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Lead risk hazards in pre-1978 childcare facilities located in Clark County, Nevada, USA

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LEAD RISK HAZARDS IN PRE-1978 CHILDCARE FACILITIES

LOCATED IN CLARK COUNTY, NEVADA, USA

by

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ABSTRACT

Lead Risk Hazards in Pre-1978 Childcare Facilities in Clark County, Nevada, USA

by

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The harmful health effects of lead exposure have been known for centuries, yet lead is still produced and utilized in a variety of ways. There have been many movements to rid the environment of this toxic metal in hope to reduce the number of individuals who are and who may potentially be exposed. Lead exposure is responsible for a myriad of negative health effects most notably lowering IQ scores in children.

Extensive amounts of data have been collected from areas of the country with known lead hazards, hazards that have been identified through hundreds of thousands of elevated blood lead levels and through research studies. This study begins to answer the questions of the presence of traditional and some non-traditional lead hazards in the housing and commercial building stock of Clark County, Nevada, USA.

This study is the first of its kind, in that, lead risk assessments were performed for the total population of pre-1978 permitted childcare facilities in Clark County, Nevada (N=94). These risk assessments included X-ray fluorescence analyses of paint, tile, and large pieces of playground equipment, while laboratory analyses were performed on dust, soil, and water samples.

The analyses suggest that the pre-1978 structures in Clark County Nevada, USA do not follow national trends pertaining to the prevalence of lead-based paint, and lead in

dust and soil. Only a small portion of the childcare center screened had traditional lead hazards, while a slightly higher portion of centers had non-traditional sources such as tile, and playground equipment.

The data collected in this study contributes to the growing body of data of the lead hazards present in the Clark County, Nevada housing stock. This information could help by directing primary prevention efforts to the non-traditional sources of lead exposure that are pertinent to Clark County, Nevada.

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CHAPTER 1

INTRODUCTION

The Southern Nevada Health District (SNHD) received a local Childhood Lead Poisoning Prevention Program (CLPPP) grant from the Centers for Disease Control and Prevention (CDC) in 2006. This grant provided for the creation of the CLPPP in Southern Nevada that will be improved upon and eventually expanded to encompass the entire state of Nevada. One important aspect of the program is Primary Prevention which aims to determine what lead hazards exist in a community and how to abate those hazards to prevent children from being exposed to lead.

The SNHD in partnership with the University of Nevada, Las Vegas (UNLV) implemented a lead hazard risk assessment program for all pre-1978, health-permitted childcare facilities of Clark County, Nevada. This project will focuses on locating and identifying potential and actual lead hazards in childcare facilities. Once a hazard is identified, and the degree of hazard is evaluated, a required course of action to address the hazard is given to each facility.

Data that are generated from this project will be combined with data being collected by the CLPPP, to determine the extent of Southern Nevada's pre-1978 housing stock that is comprised of homes containing lead hazards. Currently, the extent of lead hazards in Clark County is unknown, but the gathered data will provide a better understanding of what lead issues are present in the valley. This information will then be added to the data gathered for the state of Nevada and will encompass the lead hazards for the entire state. Las Vegas is a relatively young city (post-1978 dominated), consisting of a newer housing stock (post-1978 dominated). Therefore, Las Vegas should have fewer lead paint issues compared to older housing stock located in the Midwest and the East Coast.

The goal of this project was to screen all pre-1978 childcare facilities for lead, and to prevent the lead exposure in children. Lead exposure could impact a child's physical and mental development and lead has been identified as a cause of many developmental problems in children under the age of six. Removing lead hazards before children are exposed could save money and time; and reduce needs related to special education, health complications, and a decrease in expected earnings (Farr & Dolbeare, 1996). It is estimated that after the third National Health and Nutrition Survey (NHANES) was administered in 1988-1994 that there were 1.7 million children in the U.S. with blood lead levels (BBL) above 10µg/dL (Myers, Davidson, Weitzman, & Lanphear, 1997). A BLL ≥ 10µg/dL can severely affect a child's health and well being and lower values may also cause harm (Canfield, Henderson, Cory-Slechta, Cox, Jusko, & Lanphear, 2003). The CDC estimates that there are currently 250,000 children with blood lead levels above 10µg/dL (Department of Health and Human Services; Center for Disease Control and Prevention, 2008).

Assessing local childcare facilities is important because it canl provide direct benefits to those involved on several different levels. First, it can reduce the liability of the childcare owner should one of the children be identified with an elevated blood lead level (EBLL) concentration. Second, it may alleviate the fears of parents who leave their children in a monitored facility on a daily basis, due to work or other obligations. Finally, the assessment would benefit the child by demonstrating what the lead hazards in the facility and directing their removal. Therefore, eliminating the possibility of exposure at a childcare facility could minimize the loss of IQ points and other associated health issues.

The project will aid the SNHD in addressing reported EBLL cases. When EBLLs are reported to SNHD and are above the CDC level of concern of 10µg/dL (Jacobs, 1996), the SNHD responds by performing environmental investigations, that include a risk assessment of the child's home and other places the child spends a majority of their time (i.e., school, daycare center, alternate family residences). With this information, the SNHD can quickly determine if the daycare center that a child attends may have contributed to the EBLL based on the previous environmental information gathered at the facility. The investigation would then be able to focus on other areas of interest that may contain lead hazards.

