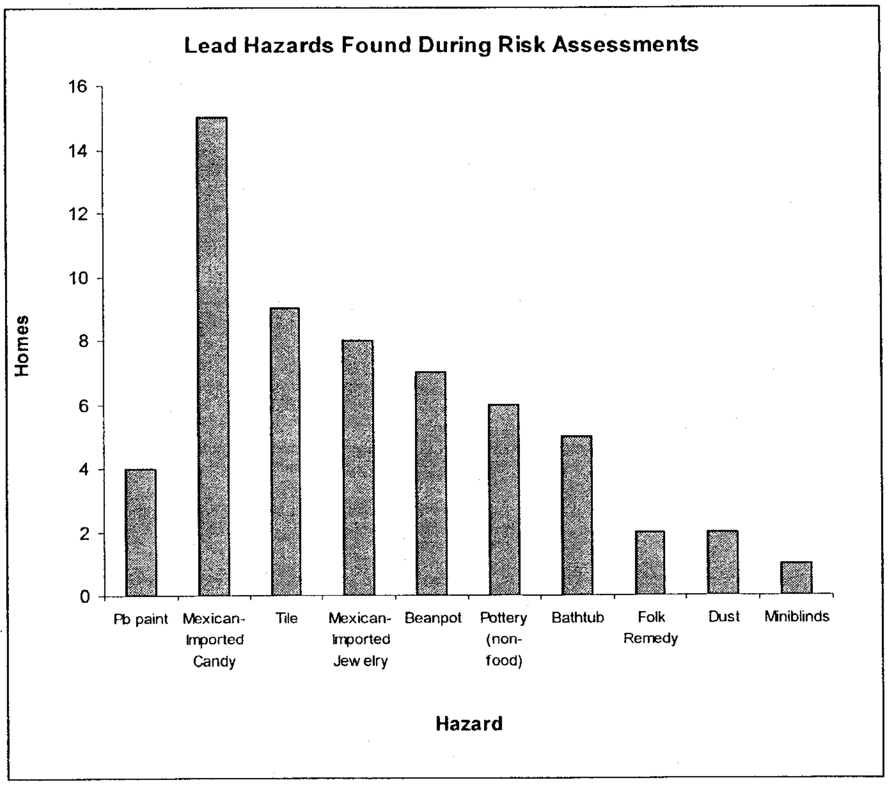

Figure 4. Types of lead hazards found during risk assessments (n = 22 homes, ≠ 22 due to multiple hazards present in homes)

Based on this sample, there is evidence to suggest that the hazards identified in investigated homes were not equally distributed among lead-based paint and non-paint hazards (χ^2 calculated = 44.08, df = 1, $p < 0.001$). Therefore, the most common hazards found in investigated homes were non-paint type sources.

Table 6. Chi-square goodness-of-fit test for paint and non-paint lead hazards

Hazard	Observed Distribution	Expected Distribution	$(O-E)^2/E$
Paint	4	29.5	22.04
Non-Paint	55	29.5	22.04
Total	59	59	44.08

Blood Lead Levels and Total Number of Lead Hazards

Four cases had only one hazard identified in the home during the risk assessment. The median BLL was 8ug/dL and the BLL range was 5ug/dL to 15ug/dL. Two hazards were identified in nine cases. The range BLL for cases with two hazards was 5ug/dL to 12ug/dL with a median BLL of 8ug/dL. The median BLL for the four cases with three identified lead hazards was 5ug/dL while the range was 5ug/dL to 8ug/dL. There were three cases in which four sources of lead were found in the home. The median BLL was 6ug/dL and the range was 5ug/dL to 7ug/dL. The greatest range occurred in the five hazard category which had two cases with a BLL of 8ug/dL and 19ug/dL. Figure 5 below provides a visual display of the distribution of BLL at different number of hazards. Overlapping dots are present in this graph which may obstruct visual distribution of data.

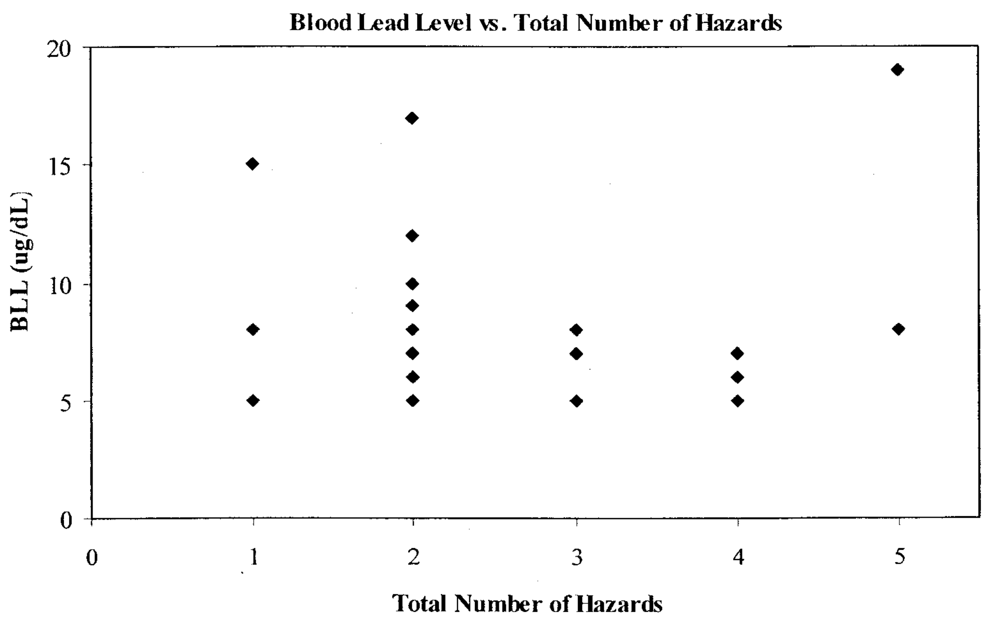

Figure 5. Scatter plot of Blood Lead Levels (ug/dL) vs. The Number of Residential Hazards Identified in Each Home

To determine the measure of agreement BLL and the number of Pb hazards found in the home, a Spearman's Rho correlation was conducted. Data were found to be non-normal (Sapiro-Wilk's Test; $p < 0.001$ for BLL and $p = 0.018$ for hazards).

Ho: There is no association between BLL and the number of hazards found during home investigations.

The correlation coefficient ($\rho = -0.172$) was insignificant. Based on this sample, there is no relationship between the BLL and number of hazards identified in home investigations.

Nutritional Status

To examine if nutritional deficiencies were uniformly distributed among all children from home investigations, a Chi-square goodness-of-fit test was used.

Ho: Nutritional status is uniformly distributed among children from home investigations.

Table 7 below shows the observed and expected distribution of nutritional status for the children with BLLs $\geq 5\mu g/dL$.

Table 7. Chi-square goodness-of-fit test for distribution of nutritional status

Nutritional Status	Observed Distribution	Expected Distribution	$(O-E)^2/E$
Deficient	8	11	.818
Non-deficient	14	11	.818
Total	22	22	1.636

The χ^2 calculated = 1.636 and the χ^2 critical = 3.841. The $p = 0.201$, therefore there is evidence to suggest that there is not a difference in nutritional status (i.e. deficient and non-deficient) among children with BLL $\geq$ 5ug/dL.