CHAPTER 2

LITERATURE REVIEW

Historical Uses of Lead

Human activities are the primary cause of adverse environmental and human health impacts caused by lead (Myers, Davidson, Weitzman, & Lanphear, 1997). Lead is present in the atmosphere, hydrosphere and living biota due to the multiple uses humans have found for this money saving, useful, toxic metal. Ice core studies conducted in Greenland have shown that lead contamination in the air has existed since both early Roman and Greek times (500BC to 300AD), but the concentrations have increased dramatically since the addition of tetra-ethyl lead to gasoline (Myers, Davidson, Weitzman, & Lanphear, 1997; Boutron & Gorlach, 1991; Hong, Candelone, & Patterson, 1994). Once this naturally occurring metal is extracted from the earth's crust it becomes a issue for the environment and humans alike, as elemental lead does not breakdown and there is no way to safely dispose of it once extracted (Lansdown & Yule, 1986).

Human contact with lead dates back to at least 4000 B.C. when it was first smelted as a by-product of silver processing (Nadakavukaren, 2006). Environmental levels of lead have increased more than 1000-fold over the past three centuries as result of human activity (U.S. Department of Health and Human Services, 2007); primarily due to the extensive processing and manufacturing of this heavy metal. Lead can be found in plastic products, vinyl blinds, paint, drinking water pipes, metal, jewelry, home remedies, and cosmetics, and more products detectable lead concentrations are being discovered every day.

Recent Consumer Product Safety Commission (CPSC) recalls have shown that lead is still being used to save money when processing commercial products as there have been many recalls over this past year including but not limited to toys, jewelry, and cosmetics (Consumer Product Safety Comission, 2009). Lead has also been found in Mexican candies, ceramics, and a variety of home remedies spanning many different ethnicities (Levin, Brown, Kashtock, Jacobs, Whelan, Rodman, Schock, Padilla, Sinks 2008). Companies are adding this metal to their products to reduce production costs not concerning themselves with the consequences, until they are caught (Nadakavukaren, 2006).

Health Effects

The human body has no beneficial uses for lead, there is no nutritional value, and it is highly toxic (Williams, James, & Roberts, 2000). Lead has been shown to cause neurological damage to both animals and humans alike. The most susceptible human populations to lead poisoning are young children and occupationally exposed workers (Williams, James, & Roberts, 2000; Goyer, 1990). Exposure to lead in high enough doses can, and has, lead to death (Nadakavukaren, 2006; Williams, James, & Roberts, 2000).

Lead is known to affect many major organs and systems throughout the body such as the kidneys, liver, central nervous system, reproductive system, and the developing fetus. Of all of the complications or detrimental effects that lead is known to cause, neurological damage to children is the most detrimental (Myers, Davidson, Weitzman, & Lanphear, 1997).

Children are more vulnerable to lead exposure for three main reasons: 1) young children are more at risk of ingesting environmental lead through normal hand to mouth behaviors (Ahmed & Siddiqui, 2007; Lanphear, Hornung, Ho, Howard, Eberle, & Knauf, 2002), 2) the absorption of lead from the gastrointestinal tract for children is higher than adults. Children are able to absorb up to 50% of lead in the gastrointestinal tract while adults absorb lead at approximately 15% (Ahmed & Siddiqui, 2007; Ziegler, Edwards, & Jensen, 1978; Williams, James, & Roberts, 2000), and 3) the developing nervous system is far more vulnerable to the toxic effects of lead than the mature brain (Ahmed & Siddiqui, 2007; Lidsky & Scheider, 2003).

Symptoms of lead exposure are for the most part subtle or unnoticeable unless an acute poisoning has taken place. Abdominal pain, constipation, cramps, nausea, vomiting, anorexia, and weight-loss are a few symptoms of acute lead poisoning in humans (Williams, James, & Roberts, 2000).

Chronic exposures to lead may display no symptoms or very mild symptoms including not limited to nausea, lethargy, weight-loss, aggression, and irritability (Williams, James, & Roberts, 2000). Even though no outward symptoms may be presented, it has been shown that neurological affects are present at very low doses (Needleman & Bellinger, 1991). The CDC has set certain allowable limits to lead exposure at 10μg/dL, but it is believed that exposure at lower concentrations are also detrimental to the health of children (Bellinger, 2004, Rothweiler, Cabb, & Gerstenberger, 2007). Research conducted since 1991 has provided evidence that children's physical and mental development can be affected at BLLs less than or equal to 10μg/dL (CDC Advisory Committee, 2007).

Research has contributed information on the relationships between lead exposure at low doses and poor performance in school, loss of IQ points, attention deficit, heightened aggression, and juvenile delinquency suggesting that there is no safe threshold for lead (Rothweiler, Cabb, & Gerstenberger, 2007; Dietrich, Ris, Succop, Berger, & Bornschein, 1993).

Lead can be measured in the body in several ways, first, is the measurement of lead in the blood that can be determined by either a capillary or venous blood draw. A BLL > 10μg/dL is considered above the level of concern per the CDC (CDC Advisory Committee, 2007). Second, is the measurement of lead in the dentin of teeth, but this technique is problematic because it requires a child's tooth to be extracted or to have fallen out. Third, is the measure of lead in bone, this is referred to as the body burden of lead this is a good indication of long term exposures and uses X-Rays to determine the presence of lead (Myers, Davidson, Weitzman, & Lanphear, 1997; Rosen & Slatkin, 1993; Todd & Bloch, 1993).