Blood Lead Level and Socio-cultural Traditions

The scatter plot shown below in Figure 6 was constructed in order to visually examine the distribution of the total number of cultural practices (Mexican-imported candy, traditional bean pot, Mexican jewelry, and folk remedy) in each home vs. blood lead level in micrograms per deciliter. Overlapping dots are present in this graph which may skew visual distribution of data.

Three cases reported not practicing any socio-cultural traditions. The median BLL for the zero category was 7ug/dL with a range of 5ug/dL to 8ug/dL. Nine cases reported using one socio-cultural tradition. The range was 7ug/dL to 17 ug/dL with a median BLL of 8ug/dL. The range BLL for two socio-cultural practices was 5ug/dL to 19 ug/dL. The median BLL was 7ug/dL for 10 cases that practiced two socio-cultural traditions. One case with a BLL of 6ug/dL reported participating in three socio-cultural activities. No cases reported practicing all four socio-cultural traditions that were included in this study.

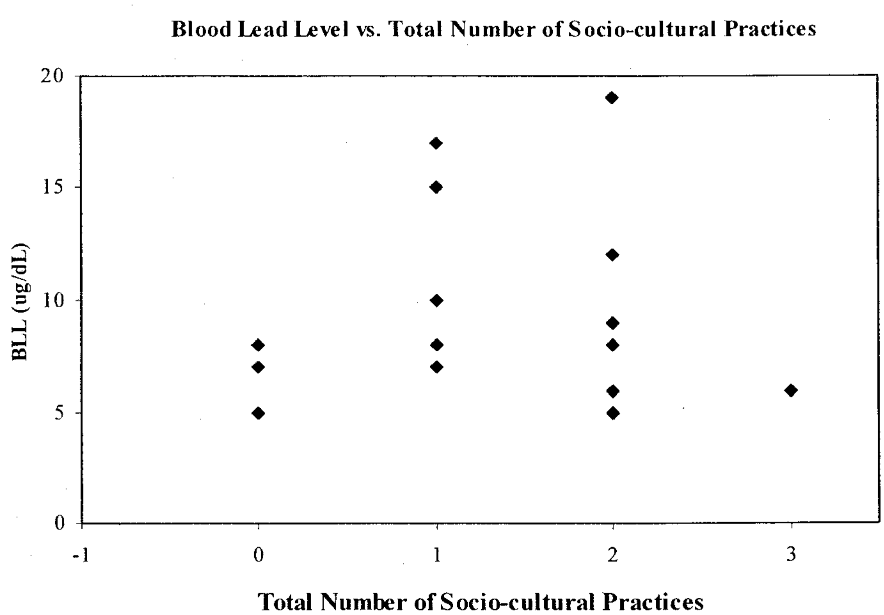

Figure 6. Scatter plot of BLLs (µg/dL) at Number of Socio-cultural Practices Reported During Home Investigations

To determine if there was an association between the number of cultural practices and blood lead levels, a Spearman's Rho correlation was conducted.

Ho: There is no association between the BLL and the number of socio-cultural traditions practiced.

Based on this sample, there is evidence to suggest that the there is no association between BLL and the number of socio-cultural traditions reported during home investigation ($\rho = -0.145$ with a $p = 0.508$).

CHAPTER 6

DISCUSSION

Paint Versus Non-paint Lead Hazards

National data suggest that lead-based paint and dust are the most common sources for lead exposure among children in the United States (ATSDR, 2005; CDC, 2005; EPA, 1992). However, this study found that lead-based paint was not the most common source for lead exposure in the home. In fact, many other non-paint sources were identified as hazards more often than lead-based paint. The top hazards found during home investigations were Mexican-imported candy, leaded tile, Mexican-imported jewelry and traditional bean pots. The statistical analyses demonstrated that the types of hazards (lead-based paint and non-paint) were not equally distributed among the 22 investigated homes. Lead-based paint accounted for 6.8% of all 59 hazards found in 22 homes. When the number of homes that had lead-based paint was considered, lead-based paint was found in approximately 18% of the homes (4 out of 22) investigated.

Pre-1978 housing is much less of a concern in Las Vegas in comparison to other parts of the country where older housing is more prevalent. However, Las Vegas is one of the fastest growing cities in the country and has a large minority community. There is a strong negative correlation between family income and age of housing. High income families typically own new homes, while low-income families own or rent older housing units (Rothweiler et al., 2007). In addition, deteriorating conditions of the residence are less likely to be addressed in a home where the family housing cost burden is high. It is assumed that children from low-income families are more likely to become exposed to lead-based paint in the residences regardless of the relative number of older housing units in Las Vegas (Jacobs et al., 2002; Rothweiler et al., 2007). Based on this information, it is important to educate families, landlords, and the community as to the risks involved with living in older homes.

Another hazard that is attributed to lead-based paint is lead contaminated dust. It is common for dust within the home to become contaminated with lead as a result of lead-based paint which may have small particles that settle in corners of the home (Caravanos et al., 2006; Clark et al., 2004; EPA, 1992; Jacobs et al., 2002). Lead-contaminated dust was found in two of the four homes that tested positive for lead-based paint. However, some uncertainty remains as to the source of the lead-contaminated dust. Lead from the soil or exterior sources may enter the home and settle along the window and contaminate the dust. The soil levels in both homes did not exceed EPA standards for soil. The dust was found on the interior window sills of both homes, supporting the fact that the lead-contaminated dust was likely a result of deteriorating lead-based paint conditions. The other two homes that had lead-based paint did not contain lead-contaminated dust. In one case, the lead-based paint was found on the exterior of the home so while it could be tracked into the home, dust wipe samples did not indicate lead-contaminated dust for that particular home. Some possible explanations for the home that contained interior lead-based paint but no lead-contaminated dust is that the paint may have been intact. The XRF has the capacity to detect lead through several layers of paint on a wall. The lead-based paint may have been detected under a new coat of paint. The family may have also recently cleaned and removed lead from surfaces where dust wipe samples were collected such as floors, window troughs, and window sills.

It was surprising that leaded tile was found in nine of the 22 homes investigated. This demonstrates that while lead is more heavily regulated, it is still a common practice to use lead for industrial purposes such as the tile glaze. On the other hand, lead may simply be present in the materials such as soil, granite, or other stones that are used for the production of tile.

While the tile is not a prominent lead hazard if intact and in good condition, it can become a great problem if remodeling or renovation occurs (EPA, 1992; Jacobs et al., 2002). Dust contamination could result which would easily expose children and adults near the site of renovation. In residential lead renovations, lead safe practices and certified workers are required to work in wet conditions and appropriately dispose of hazardous materials (EPA, 1992, Jacobs et al., 2002).

Blood Lead Levels and Total Number of Residential Lead Hazards

Chronic exposures to lead create elevated blood lead levels in children, as do acute exposures (ATSDR, 2005; CDC, 2005). However, when there are several residential lead hazards a child may be more likely to become exposed. One objective of this study was to determine the relationship between BLL and the total number of residential lead hazards. It was expected that as the number of sources identified in the home increased so would the BLL of the child. The results from a Spearman's rank correlation test indicated that BLL and number of residential lead hazards were actually not associated.

Some possible explanations for these findings may be that while potential lead hazards were found, they may not pose an actual threat. For instance, one child had a BLL of 6μg/dL and had four hazards identified in the home. The hazards were tile, reported use of Mexican-imported candy, traditional bean pots, and Mexican gold jewelry. All the sources contained lead, and may have been a source of constant low exposure. Another prime example is that of the bean pot and non-food pottery items. A home may have had several non-food pottery items for ornamental purposes and another may have had a bean pot. While both were considered hazards, the actual exposure from the non-food pottery items is likely to be minimal whereas the bean pot is a known source of chronic exposure for a child that consumes beans (Azarcona-Cruz et al., 2000; Hernandez-Avila et al., 1991; Mohammed et al., 1995; Rojas-Lopez, 1994). In another case, the child had a BLL of 15μg/dL and wore gold jewelry from Mexico. However this child displayed pica-like behavior by regularly ingesting non-food items and chewing on the jewelry. Some families recently visited Mexico, while some discontinued Mexican-candy consumption within the past year, some children ate soil and other non-food items, some families recently renovated the home, and some parental occupations included pyrotechnics and custodial work at a firing range.

Overall, there were many varying external factors that could have contributed to each child's blood lead level. Most importantly, it is important to recognize that each hazard had equal representation but not necessarily equal contribution to the child's lead exposure. The exposure from each potential hazard was not measured in this study. In a sample of 23 children, it is simply not likely to make a correlation between BLLs and the number of hazards identified in a home.

Nutritional Status

Children that have nutritional deficiencies are at an increased risk for becoming exposed to lead (CDC, 2005; Wright et al., 1999). This study gathered information on the nutritional status of each child with a BLL $\geq$ 5µg/dL. It was expected that since the study population were minorities and had BLL $\geq$ 5µg/dL, most of them would also have a nutritional deficiency. A Chi-square goodness-of-fit test provided information for the distribution of deficient and non-deficient status among all cases, with the exception of one in which the question was left unanswered in the questionnaire. Of the 22 children, eight were reported to be deficient in either iron, calcium, zinc or a combination of the three. The parents for 14 children reported that their child was not nutritionally deficient. Based on the study sample, there is not a difference in nutritional status among children with BLLs $\geq$ 5µg/dL.

The nutritional data gathered from each case was based on the questionnaire and was self-reported by the parents. This method has some mentionable flaws such as recall bias and failure to disclose. First, recall may not be an accurate measure of the child's nutritional status. During the risk assessments, many parents were also nervous and may have not provided honest answers to questions when asked the first time. The fact that many of the families were immigrants, only spoke Spanish and did not fully understand the reason for the visit considerably hindered the data collection. Many asked if they would face any legal repercussions because of their child had been exposed to lead.

Also, the nutrition question is preceded by the question "Would you say this child's health is generally: Excellent, very good, good, fair, poor", which may make parents uneasy or reluctant to answer honestly. In many cases the parent answered "excellent" then withdrew the answer after answering the other questions that followed such "Does your child take a vitamin/supplement?" Confounding issues with vitamins/supplements may exist. The child may have had a deficiency at the time of exposure but no longer presented with a deficiency at the time of blood analysis due to administration of vitamins/supplements. The nature of nutrition and lead exposure in children simply makes it difficult to assess the correlation, especially without actual medical diagnosis for nutritional deficiencies and a small sample size.

Blood Lead Levels and Socio-cultural Practices

National data show that black children have higher rates of elevated blood lead levels and that lead exposure is primarily due to lead-based paint (Bernard & McGeehin, 2003; CDC, 2002b; CDC,2005; EPA, 1992). It was the objective of this study to investigate lead hazards other than lead-based paint among another minority population. Clark County has a large minority population that is predominantly Hispanic and has fairly new housing. These two factors were different from existing data and therefore were examined to gain more insight as to the lead issues in Clark County, NV.

Hispanic communities in the United States and Mexico are deeply seeded in their culture and traditional practices. The social connection among Hispanics is strong in families and neighborhoods alike (Baer et al., 1998; Cowan et al., 2006; Schnaas et al., 2004; Vallejos et al., 2006). The four socio-cultural practices that were considered in this study in relation to blood lead levels in children were consumption of Mexican-imported candy, use of traditional bean pots and gold jewelry from Mexico, and use of folk remedies.

Of the 23 Hispanic families, three reported that they did not currently engage in any socio-cultural activities. Nine families said they did participate in one of the associated practices. Ten families currently practiced two of the four factors while one family practiced three of these activities. Zero families reported engaging in all socio-cultural practices. While there was no significant correlation between blood lead levels and the number of socio-cultural practices, it is important to note that approximately 87% (20 out of 23) of the families reported participating in at least one of the four socio-cultural practices which have been determined to contain lead.

The socio-cultural traditions were each identified as a hazard, but may have contributed differently to the child's actual BLL. Again, the exposure from each potential socio-cultural hazard was not measured in this study. Mexican imported candy may have been a source of low chronic exposure while acute exposure could result from a folk remedy. Overall, the folk remedy is considered to be the most harmful hazard to a child due to the high lead concentrations. The actual contribution from bean pots and imported-Mexican candies may be similar while the gold jewelry from Mexico most likely represents the least harmful hazard in this study.

Again, the data collected for this portion of the study were self-reported and therefore have limitations. Some families admitted hearing recent news of "toxic-treats" and no longer allowed their children to consume the lead-positive candies from Mexico. Many families willingly admitted cooking with traditional bean pots and wearing gold jewelry from Mexico. Many were also surprised when the XRF revealed that those items were positive for lead. Two families had "greta" in their homes with lead concentrations of 330,000 ppm and 910,000 ppm. In both homes, the parents were extremely reluctant to admit use of the remedy and any information regarding the remedy. After repeated questioning they revealed that they still had some of the powder in the home. This presents a critical cultural issue that needs to be addressed through education in order to protect children from lead exposure.

The results from this study demonstrate that different regions in the United States may have different exposures that need to be specifically addressed. As the American population continues to grow, atypical lead hazards are likely to become more of a threat than lead-based paint (Baer et al., 1998; CDC, 2005; Lynch et al., 2000). It is critical to implement culturally appropriate strategies in order to educate the at risk population. Community health fairs and physician education may be two strategies that can be targeted as a means to transfer information to the Hispanic population and thereby educate them about specific lead hazards. Free health fairs and blood lead analyses will most likely increase community attendance and the distribution of information. Physician education can become a route for relaying information to the physicians who could then inform Hispanic parents.

A recent study which involved a Mexican immigrant community revealed that many parents were uneducated about typical lead hazards and the effects of childhood lead poisoning and much less aware of atypical sources. The study recommended incorporating the Health Belief Model (HBM) into outreach programs (Vallejos, 2006). The HBM is a value-expectancy theory that is centered on changing the individual's behavior towards preventive action (Janz, Champion & Strecher, 2002). The key constructs for the HBM include: perceived risk, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. The first construct, perceived risk refers to one's subjective perception of the risk of contracting the disease. In this case, the risk is their child becoming exposed to lead. The second, perceived severity is about the individual's feelings concerning the seriousness of lead exposure (Janz et al., 2002).

Since the HBM's initial concept is perceived risk, it would be beneficial to consider implementing a similar program in Nevada. Many families know little about lead and therefore do not perceive a risk. Since they have participated in certain socio-cultural traditions for their lifetime, they may have difficulty in understanding the effects of chronic lead exposure since they may not be life-threatening. Therefore, explaining how the socio-cultural practices contribute to their child's lead exposure and the importance of that exposure on their child's development and learning abilities is crucial. In addition, their socio-cultural beliefs are so strong that unless educated as to the real dangers of using lead-contaminated products they may continue exposing their children to lead (CDC, 2005; Vallejos, 2006).