Lead Exposure in Water

There are several traditional ways that a child may be exposed to lead in their environment. Lead can be found in paint, soil, dust, and water (Goyer, 1991; Nadakavukaren, 2006). The condition of painted surfaces is one factor, if paint is found to be in fair or poor condition this allows children to peel or pick at the paint enabling them to inhale paint dust particles or ingest paint chips or dust. The dose of lead a child may receive from soil, dust, and water may be greater if different factors or conditions are present. Lead concentrations in soil may be greater depending if an industrial source such as a smelter or a high traffic area such as a heavily traveled highway in an urban setting (Myers, Davidson, Weitzman, & Lanphear, 1997; Landrigan, Whitworth, Baloh, et al., 1975; Romieu, Palazuelos, Meneses, et al., 1992). Higher doses of lead may be present in water if a home contains internal plumbing with brass fixtures, lead service lines or lead soldered copper piping (Berkowitz, 1995). Exposure via water is increased when the pH of the water is low, as lead is leached out of metal in acidic conditions (Bryant, 2004). The Lead and Copper Rule and other laws and regulations have been enacted to minimize the risk of lead exposure via water (U.S. Environmental Protection Agency, 2007).

Drinking water is still considered a possible source of lead exposure although it is not as widely publicized (Bryant, 2004). Lead contamination of drinking water has been nationally recognized as a contributor to childhood lead exposures 14-20% of the total lead exposure (Maas, Patch, Morgan, & Pandolfo, 2005; U.S Environmental Protection Agency (US), 1991). Lead contamination of drinking water can result from many factors; hot temperatures, high water velocity, soft water, low pH, aged infrastructure, and corrosion (Bryant, 2004).

The Safe Drinking Water Act passed in 1974, was created to limit human exposure to harmful contaminants in drinking water supplied by public water systems. Lead is one of those contaminants that may be present in drinking water due to the plumbing materials used, namely lead solder, lead pipes or brass which is approximately 8% lead (Bryant, 2004). Congress banned the use of leaded plumbing materials in 1986 to reduce the possibility of exposure via drinking water in new construction and rehabilitated infrastructure (Berkowitz, 1995).

In 1988, the Lead Contamination Control Act (Public Law 100-572, 1988) was established to ensure those most susceptible to the effects of lead were protected. State programs were established to help childcare facilities and schools determine if they had lead contamination in their drinking water supplies. If lead contamination was present a plan on how to remediate the situation was created (Berkowitz, 1995). This act also prohibited the use of lead in water coolers and established civil and criminal penalties for those that continued to manufacture lead lined water coolers (US Environmental Protection Agency, 1988).

In 1991, under the Safe Drinking Water Act (SDWA) the U.S. Environmental Protection Agency (USEPA) established the National Primary Drinking Water Regulation for Lead, otherwise known as the Lead and Copper Rule (LCR), which can be found in the Code of Federal Regulations 40 CFR Part 141. This rule initially set the Maximum Contaminant Level, (MCL) at 50ppb; the MCL had been changed to an Action Level and had been lowered through rule revisions to the current Action Level of 15ppb (US Environmental Protection Agency, Lead and Copper Rule, 2007). The LCR helped reduce exposure by monitoring distribution systems more thoroughly, controlling corrosion, replacing lead service lines, through public education and notification (US Environmental Protection Agency, Lead and Copper Rule, 2007). The Lead and Copper rule has recently undergone revision in 2007, which has brought about changes regarding public notification, public education, clarifying sampling requirements, and the replacement of lead service lines that have previously been tested and found to contain lead (US Environmental Protection Agency, Lead and Copper Rule, 2007).

There have been publicized incidents revealing lead exposure in drinking water though not many. One such incident occurred in Washington D.C. during the years 2001-2004, when the local water department changed their disinfection treatment technique from chlorination to chloramination (a disinfection treatment technique consisting of a mixture of chlorine and ammonia) (Renner, 2004). The switch in treatment techniques caused the corrosion of service lines and the accelerated leaching of the lead. The change in treatment resulted in large amounts of lead entering the distribution system and homes. It was documented that of the homes water tested for elevated lead concentrations in, 157 houses contained concentrations exceeding 300ppb, and thousands more exceeded the Action Level of 15ppb (Renner, 2004).

The tolerable dietary daily intake of lead for infants and children as defined by the US Food and Drug Administration is 6µg (Bryant, 2004; U.S. Food and Drug Administration, 1993). "Ingestions of 0.5L of water with lead concentrations of 20ppb, 50ppb, or 100ppb by children would result in a daily intake of approximately 10µg, 25µg, and 50µg, respectively." If children or infants were to drink this water theywould be dosed with over approximately 150µg of lead in one day drastically improving the possibility of experiencing elevated blood lead levels. Preparing powdered infant formula with lead-contaminated drinking water is the second most common cause of lead poisoning in infants (Bryant, 2004; Shannon M., 1992; Shannon M., 1989).

The change in disinfection techniques was required to comply with another US EPA rule for drinking water, The Disinfection Byproducts Rule (DBPR). This rule was established to reduce the amount of harmful by-products created when organic matter mixes with chlorine in the water distribution system (Renner, 2004). There is an estimate of 30% of major water utilities making this switch from chlorine to chloramines increasing their chances for spikes in lead contamination. This switch could mean many more distribution systems becoming a source of lead contamination if the proper control techniques are not in place to reduce the chance of leaching lead into the water supply.

The LCR and the DBR appear to clash with each other, for one to succeed it seems the other will have to falter or fail. The crux of this situation is corrosion control. If a solution can be reached using chloramines while not affecting corrosion control techniques then there will be a lessened chance of lead leaching, avoiding the contamination of drinking water.

Lead in Soil and Dust

Lead exists naturally in our environment but human activities have lead to contamination of soils and dust. The most common sources of lead in soil and dust are chipping of lead-based paint, disturbance of lead-based paint through renovations/remodeling, automotive exhaust of leaded gasoline, factory/smelter emissions, and waste disposal (Viverette, Mielke, Brisco, Dixon, Shaefer, & Pierre, 1996). Lead particles have been distributed to far reaching areas of the earth primarily due to it us as an anti-knocking agent in gasoline (Nadakavukaren, 2006; Williams, James, & Roberts, 2000). Leaded particulate matter has been spewed from cars exhaust contaminating soils, waterways, food supplies, and human systems world-wide.

The U.S. as well as a number of other countries has phased out the use of tetraethyl lead as a gasoline additive, which has substantially reduced blood lead levels around the world. By 1999 the geometric mean blood lead for U.S. children 1-5 years of age had fallen from 15μg/dL in the late 1970s to 2.0μg/dL (Ahmed & Siddiqui, 2007). The removal of lead can be considered the single greatest contribution to lowering the mean blood lead level in the U.S., followed by the ban on the addition of lead to residential paint. Unfortunately, there are still developing countries that are unable to make the switch to unleaded gasoline and they continue to harm the global environment and welfare of the local communities (Lanphear, 2007).

The Clean Air Act (CAA) was a regulating segue that brought about major positive changes to our environment and daily lives. Passage of the CAA in 1970, had the greatest impact on the crusade against lead pollution (Kasubasek & Silverman, 2008); and eventually resulted in the ban of leaded gasoline in the U.S. in 1996. Lead concentrations have decreased dramatically both in the environment and humans since that time (Nadakavukaren, 2006). Lead was finally added as a criteria air pollutant in the late 1970s when the CAA was reauthorized (Kasubasek & Silverman, 2008). The change was a result of the detrimental effects on a child's physical and intellectual development caused by lead exposure finally being realized (Nadakavukaren, 2006).

The CAA was recently revised in October 2008. This revision strengthened the National Air Ambient Air Quality Standards for Lead. The lead air standard or allowable concentration of lead before this revision was set at 1.5$\mu g/m^3$, the new standard was lowered to 0.15$\mu g/m^3$ (USEPA, 2008). The change has been made to protect those who are most susceptible to lead poisoning, children.

Leaded gasoline, mining, and industry were the main causes of lead production and contamination in the recent past: since leaded gasoline has been banned in the U.S. and other countries, industry and mining are now the main producers of leaded particulates that are released into the air (Kasubasek & Silverman, 2008). Lead is still being mined and refined in the U.S. for use in many products, currently 70% of the total U.S. consumption of lead is for lead storage batteries (there are approximately 20 pounds of lead in each car battery); other products include ammunition, brass, coverings for power and communication cables, glass television tubes, solder, toys, turf, pottery, home remedies, for use in plastics and pigments (Nadakavukaren, 2006).

Lead occurs naturally in the soil, but elevated lead in certain soils may be a result of deposition of particulate matter from air pollution. Lead concentrations in uncontaminated soil generally range from 10-50 ppm, while soil affected by human activities can be raised by a factor of 10-200 ppm (Needleman & Bellinger, 1991). Soils collected near major roadways have shown increased concentrations of lead close to the roadway compared the lead concentrations in soils collected further away from the roadways (Needleman & Bellinger, 1991). Soil near smelters, and industry are additional areas where lead concentrations tend to be high, concentrations as high as 60,000 ppm have been recorded (Needleman & Bellinger, 1991). Although Las Vegas lacks smelters there are major roadways that existed well before the ban of leaded gasoline, the existance of these roadways make it important to determine if the valley soil has been contaminated.

A study conducted by Viverette et al. (Viverette, Mielke, Brisco, Dixon, Shaefer, & Pierre, 1996) focused their efforts in identifiying outdoor lead hazards primarily soil and dust. They chose two inner city childcare centers (one private and one public) and two outer childcare centers. To evaluate potential lead hazards, they took dust wipes of indoor surfaces and outdoor surfaces including but not limited to: playground equipment, asphalt, table tops, door knobs, cribs, and toys. Soil samples were also collected from the facilities that had bare soil cover. The results from the study were that the private inner city childcare center exeeded the USEPA's recommended soil clearance standard of 400 ppm and 60% of the outdoor dust wipes exceeded the USEPA clearance standard (at that time) of 100µg/ft^2. The current USEPA clearance standard for interior floors is 40µg/ft^2 (Rothweiler, Cabb, Gerstenberger, 2007). The other three sites did not excceed the USEPA's standards for soil or dust on floors. Since then clearance standards have been reduced, it is likely that these centers had lead dust concentrations present that would exceed current standards.