Research Limitations

This study used a convenience non-random sample that cannot be considered representative of the general population. The children in this study were most likely insured and upon a well-child visit to their physician were tested for lead. At the time of data collection, only two local laboratories were voluntarily reporting blood lead analysis to the SNHD. There may have been laboratories that analyzed blood lead concentrations but did not report the results to the SNHD. The sample size, n=23 is too small to make any sound conclusions between lead exposure and the Hispanic community of Clark County.

As mentioned above, much of the data collected were self-reported. While the questionnaire was conducted by a bilingual risk assessor, the families were assured that their child's safety was in mind and that no actions would be taken against them, they may have still had reservations in disclosing complete information.

In addition, the majority of Hispanics in the Clark County are from Mexico, which also does not provide a good representation of various nationalities among Hispanics (Guzman, 2001; Rothweiler et al., 2007). Families from Central and South American countries are similar in many aspects, but also have different norms and customs that were not considered in this study. While the socio-cultural practices that were investigated were appropriate for a Mexican community, many other socio-cultural factors should to be examined.

CHAPTER 7

CONCLUSION

Summary

Childhood exposure to lead is a preventable environmental threat (ATSDR, 2005; CDC, 2005). Young children are in a state of rapid brain development, explore the world around them with their hands, and are also at risk for nutritional deficiencies which all together makes them highly susceptible to the deleterious effects of lead once exposed (CDC, 2005). As a result of lead exposure, children are put at risk for health consequences that range from cognitive deficits to behavior problems (Bellinger, 2004; Cranfield et al., 2003; Finkelstein et al, 1998).

A child's environment may have various lead hazards such as lead-based paint, lead contaminated dust to leaded tiles. However, atypical sources of lead are beginning to emerge as the US population grows and diversifies (Baer et al., 1998; CDC, 2002b; CDC, 2005; Vallejos et al., 2006). Recently, candies imported from Mexico, gold jewelry from Mexico, traditional bean pots and folk remedies have been shown to contain lead. Little, information is known about childhood lead poisoning in Nevada, which has a large Mexican population and fairly new housing (Rothweiler et al., 2007). In efforts to determine the environmental risks that affect children in Clark County, NV, this study examined residential lead hazards, nutritional deficiencies, and socio-cultural factors related to children with blood lead levels $\geq 5\mu g/dL$.

The results from the study revealed that lead-based paint was not the most common lead hazard found during home risk assessments. In fact, lead contaminated candies from Mexico were the most frequent lead hazard in the home followed by leaded tiles and gold jewelry from Mexico. No significant correlations were observed between BLL and number of hazards found in the home or BLL and the number of socio-cultural activities that were practiced. Nutritional status was also equally distributed among the children in this study. The major research limitation to this study was the sample size and possibly inaccurate self-reporting.

Information gathered from this study provides base-line data for Nevada. It also provides some insight as to hazards that are prevalent among Hispanics. Although there were only 23 investigated cases, 59 hazards were identified in the homes. It is evident that lead hazards do exist in Clark County, and may not be the usual types of hazards that are nationally known to cause EBLLs in children. As a community, is important to identify these atypical hazards and develop a culturally appropriate strategy to educate the public in Clark County. As a nation, it is crucial to educate the public about the hazards that exist in their environment in order to attain the goal of Healthy People 2010 and eliminate BLLs $\geq$ 10μg/dL in children.

Recommendations for Future Research

In order to gather a more inclusive data set, more cases need to be investigated. Also if families are educated and counseled, they may be more willing to divulge information regarding their child's behavior, diet, health and so on. If laboratories reported all BLL testing results, demographic information in regards to children who do not have EBLLs could be compared to the demographics of children with EBLLs. In addition to collecting a blood sample for lead analysis, it is recommended that the sample also be checked for nutritional deficiencies; therefore nutritional status information can be obtained. If physicians, analytical laboratories, and government agencies worked together, then much more information could be collected. In conclusion, assessing a population's risk for lead exposure requires many collaborative efforts that would prove to be beneficial in reducing blood lead levels among children.

APPENDIX I

FEDERAL AGENCIES AND REGULATIONS REGARDING

ENVIRONMENTAL LEAD

Agency	Media	Level	Regulation or Recommendation
CDC	Blood	10 µg/dL	• Action level for children • Recommendation that states develop a method of identifying and testing lead poisoned children • Recommendation that states test blood lead levels in children
Consumer Product Safety Commission (CPSC)	Paints and Surface Coatings	600 ppm	• Defines lead-containing paint • Except for motor vehicles and boats applications, if a paint exceeding this limit is applied to an item intended for consumer use, the item becomes "banned hazardous products"
EPA	Air	1.5 ug/m^3	• National Ambient Air Quality Standard
EPA	Water	15 ug/L	• Action level for public drinking water
EPA	Dust - Floors	40 ug/ft^2	• Residential Lead Hazard Standard
EPA	Dust – Interior Window Sills	250 ug/ft^2	• Residential Lead Hazard Standard
EPA	Residential Bare Soil – Children's Play Area	400 ppm	• Residential Lead Hazard Standard
EPA	Residential Bare Soil – Rest of the Yard	1,200 ppm	• Residential Lead Hazard Standard
EPA	Lead-Based Paint Hazards	> 10 ft^2 deteriorated paint (exterior surface) or > 2 ft^2 deteriorated paint (interior surface)	• Definition of paint in "fair" or "poor" condition

Food and Drug Administration (FDA)	Food and Packaging	Various – 0.1 to 10 ppm	• Action levels for foods • Handles ingredients and packaging materials
FDA	Fruit Beverages	80 ug/kg	• Action Level
FDA	Foods packaged in Lead-Soldered Cans	250 ug/kg	• Action Level
FDA	Ceramic Flatware	3.0 ug/mL	• Action level
FDA	Ceramic Hollowware (Small)	2.0 ug/mL	• Action Level
FDA	Ceramic Hollowware (Large)	1.0 ug/mL	• Action Level
FDA	Ceramic Cups, Mugs, and Pitchers	0.5 ug/mL	• Action Level
FDA	Bottled Drinking Water	0.005 mg/L	• Action Level
Health Care Financing Administration (HCFA)	Blood	Test children at 12 and 24 months	• Within the Department of Health and Human Services • Administers Medicaid program • Requires state agencies to conduct blood lead screening
HCFA	Lead-Based Paint		• Requires paint testing in federally funded housing
Department of Housing and Urban Development (HUD)	Lead-Based Paint		• Use of lead-based paint in residential structures built or rehabilitated by a federal agency or with federal assistance prohibited
HUD	Lead-Based Paint	0.06% lead by weight in nonvolatile content	• Definition of lead-based paint manufactured after June 22, 1977
Occupational Safety and Health Administration (OSHA)	Blood	40 ug/dL 50 ug/dL	• In occupational exposures, action level - written notification and exam • Removal of employee from exposure
OSHA	Air	50 ug/m^3 30 ug/m^3	• The Permissible Exposure Limit (8-hour average) in the workplace • Action level

Source: Rothweiler et al., 2007.

APPENDIX II

LEAD INVESTIGATION QUESTIONNAIRE

The following questionnaire was created by Shawn Gerstenberger, Anne Rothweiler, and Elena Cabb at the University of Nevada Las Vegas, Department of Environmental and Occupational Health, 4505 Maryland Parkway, Box 453063, Las Vegas, Nevada, 89154.