The researchers in the Viverette et al. study also took dust wipes from the hands of ten children from each facility to determine their contact with lead hazards both inside and outside of the facilities. The researchers found that at the private inner-city center, 100% of the children tested had an average increase in hand lead exposure of 760% after playing outside, while 80% of children tested from the private outer-city center showed an average increase in hand lead exposure of 33% after playing outside (Viverette, Mielke, Brisco, Dixon, Shaefer, & Pierre, 1996). Ninety-one percent of the children tested from the public inner-city center, showed an average increase in hand lead exsposure of 36%, while at the public outer-city center, 90% of the children tested showed an average increase of 28% lead hand contamination (Viverette et al., 1996). The study illustrated the importance of examining exterior sources for lead content and to compile targeted efforts beyond the interior of the home by health officials. This study revealed that more environmental lead to hand transference occurred outside of the chilcare facilities. This study demonstrates the need to determine the extent of lead contamination of both soil and interior dust in the Clark County childcare facilities.

Lead in Paint

Leaded paint was eventually phased out and eventually banned for residential use in 1978 in the U.S., but leaded paint for industrial use is still produced for buildings, bridges, and ships in the U.S. (Lansdown & Yule, 1986). The toxic effects of lead have been known for centuries yet lead laden products are still being introduced. Lead can also escape into the environment via lead dust from chipping residential paint to be transported for long distances and distributed onto soils and crops (Needleman & Bellinger, 1991). These crops may be harvested and sent to processing plants to produce a product intended for human consumption. Lead dust can migrate into the atmosphere to be released during a wet weather event or be subject to fall out thus being distributed on the earth's surface.

Although all are still at risk for lead poisoning, children under the age of six are the most susceptible, followed then by workers exposed to lead in occupational settings (Gracia & Sondgrass, 2007). Lead paint and dust are the major causes of lead poisoning today (Berkowitz, 1995). As lead-based paint deteriorates or is disturbed, lead dust is created. Inhalation and ingestion of this dust are the main routes of exposure for humans. The CDC estimated that there are "4.1 million homes in the United States (25% of U.S. homes with children aged <6 years) have lead-based paint hazards. An estimated 68% of U.S. homes built before 1940 have lead hazards, as do 43% of those built during 1940-

1959 and 8% of those built during 1960-1977 and estimates are higher for homes in the Northeast and Midwest" (CDC Advisory Committee, 2007).

The Lead-based Paint Poisoning Prevention Act (LBPPPA) was passed in 1971, to prohibit the use of lead-based paint in residential housing that is constructed or rehabilitated by the Federal government most notably the U.S. Department of Housing and Urban Development (U.S. Department of Housing and Urban Development, 2004). At this time lead-based paint was considered to be paint that contained more than 1% of lead by weight (U.S. Department of Housing and Urban Development, 2004). This Act developed and implemented a national program to screen children for lead exposure and determine where those exposures were occurring and how to mitigate their exposure using risk assessments. This function was carried out by the CDC until 1981 when those duties were turned over to the individual states (Centers for Disease Control, 1992).

The LBPPPA was amended several more times to lower the acceptable concentration of lead in paint. Eventually in 1976 the CPSC agreed to lower the allowable lead concentration in paint to 0.06% by weight (U.S. Department of Housing and Urban Development, 2004). The CPSC is responsible for banning the sale of lead-based paint for residential use under the Consumer Product Safety Act in 1978.

The sale of lead-based paint for residential properties was banned in 1978; but the problem still existed because many residential structures were already covered in lead-based paint. The Community Development Act (Public Law 102-550) of 1992 was signed into law by President George H.W. Bush and included in that law was Title X (US Environmental Protection Agency, 1996).

Title X or the Residential Lead-based Paint Hazard Reduction Act (LBPHRA) of 1992 was passed which required federal agencies create rules for working with lead. The main focus shifted away from the mere the presence of lead-based paint to the hazards associated with the structures that had used lead-based paint. Many laws and regulations have since followed the LBPHRA that have dealt with disposal of lead-based paint, the disclosure of lead-based paint, certification of risk assessors to identify lead-based paint hazards and many more. This Act has reduced the amount of people, especially young children, who could possibly be exposed to lead-based paint hazards and to help the individuals that have been exposed.

Title X Section 1018, the Requirements for Disclosure of Known Lead-based Paint and or Lead-based Paint Hazards in Housing (40 CFR Part 745 and 24 CFR Part 35), states that upon sale or lease of a pre-1978 structure the owner is required to disclose if there is lead-based paint present (Federal Register, 1996). An educational pamphlet entitled "Protect Your Family from Lead" is to be provided to the buyer or renter of a pre-1978 structure regardless if it is known that lead is or is not present (US Environmental Protection Agency, 1996).

The real estate broker is responsible to inform both parties of their responsibilities and obligations pertaining to this rule (U.S. Environmental Protection Agency, 1996). Under this rule an owner is required to include the lead disclosure with the lease or sale papers. The owner must report if there is lead present, not present or that they do not know. If the owner does not know if lead is present then the buyer has ten days to have a lead-based paint inspection performed at their expense, if they decide that they want to know (Federal Register, 1996). This ten-day grace period does not apply to rental or lease agreements. Once an owner determines that lead-based paint is present they are then required by law to always disclose that information to potential renters and buyers of that property (Federal Register, 1996). The US EPA and Housing and Urban Development (HUD) are responsible for enforcing this rule, although this does not always happen.