This questionnaire is administered to parents of children with elevated blood lead levels in Nevada and has been approved by the UNLV Office for the Protection of Research Subjects prior to use.

For additional information regarding this protocol, please call 702-895-5420.

If you use materials from this questionnaire, please let us know by sending an email to shawn.gerstenberger@unlv.edu

Thank You!

LEAD INVESTIGATION QUESTIONNAIRE

Case Number:
Date Reported:

Address:

Date of Investigation:

INVESTIGATOR REMINDERS
The purpose of this investigation is to identify a cause or causes for lead poisoning.
Explain the reason for the visit to the parents/guardians.
Explain how a child gets lead poisoning.
Explain symptoms and health effects.
Explain the questionnaire and give a time estimate for completion.
Inform them that we will be collecting samples and they will be notified with the results.
Explain that a Public Health Nurse will contact them for further testing and/or treatment of the affected child as well as other household members.
Counsel about in-place management and prevention techniques.

Release of Information obtained from family? [ ] YES [ ] NO

Date: __________________

Questionnaire Sections:
Basic information
Water
Other Locations the Child May Spend Time
Household Members
Hazard Control Measures
Hobby Factors
Health Information
Occupational Factors
Residential Information
Products
Paint and Dust
Previous Testing
Soil
Additional Sources

BASIC INFORMATION

<table>
<tr><td colspan="2">Last Name:</td><td colspan="2">First Name:</td><td>Middle Name:</td></tr>
<tr><td>Date of Birth:</td><td colspan="2">Age: _____ Years
_____ Months</td><td colspan="2">Gender:
[ ] Female
[ ] Male</td></tr>
<tr><td colspan="2">Primary Language:
[ ] English [ ] Spanish
[ ] Other: ________________</td><td colspan="3">Race:
[ ] Asian [ ] Black [ ] Hispanic
[ ] Native American [ ] White
[ ] Other: ______________</td></tr>
</table>

Parent or Guardian Name(s):		Relationship to Child:		
Address:		City:		State:
Zip Code:	County:		Census Tract:	
Home Phone:	Work Phone:		Mobile Phone:	
Environmental Case #:		Nursing Case #:		
Who would know how to contact you if you move? Name:				
Relationship:		Phone:		

OTHER LOCATIONS THE CHILD MAY SPEND TIME

1. Has the child lived at any different addresses during the past 12 months? [ ] YES
[ ] NO

   a. If yes, complete the following table:

Address	Dates of Residency	Approximate Age of Dwelling	General Condition of Dwelling (Any remodeling or renovation?)

2. Where do you think your child is exposed to a lead hazard?

____

____

3. Where does the child spend the most time and do activities when at home? (i.e. living room, bedroom, front or back yard, etc.)

____

____

4. Where does the child like to play? (i.e. rooms, closets, porches, outside buildings)

____

____

5. Where does the child like to hide? (i.e. rooms, closets, porches, outside buildings)

____

____

6. Is the child cared for away from the home? [ ] YES [ ] NO
   b. If yes, where?

[ ] Preschool/School [ ] Daycare/Babysitter [ ] Relative/Friend
[ ] Neighbor [ ] Other: ______________________

Information regarding the above location(s):

Type of Care	Location of Care (Name of Contact Person, Address, and Phone)	General condition of the building	Approx. Year of Construction	Approx. Number of Hours Spent at Location in a Week	Any Lead Investigation?
					[ ] YES [ ] NO
					[ ] YES [ ] NO

7. Has the child attended school in the last three years? [ ] YES [ ] NO

a. If yes, where?

Name of School:					
Address	Phone	Years Attended	Approximate Year of Construction	Amount of Time Spent at the School in a Week	Any Lead Investigation ?
					[ ] YES [ ] NO

Name of School:					
Address	Phone	Years Attended	Approx. Year of Construction	Amount of Time Spent at the School in a Week	Any Lead Investigation?
					[ ] YES [ ] NO

Name of School:					
Address	Phone	Years Attended	Approximate Year of Construction	Amount of Time Spent at the School in a Week	Any Lead Investigation?
					[ ] YES [ ] NO

8. Has the child lived or traveled outside of the U.S. in the last year? [ ] YES [ ] NO

a. Where? ______________________________

b. Reason? ______________________________

c. From: ____________________ To: ____________________

9. Has the child lived or traveled outside the U.S. in the last month? [ ] YES [ ] NO

d. Where? ______________________________

e. Reason?

____

f. From: ____________________ To: ______________________________

10. Does the family visit friends or relatives who may live in a residence built before 1978?

[ ] YES [ ] NO

g. If yes, where is the building?

____

11. Notes:

HAZARD CONTROL MEASURES

1. What cleaning equipment does the family have in the home?

[ ] Broom [ ] Mop and Bucket [ ] Vacuum [ ] Sponges and Rags

2. Does the vacuum work? [ ] YES

[ ] NO

3. How often does the family sweep the floors? ______________________________

4. How often does the family wet mop the floors? ______________________________

5. How often does the family vacuum the floors? ______________________________

6. How often does the family wash the window sills and/or troughs?

____

7. What type(s) of floor coverings are found in the home?

[ ] Vinyl/Linoleum

[ ] Carpeting

[ ] Wood

[ ] Other: ______________________________

8. Are floor coverings smooth and cleanable? [ ] YES

[ ] NO

9. Describe the amount of dust on surfaces, including furniture:

____

10. Describe the condition of the carpets (i.e. any matted or soiled carpeting?):

____

11. Describe the amount of debris and/or food particles in the home:

____

12. Describe the amount of visible cobwebs:

____

13. Describe the cleanliness of the kitchen floor:

____

14. Describe the cleanliness of the doorjambs:

____

15. Is there evidence of recent vacuuming? [ ] YES

[ ] NO

16. Overall cleanliness of the home:
    [ ] Appears clean

    [ ] Some evidence of house cleaning
    [ ] No evidence of house cleaning

17. Notes:

HEALTH INFORMATION

PHYSICIAN INFORMATION	
Name:	
Clinic:	
Address:	Phone:

LABORATORY INFORMATION		
Laboratory Name:		
Address:		Phone:
Blood Lead Level:	Collection Date:	Report Date:
Blood Lead Level:	Collection Date:	Report Date:
Blood Lead Level:	Collection Date:	Report Date:

CHILD'S MEDICAL HISTORY

1. Would you say this child's health is generally:
   [ ] Excellent
   [ ] Very Good
   [ ] Good
   [ ] Fair
   [ ] Poor

2. Does your child receive a regular vitamin/mineral supplement?[ ] YES [ ] NO

3. Has your child's doctor ever told you the child was low in:
   a. Iron [ ] YE [ ] NO
   b. Calcium [ ] YES [ ] NO
   c. Zinc [ ] YES [ ] NO

4. Has the child ever received treatment for lead poisoning? [ ] YES
   [ ] NO

   d. If yes, did the child receive chelation treatment?
      [ ] YES [ ] NO [ ] Don't Know

5. Has your child experienced any of the following symptoms more than 3 times in the last three months?

Symptoms	Yes	No	Don't Know
Vomiting			
Nausea			
Weight Loss			
Loss of Appetite			
Stomach Aches			
Constipation			
Difficulty Urinating			
Extreme Weakness and Fatigue			
Joint Pain			
Paleness			
Headaches			
Dizziness			
Irritability			
Seizures or Convulsions			
Trouble Sleeping			