Several U.S. regulatory agencies are involved in regulating the amounts of lead the American public is exposed to on a day-to-day basis. Most notably is the exposure to lead-based paint. Title X amended the Toxic Substance Control Act (TSCA) of 1976 which is the primary statutory authority under which the US EPA issues regulations on working with lead-based paint (Federal Register, 1996). Some of the most important sections of Title X regulation are in TSCA Title IV. Section IV was created because the Disclosure Rule required lead professionals to be adequately trained and certified to inspect and assess lead-based paint hazards. This paper reviews some of the requirements under TSCA sections 402, 403, 404 and 406.

TSCA Title IV section 402 (c) requires several actions to be taken by the US EPA. First, the US EPA is to develop guidelines for remodeling and renovating structures with lead-based paint to prevent undo exposure (Federal Register, 1996). Second, the US EPA is to study renovation and remodeling activities to determine how much dust and lead-based paint hazards are generated. Finally, under this section the US EPA is to update renovation and remodeling regulations for activities that could potentially create a lead-based paint hazard (Federal Register, 1996).

Under TSCA Title IV, Sections 402/404 the US EPA is required to create a training and certification program to educate those in the lead profession on how to identify hazards and to work in a safe manner. These courses apply to the following professions: inspector, risk assessor, project designer, abatement worker, and abatement supervisor (Federal Register, 1996).

These programs educate the lead professionals in identifying lead-based paint by using proper sampling techniques. In the past paint chip sampling was the preferred method of paint sampling to determine if paint was lead-based, but this required removing a square inch of paint from the painted area in question. This sampling technique was not only expensive and time consuming; it also caused damage to the areas being tested. Today, the preferred method of paint sampling is using an X-Ray Fluorescence instrument that gives an instant result without damaging the component being tested (Jacobs, 2002).

Section 404 allowed states and tribal lands to create their own training and certification programs that must be approved by the US EPA. Nevada is one of sixteen states that do not have their own program; therefore Nevada follows the US EPA designed courses. As of March 2000, any state or tribe that did not have its own US EPA approved training and certification program would result in any worker in the lead field to be required to attend and complete US EPA training.

TSCA Title IV, Section 403 is very important in that this section has set standards for the acceptable concentrations of lead dust on floors, windowsills, in window troughs, soil, on concrete. Only a certified clearance technician, inspector or risk assessor may collect these environmental samples to determine if an area is in exceedence of the set standards. These standards were revised on December 26, 2000 to reflect the stricter standards that are used today in the lead profession (US Enviornmental Protection Agency, 2000).

TSCA Title IV, Section 406 (b) requires that those performing any work in pre-1978 structures provide educational materials regarding lead to the occupants no earlier than 60 days before the works begins and no later than seven days before the work begins. There are several exceptions to this requirement; if it is an emergency renovation or repair, if the painted area to be disturbed is less than 2ft^2 in total area on an interior wall 20ft^2 in total area on an exterior wall, if it is a zero bedroom unit, a housing unit designated for the elderly or those with disabilities, unless a child under six resides there (Federal Register, 1996). This section has recently been revised in April 2008. The changes made include addressing renovation, repair, and painting activities that occur in child occupied facilities (childcare centers and schools). These changes require the use of "Lead Safe Work Practices" and in 2010 any work done in a pre-1978 childcare facility must be done be a trained professional (U.S. Environmental Protection Agency, 2009).

Socioeconomics and Lead Exposure

Socioeconomic status (SES) plays a large role with regards to lead exposure and children who have elevated blood lead levels. There is the possibility for anyone to be exposed to lead, but research has demonstrated there is a greater chance of lead exposure and elevated blood lead levels for individuals of lower SES (Myers, Davidson, Weitzman, & Lanphear, 1997; Casey, Wiley, & Rutstein, et al., 1994). It is reported that over the last two decades that poverty has become centered in inner-city neighborhoods among poor African Americans (McLoyd, 1998). They are at a disadvantage because of the lack of accessible jobs, the absence of high-quality public and private services including but not limited to child care facilities, schools, and communitiy centers, and the increase in exposure to environmental stressors (McLoyd, 1998). Children from lower socioeconomic classes are subject to higher rates of residing in older structures containing lead-based paint in poorer conditions, leaded soldered water service lines, and higher exposures to industry and automobile pollution (McLoyd, 1998). According to the 2000 US Census approximately 33.9 million people were living below poverty levels, of those 33.9 million people, 16.6% were children (Bishaw & Iceland, 2003).

Lead In Childcares

Not much information is known about the extent of lead hazards in childcare centers. There have been few studies that explore these hazards and even fewer studies that require action to be taken when lead is found. This area of study is important because of the amount of time children spend in these facilities. Most states regulate childcare facilities in some capacity. In Las Vegas the Southern Nevada Health District and the office of Business License regularly inspect childcare facilities. Until recently, pre-1978 childcare facilities in Clark County were not tested for lead hazards (potential or actual hazards). This study is important as it is the first to assess the extent of lead hazards in the pre-1978 Clark County childcare facilities. This information and possible implications from this study can provide awareness to a health hazard that could exist nationwide.

A call for studies to be conducted in childcare facilities came about in a 1993 report from the United States General Accounting Office entitled "Toxic Substances: The Extent of lead hazards in Child Care Facilities and Schools is Unknown" (United States General Accounting Office, 1993). As discussed earlier, USEPA has guidelines for testing drinking water in childcare facilities but the USEPA does not have specific guidelines or recommendations of testing for lead in the structural components of childcare facilities. The guidelines for testing the structural components of a pre-1978 structure have been established by the USEPA. The "Renovate Right" pamphlet distributed by the USEPA provides language that requires "Lead Safe Work Practices" and certified lead abatement firms to be used in remodeling or renovating pre-1978 childcare facilities.

Lead in Playground Equipment

There is a possibility that lead-based paint or plastics that contain lead were used in larger pieces of anchored playground equipment. The U.S. Department of Defense (US DOD) chose to conduct a study in 2002 to determine if playground equipment in their overseas employee housing barracks contained lead hazards, these findings were delivered in a report compiled by Belfit et al. (Belfit et al, 2002). Most of these facilities were located in Europe and obtained their playground equipment from one of three companies; however one facility with playground equipment that tested positive for lead content was located in Washington D.C. (Belfit, Nix, & Graham, 2002). The Washington D.C. playground was closed after this discovery (Belfit, Nix, & Graham, 2002). The study revealed that 37% of US DOD playground equipment exceeded the $40\mu g/ft^2$

standard set by the US EPA as applied to flooring, this standard was used because of the nature of contact with these types of structures.

CPSC has set a standard of 600 ppm of lead for any product intended for the use of children under the age of twelve, the standard will be lowered to 300 ppm and then to eventually 90 ppm in the future (U.S. Consumer Product Safety Comission, 2009). The 600 ppm standard went into effect February 10, 2009 (U.S. Consumer Product Safety Comission, 2009). The existing playground equipment was installed prior to this standard, thus it is possible that these structure may contain unsafe concentrations of lead in the future. The US DOD study demonstrates the need to test pieces of playground equipment to ensure the safety of the children using them.

Conclusion

Lead regulation is a topic that is included in many different environmental regulations, policies, laws, and is monitored by numerous federal agencies. The regulations covered in this paper revolve around the premise of protecting humans, especially children. Lead in paint, drinking water, soil, and air have been concerns for at least the last 30 years and we are still trying to prevent exposures and poisonings from occurring. Researchers are now focusing on newer sources and possible locations to further prevent undue lead exposure. Even though there is a desire to rid the environment of such toxic metals, lead is constantly being re-introduced into human lives and environment in both known and unsuspecting ways. Much progress has been made in limiting daily exposures to lead through the revising of regulations and the dedication of concerned individuals. This work will be continued and refined until lead poisoning, a completely preventable problem, is an issue of the past. This highlights the need for studies focused on lead hazards in childcare facilities constructed before 1978.

CHAPTER 3

QUESTIONS, OBJECTIVES AND HYPOTHESES

Questions

- Is there a significant relationship between the age of a pre-1987 childcare facility and the concentrations of lead hazards in paint, soil, dust, and playground equipment?
- Is there a relationship between lead hazard concentrations and the mean income of households by zip code?
- Will leaded ceramic tile be more common than leaded paint in childcare centers grouped by zip code?
- Could lead be present in the soils, dust, and drinking water above set human health standards in childcare facilities in Clark County, NV?
- Is permanent (anchored) playground equipment a possible non-traditional source of lead exposure?

Objectives

- To determine if there is a correlation between lead hazard concentrations in paint, soil, dust, playground equipment and the age of the childcare facility.
- To determine if the mean income of households in a zip code can predict the lead hazard concentrations in childcare facilities.
- To determine if the most common source of potential lead exposure in a Family Care Home or Commercial Child Care facility is a non-traditional source or lead-based paint.
- To determine if water, dust, and soil are uncommon sources of lead exposure in

Clark County, NV.

- To determine if lead hazards exist in large permanently anchored pieces of playground equipment.

Hypotheses

Lead Concentrations in Older Facilities: Soil, Dust, Water, Paint, and Playground Equipment

- Pre-1978 childcare facilities will have higher concentrations of lead in paint, soil, dust, and playground equipment in older facilities than newer facilities.

Socioeconomic Status and Lead Concentrations

- The number of lead hazards in childcare facilities will be higher in zip codes with lower mean incomes.

Ceramic Tile vs. Lead-based Paint

- Leaded ceramic tile will occur with higher frequency than lead-based paint in the childcare facilities assessed for this study.

Soil, Water, and Dust Samples

- Water, dust, and soil samples collected will contain lead over the clearance standards set forth by the US EPA/HUD and the American Water Works Association (AWWA).

Playground Equipment

- Lead will be detected by XRF in permanently anchored playground equipment tested in childcare facilities.

Statistical Analyses

- Simple linear regression and correlations will be used to determine if there is a relationship between the age of a facility and concentrations of lead in each of the following; paint, soil, dust, and playground equipment found in and around the facilities.
- A Mann Whitney U-test based on ranks of the median incomes will be used to compare zip codes and median income levels of households by zip code to analyze if the median income of a household by zip code is associated with lead hazard concentrations.
- An Independent t-test will be used to compare the mean frequencies of leaded tile and lead-based paint hazards within the assessed childcare facilities.
- Descriptive statistics will be used to evaluate water, soil, and dust sample characteristics. Formal statistical tests were not possible due to the few samples exceeding clearance standards for each of the categories.
- Descriptive statistics will be used to evaluate playground equipment characteristics. A formal statistical test was not possible due to the few samples exceeding the clearance standards.