FOLK REMEDIES

1. Does your child suffer from stomach illness? [ ] YES [ ] NO

2. Has your child ever had "empacho?" [ ] YES [ ] NO

3. Have you taken your child to a sobadora/healer/curandera?[ ] YES [ ] NO

4. Does your family use any home remedies or herbal treatments? [ ] YES [ ] NO
   a. If yes, complete the following table:

Folk Remedy	Used By	Who Gives the Remedy?	Where Obtained?	Used How Often?	Date Last Used	Sample Obtained?
Greta						[ ] Yes [ ] No
Azarcon						[ ] Yes [ ] No
Paylooah						[ ] Yes [ ] No
Other:						[ ] Yes [ ] No
Other:						[ ] Yes [ ] No
Other:						[ ] Yes [ ] No

BEHAVIOR AND DAILY ACTIVITIES

1. If the family includes more than one child, do the children sleep in the same room/bed?
   [ ] YES
   [ ] NO
   [ ] NA

2. Has anyone seen the child eat any of the following?
   a. Paint and/or Paint Chips [ ] YES [ ] NO
   b. Soil [ ] YES [ ] NO
   c. Non-Food Items [ ] YES [ ] NO

Describe: ______________________________
When? ______________________________

3. Has anyone seen the child do any of the following:
   d. Suck their fingers or bite their nails?
   [ ] YES [ ] NO

   e. Place painted objects in their mouths?
   [ ] YES [ ] NO
   i. Specify:
   ____

f. Chew on painted surfaces, pick at painted surfaces, chew or eat paint chips? (such as cribs, window sills, furniture edges, railings, door molding, broom handles, etc.)
[ ] YES [ ] NO

g. Chew on putty around windows? [ ] YES [ ] NO

h. Put soft metal objects in the mouth? (such as lead and pewter toys and toy soldiers, jewelry, gunshot, bullets, beads, fishing sinkers, or any item containing solder – like electronics)
[ ] YES [ ] NO

i. Specify: ______________________________

i. Put foreign printed materials in their mouths? (such as newspapers or magazines)
[ ] YES [ ] NO

j. Play with matches or put them in their mouths?
[ ] YES [ ] NO

4. Does the child frequently play in bare soil?
[ ] YES [ ] NO

5. Does the child ride a bike or all-terrain vehicle (ATV)? [ ] YES [ ] NO

6. Does the child play, bike, or ride an all-terrain vehicle (ATV) on or around mine tailings? [ ] YES [ ] NO

7. Does the child wear jewelry? [ ] YES
[ ] NO

k. If yes, where was the jewelry obtained? ______________________

8. Does the child have a dog, cat, or other pet that could track in contaminated soil or dust from outside? [ ] YES
[ ] NO

l. If yes, where does the pet sleep?
____

9. If the child is present, note the extent of hand-to-mouth behavior observed:
____
____

10. Notes:

RESIDENTIAL INFORMATION

1. Describe the current type of residence:
   [ ] Single
   [ ] Multi
   [ ] Trailer
   [ ] Other: ____________________________

2. Is the current occupant an:
   [ ] Owner
   [ ] Renter
   [ ] Public Housing (i.e. Section 8, Housing Project)

3. Owner or Landlord Information (if different from the occupant)

Name:	Relationship to Occupant:
Address:	Phone:

4. Does the family receive any housing assistance from any agency? [ ] YES [ ] NO

   a. If yes, what is the Agency?

   ____

5. Does the family have a housing case manager? [ ] YES [ ] NO

   b. If yes, name and phone of manager:

   ____

6. When did the family move into the current residence?

   ____

7. Approximate year of construction: ___________________

8. If the home was built before 1978, did the family receive disclosure of the possible presence of lead-based paint, or any information regarding lead-based paint and/or lead-based paint hazards in the home? [ ] YES [ ] NO

9. Notes:

PAINT AND DUST

1. Visual assessment of paint conditions:

Areas Where the Child Likes to Play and/or Hide	Paint Condition	Description*

	[ ] Intact [ ] Some cracking or peeling [ ] Significant deterioration [ ] No paint present	
	[ ] Intact [ ] Some cracking or peeling [ ] Significant deterioration [ ] No paint present	
	[ ] Intact [ ] Some cracking or peeling [ ] Significant deterioration [ ] No paint present	
	[ ] Intact [ ] Some cracking or peeling [ ] Significant deterioration [ ] No paint present	
	[ ] Intact [ ] Some cracking or peeling [ ] Significant deterioration [ ] No paint present	

*Note location and extent of any visible chips and/or dust in window wells, on window sills, and on the floor directly beneath windows. Do you see peeling, chipping, chalking, flaking, or deteriorated paint? If yes, note locations and extent of deterioration. Note the location(s) of painted components with visible bite marks.

2. Has there been any recent remodeling, repainting, renovation, window replacement, sanding or scraping of painted surfaces inside or outside this residence in the last six months?

   [ ] YES   [ ] NO

   a. If yes, describe the activities and duration:

   ____

   ____

   ____

3. Has any lead abatement work been conducted at this residence recently? [ ] YES [ ] NO

   b. If yes, describe:

   ____

   ____

   ____

4. Notes:

SOIL

1. Is the residence near a lead industry, such as a battery plant, smelter, radiator repair shop, or electronic/soldering facility?

[ ] YES   [ ] NO

2. Can the family smell automobile fumes from the current residence, or any residence where they have lived in the last three years? [ ] YES
[ ] NO

3. Is the residence located within two blocks of a major roadway, freeway, elevated highway, or other transportation structure? [ ] YES
[ ] NO

    a. If yes, how far?

    ____

4. Are nearby buildings or structures being renovated, repainted, or demolished?
[ ] YES [ ] NO

    b. If yes, describe location and activities:

    ____

    ____

5. Is there deteriorated paint on outside fences, garages, play structures, railings, or mailboxes? [ ] YES [ ] NO

6. Are there visible paint chips near the perimeter of the building, fences, garages, or play structures? [ ] YES
[ ] NO

    c. If yes, describe the location(s):

    ____

    ____

7. Did the family ever use gasoline or other solvents to clean car parts or other items, or disposed of at the property? [ ] YES
[ ] NO

    d. If yes, describe the location(s):

    ____

    ____

8. Has the family burned painted wood in a woodstove or fireplace? [ ] YES
[ ] NO

    e. If yes, did they empty the ashes onto the soil? [ ] YES
    [ ] NO

    f. If yes, where?

    ____

9. Notes:

WATER

1. What is the source of drinking water for the family?
   [ ] Municipal (Tap)
   [ ] Purchased
   [ ] Filtered
   [ ] Private Well
   [ ] Other:

____

If tap water is used for drinking, answer the following questions:

a. Which faucets does the family use for drinking water?

____

b. Does the family use the water immediately, or do they let the water run for a while first?
   [ ] Immediately [ ] Run

If water is purchased, answer the following question:

c. Where is the water purchased?

____

If water is filtered, answer the following question:

d. What type of filter is used?

____

2. Sometimes children get their water from a different source than the rest of the family. What is the specific source of the child's drinking water?

____

3. What type of water is used for making baby formula, powdered milk, and juices?

____

e. If the family uses Municipal (Tap) water, do they use hot or cold tap water?

   [ ] Hot [ ] Cold

4. Is the family's cooking water from a different source than their drinking water?

   [ ] YES [ ] NO

If yes, answer the following questions:

f. What type of water does the family cook with?
   [ ] Municipal (Tap)
   [ ] Purchased

[ ] Filtered
[ ] Private Well
[ ] Other:

---

5. Are there lead pipes or solder in the residence?

   [ ] YES
   [ ] NO

6. Has anyone repaired the plumbing? [ ] YES
   [ ] NO

   g. If yes, when?

   ___

   h. By whom?

   ___

7. Has new plumbing been installed within the last five years? [ ] YES
   [ ] NO

   i. If yes, identify the location(s):

   ___

   j. Did the family do any of this work themselves?

   [ ] YES
   [ ] NO

   k. If yes, describe the work done:

   ___

   ___

8. Have the faucets been replaced?

   [ ] YES
   [ ] NO

   g. If yes, when?

   ___

9. Is the glazing on the bathtubs old or deteriorated? [ ] YES
   [ ] NO

   c. If yes, describe:

   ___

10. Notes:

HOUSEHOLD MEMBERS

Recommend that the following persons get blood lead tested:

1. Children under 6 years old.
2. Adults who have hobbies or jobs involving lead.
3. Pregnant women.

Notes:

1. Name:		
Date of Birth:	Age:	Pregnant? [ ] YES [ ] NO
Blood Tested for Lead? [ ] YES [ ] NO	Result:	
Hobbies:		
Length of Time:	Where Done?	
Clothes Changed? [ ] YES [ ] NO	Shower Taken? [ ] YES [ ] NO	
Place of Employment:		
Occupation or Job Title:	Routine Blood Tests? [ ] YES [ ] NO	
Clothing Changed at Work? [ ] YES [ ] NO	Shower Taken at Work? [ ] YES [ ] NO	

2. Name:		
Date of Birth:	Age:	Pregnant? [ ] YES [ ] NO
Blood Tested for Lead? [ ] YES [ ] NO	Result:	
Hobbies:		
Length of Time:	Where Done?	
Clothes Changed? [ ] YES [ ] NO	Shower Taken? [ ] YES [ ] NO	

Place of Employment:	

Occupation or Job Title:	Routine Blood Tests? [ ] YES [ ] NO
Clothing Changed at Work? [ ] YES [ ] NO	Shower Taken at Work? [ ] YES [ ] NO

3. Name:		
Date of Birth:	Age:	Pregnant? [ ] YES [ ] NO
Blood Tested for Lead? [ ] YES [ ] NO	Result:	
Hobbies:		
Length of Time:	Where Done?	
Clothes Changed? [ ] YES [ ] NO	Shower Taken? [ ] YES [ ] NO	
Place of Employment:		
Occupation or Job Title:	Routine Blood Tests? [ ] YES [ ] NO	
Clothing Changed at Work? [ ] YES [ ] NO	Shower Taken at Work? [ ] YES [ ] NO	
4. Name:		
Date of Birth:	Age:	Pregnant? [ ] YES [ ] NO
Blood Tested for Lead? [ ] YES [ ] NO	Result:	
Hobbies:		
Length of Time:	Where Done?	
Clothes Changed? [ ] YES [ ] NO	Shower Taken? [ ] YES [ ] NO	
Place of Employment:		

Occupation or Job Title:	Routine Blood Tests? [ ] YES [ ] NO
Clothing Changed at Work? [ ] YES [ ] NO	Shower Taken at Work? [ ] YES [ ] NO

5. Name:		
Date of Birth:	Age:	Pregnant? [ ] YES [ ] NO
Blood Tested for Lead? [ ] YES [ ] NO	Result:	
Hobbies:		
Length of Time:	Where Done?	
Clothes Changed? [ ] YES [ ] NO	Shower Taken? [ ] YES [ ] NO	
Place of Employment:		
Occupation or Job Title:	Routine Blood Tests? [ ] YES [ ] NO	
Clothing Changed at Work? [ ] YES [ ] NO	Shower Taken at Work? [ ] YES [ ] NO	
6. Name:		
Date of Birth:	Age:	Pregnant? [ ] YES [ ] NO
Blood Tested for Lead? [ ] YES [ ] NO	Result:	
Hobbies:		
Length of Time:	Where Done?	
Clothes Changed? [ ] YES [ ] NO	Shower Taken? [ ] YES [ ] NO	
Place of Employment:		

Occupation or Job Title:		Routine Blood Tests? [ ] YES [ ] NO
Clothing Changed at Work? [ ] YES [ ] NO	Shower Taken at Work? [ ] YES [ ] NO	

Activity	YES	NO
Remove paint or varnish (includes paint removal from woodwork, furniture, cars, bicycles, boats, etc.)?		
Make pottery?		
Make ceramics?		
Apply glaze to ceramic or pottery objects?		
Work with stained glass?		
Use artist's paints to paint pictures or jewelry?		
Make or repair jewelry?		
Weld or solder?		
Solder electric parts?		
Melt lead to make bullets or fishing sinkers?		
Auto body repair work?		
Play pool or billiards?		
Reload bullets, target shoot, or hunt?		
Go to the shooting range?		
Other hobby involving lead:		

HOBBY FACTORS

1. Does anyone in the household have a hobby involving lead? [ ] YES [ ] NO

2. Does anyone in the household do any of the following activities at the home?

3. Are hobby clothes separated from other laundry?
[ ] YES
[ ] NO

4. Notes:

OCCUPATIONAL FACTORS

Work Activity	YES	NO
Auto body repair work?		
Making batteries?		
Salvaging and/or recycling metal or batteries?		
Building, repairing, or painting ships?		
Chemical stripping?		
Pouring molten metal or other foundry work?		
Making explosives or ammunition?		
Making paints and/or pigments?		
Painting?		
Paint removal (including sandblasting, scraping, abrasive blasting, sanding, using a heat gun or torch, etc.)?		
Making pottery?		
Making or repairing jewelry?		
Making or working with stained glass items?		
Making or splicing cable or wire?		
Plumbing?		
Remodeling, repairing, renovating, or demolishing buildings or metal structures?		
Construction?		
Working with ceramic tiles (such as installing and cutting)?		
Repairing radiators?		
Smelting (melting metal for reuse)?		
Welding, burning, cutting, or torch work?		
Working at a firing range?		
Working in a chemical plant?		
Working in a glass factory?		
Working at an oil refinery?		
Other work involving lead:		

1. Are work clothes separated from other laundry?

[ ] YES
[ ] NO

2. Does anyone in the household engage in any of the following activities?

3. Notes:

PRODUCTS

BLINDS AND SHUTTERS

1. Are there any mini-blinds in the home? [ ] YES [ ] NO

h. If yes, where are the mini-blinds located?
[ ] Living Room

[ ] Kitchen

[ ] Dining

Room

[ ] Child's Bedroom
[ ] Bathroom
[ ] Family Room
[ ] Parents' Bedroom
[ ] Other: ____

b. Are the miniblinds accessible to the child? [ ] YES
[ ] NO

c. Does the child handle or place their mouth on the miniblinds? [ ] YES
[ ] NO

2. Are there vertical blinds in the home? [ ] YES
[ ] NO

a. If yes, where are the vertical blinds located?
[ ] Living Room
[ ] Kitchen
[ ] Dining Room
[ ] Child's Bedroom
[ ] Bathroom
[ ] Family Room
[ ] Parents' Bedroom
[ ] Other: ________________________________

b. Are the vertical blinds accessible to the child? [ ] YES [ ] NO

c. Does the child handle or place their mouth on the vertical blinds? [ ] YES
[ ] NO

3. Are there shutters in the home?

[ ] YES
[ ] NO

c. If yes, have the shutters been painted or covered with an industrial covering?

[ ] YES [ ] NO

i. Describe the condition of the shutters (any paint deterioration?): ______________________________

4. Notes:

COSMETICS

1. Does the child play with cosmetics, hair preparations, or talcum powder?
   [ ] YES
   [ ] NO

2. Does the child put cosmetics, hair preparations, or talcum powder in their mouth?
   [ ] YES
   [ ] NO

   a. If yes, are any of these items foreign-made? [ ] YES [ ] NO

3. Are any imported cosmetics used in the home? [ ] YES [ ] NO

   b. If yes, complete the following chart:

Cosmetic	Used By	Length of Use	Location of Purchase	Sample Obtained?
Kohl				[ ] YES [ ] NO
Surma				[ ] YES [ ] NO
Ceruse				[ ] YES [ ] NO
Other:				[ ] YES [ ] NO
Other:				[ ] YES [ ] NO
Other:				[ ] YES [ ] NO

4. Notes:

CANDLES

1. Does the family light candles in the home? [ ] YES [ ] NO

2. How often do the family light candles?

____

3. Do the candles have metal wicks? [ ] YES [ ] NO

4. What brand(s) of candles does the family use?

____

5. Where do the family light candles?
   - [ ] Living Room
   - [ ] Kitchen
   - [ ] Dining Room
   - [ ] Child's Bedroom
   - [ ] Bathroom
   - [ ] Family Room
   - [ ] Parent's Bedroom
   - [ ] Other:

____

6. Notes:

COOKWARE AND UTENSILS

1. Describe the type(s) of materials of the dishes and cups that the child eats and drinks from?
   - [ ] Metal
   - [ ] Plastic
   - [ ] Ceramic
   - [ ] Other:

____

2. Does the child have a favorite cup or eating utensil? [ ] YES [ ] NO

   a. If yes, are they handmade or ceramic? [ ] YES [ ] NO

3. What type(s) of containers are used to prepare and store the child's food?
   - [ ] Metal
   - [ ] Glazed
   - [ ] Soldered
   - [ ] Plastic

[ ] Other:

____

4. Does the family use any imported or handmade ceramics? [ ] YES [ ] NO

    b. If yes, what do they use them for?
    [ ] Bean Pot
    [ ] Cooking
    [ ] Food Storage
    [ ] Water
    [ ] Other:

    ____

    c. Where were they purchased?
    [ ] U.S. [ ] Mexico
    [ ] Other: ____________________

    d. How long have they been used? ________________________________

5. Does the family use an imported tamale steamer? [ ] YES [ ] NO

6. Does the family use any crystal or pewter? [ ] YES [ ] NO

7. Are any liquids stored in metal, pewter, or crystal containers? [ ] YES [ ] NO

8. Does the family use imported canned items regularly? [ ] YES [ ] NO

9. Has the child eaten foods that have been stored in opened cans? [ ] YES [ ] NO

10. Has the child eaten vegetables grown in the family, friend, or neighboring garden?
[ ] YES [ ] NO

11. Does the child eat Mexican candy or other imported candy? [ ] YES [ ] NO

    e. If yes, fill out Imported Candy Table

12. Notes:

HOUSEHOLD MATERIALS

1. Does the child play in, live in, or have access to any areas where the following materials are kept?

Material	YES	NO	Description of Access
Shellacs?			
Lacquers?			
Driers?			
Coloring Pigments?			
Epoxy Resins?			
Pipe Sealants?			
Putty?			
Dyes?			
Industrial Crayons or Markers?			
Gasoline?			
Paints?			
Pesticides?			
Fungicides?			
Gear Oil?			
Detergents?			
Old Batteries?			
Battery Casings?			
Fishing Sinkers?			
Lead Pellets?			
Solder?			

Drapery Weights?			
Old Radiators?			
Other:			
Other:			

2. Notes:

TOYS

1. Does the child have any imported toys? [ ] YES [ ] NO

    m. If yes, please describe the toys:

    ____

    ____

2. Does the child have imported crayons? [ ] YES [ ] NO

    a. Brand?

    ____

    b. Where purchased?

    ____

    c. When?

    ____

    d. Does the child chew on the crayons? [ ] YES [ ] NO

3. Does the child use imported sidewalk chalk? [ ] YES [ ] NO

    e. Brand?

    ____

    f. Where purchased?

g. When?

h. Does the child chew on the chalk? [ ] YES [ ] NO

4. Notes:

PREVIOUS LEAD TESTING

1. Have any of the following been tested for lead?

HOME		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

LEAD-BASED PAINT OR LEAD-CONTAMINATED DUST IN THE HOME		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

SOIL		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

WATER		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?

When was the test performed?	Where can the test results be obtained?

CHILD'S BATHTUB		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

MINIBLINDS		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

VERTICAL BLINDS		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

SHUTTERS		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

IMPORTED OR HANDMADE CERAMICS		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

COOKING UTENSILS		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

CHILD'S DISHES		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	
CHILD'S TOYS		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

OTHER:		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

OTHER:		
Tested for Lead? [ ] YES [ ] NO	Results? [ ] + [ ] -	Lead Concentration?
When was the test performed?	Where can the test results be obtained?	

Candy	Purchase Location	How Much
Aldama Obleas con Cajeta		
Arco Iris Tamarind		
Arcor Frutilla		
Astro Pop		
Baby Lucas		
Beso Ardiente		
Besos Ricos		
Betamex Dulce de Tamarindo		
Bolirindo		
Bomba Chile		
Brinquitos		
Cachitos		
Canel's Gum		
Chaca Chaca		
Chaca Chaca Rielito		
Chiclorindo		
Chupirul		
De La Rosa Paleta		
Diablitos Tamarindin		
Dulce de Tamarindo La Colonial		
Duvalin		
Enchiladas Luxus		
Hershey's		
Indy Hormigas		
Lickem Pop		
Limon 7		
Lucas Acidito		
Lucas Dulce de Tamarindo		
Lucas Limon		
Lucas Pelucas		
Margarita Dulce de		
Melon con Chile		
Milkoko		

Montes Damy		
Montes Tomy		
Paleta Ricorindo		
Paleton con Chile "Teco"		
Pelon Pelo Rico		
Picante Peanuts (El Senor)		
Pico Diana		
Pina Loca		
Pinto Rojo		
Pulpitas		
Rollito de Coco		
Rollito de Tamarindo		
Saladulces Hola, Sabor Agridulce		
Saladulces Hola, Sabor Naranja		
Serpentinas		
Simpsons con Super Chile		
Storck Eucalyptus Menthol		
Super Lucas Hot'n Spicy Chili Mix		
Tablarindo		
Tama Roca		
Taman Zela con Chile		
Tamarindo		
Tiramindo con Sabor de lo Lindo		
Tutsi Pop		
Uy Uy Uy		
Vagabundo con Chile		
Vagabundo Extremo		
Vero Chupadedo		
Vero Elotes		
Vero Manita		
Vero Palerindas		
Vero Pinaleta		
Vero Rebanaditas		

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