CHAPTER 4

METHODOLOGY

Selection of Childcare Facilities

The SNHD is the regulating agency in charge of ensuring a safe, clean environment for children who are cared for in a group setting such as a Family Care Home (FCH), Group Care Home (GCH), and Commercial Childcare Center (CCC) in Clark County, NV. The SNHD issues permits to all FCHs, GCHs and CCCs that hold a business license in Clark County. At this time, SNHD issues and regulates permits for over 600 childcare facilities, both pre- and post-1978 this information was compiled using the internal SNHD VAX computer program. Childcare facilities are classified based on the maximum number of children that may attend each facility. A FCH may serve up to six children at one time and typically operates out of the care givers private residence. Similarly, a GCH is permitted to care for up to twelve children at one time and; GCHs also typically operate out of the care givers private residence. For the purpose of this study FCHs and GCHs were grouped into one category as they both typically operate out of private residences. Childcare Centers are permitted to care for twelve or more children and generally operate in a commercial center, large church or school facility. However, a few CCCs were found to operate out of converted private residences. Childcare facilities on whole are prohibited from operating out of a condominium or an apartment.

In this study, childcare facilities constructed in or before 1978 were tested for lead hazards. The year 1978 is significant because that is the year that the manufacturing and sale of lead-based paint was banned.

The SNHD maintains the addresses and owner information of the permitted childcare facilities in an internal database. The age of construction of each facility can be determined by utilizing the information in the SNHD database and cross checking using the Clark County Assessor's web page (http://www.accessclarkcounty.com/depts/assessor/Pages/disclaim.aspx). At the time of the study the Las Vegas area had 94 permitted childcare facilities that were constructed in or before 1978.

An excel spreadsheet was created for all of the scheduled lead risk assessments. The spreadsheet contained information on the childcare facility name, the lead case number (SNHD-CC-XXX), address, the SNHD permit number, the Clark County parcel number, the year of construction, the delivery date of the Childcare Lead Risk Assessment Notice Letter (Appendix 1), and the date of lead risk assessment and where lead was discovered, if lead was present.

It is possible due to the natural cycles of business that new permits were added and existing ones deleted from the SNHD master list of childcare facilities during the course of this study. Accordingly, it was impossible to give a static number at the beginning of the study of the number of facilities that would have been screened. Instead all active pre-1978 childcare facilities on file at the SNHD as of January 31, 2009 were included in this project.

This study did not include the unpermitted childcare facilities in Clark County. With the downturn in the economy it is possible that there are private residences operating as family care homes or group care homes without proper health permits or business licenses. These unpermitted facilities were not included in this study as they could not be accounted for. Each childcare facility permitted by the SNHD received a letter from its respective inspector informing them of the SNHD Childcare Facility Lead Risk Assessment Program. The centers were informed lead testing was to be performed at all childcare facilities constructed in and before 1978, and that it was not a voluntary program. The Childcare Lead Risk Assessment Notice Letter also contained information on a voluntary toy risk assessment program offered by fellow graduate students at the University of Nevada, Las Vegas. Childcare inspectors focused on delivering the Childcare Lead Risk Assessment Notices to all pre-1978 childcare facilities in their assigned districts. Districts are determined by zip codes and allows for a more accurate way to track the notice deliveries. The SNHD required letters to be delivered at least two weeks prior to the phone call to schedule an appointment.

At least two weeks after the letter has been delivered, childcare facilities were contacted and appointments were scheduled by a Lead Risk Assessor with the facility operator. Morning appointments were preferred due to the lunch and nap time schedules of the children attending these facilities.

When a lead risk assessment team arrived at a facility they explained the lead risk assessment procedure to the facility operator and ask if there were any questions. An operator was either the facility's manager facility/homeowner or person in charge at the time of the inspection. The operators of the FCHs and GCHs were given the option to have their entire facility (house) screened for lead. If that offer was declined only the childcare areas (kitchen, bathrooms, outdoor play areas, and rooms that were utilized by the children) were screened as those were the only areas permitted by the SNHD. If the operator declined this offer it is noted in the final report. Once all questions were answered the lead risk assessment began.

The socioeconomic status of a zip code was determined by accessing a web based data base, American Fact Finder, which provides that information (http://factfinder.census.gov/home/saff/main.html?_lang=en). The median household income data for zip code 89005 was obtained from www.realestate.com. The collected information was used to determine low and higher socioeconomic areas.

Lead Risk Assessment Procedures

X-Ray Florescence

The lead risk assessment was conducted using one of two Niton XLp 300A series X-Ray Florescence (XRF) analyzers in accordance with US EPA/HUD guidelines (U.S. Department of Housing and Urban development, 1996, http://www.hud.gov/offices/lead/lbp/hudguidelines/index.cfm). ^{109}Cadmium is the radioactive isotope source that allows the detection of lead in many different substrates at varying depths (United States Department of Forestry and Agriculture, 2008, http://www.fs.fed.us/t-d/pubs/htmlpubs/htm08732310/). The XRF operates by emitting gamma rays onto a surface exciting the lead present causing it to emit energy or x-rays (Figure 1).

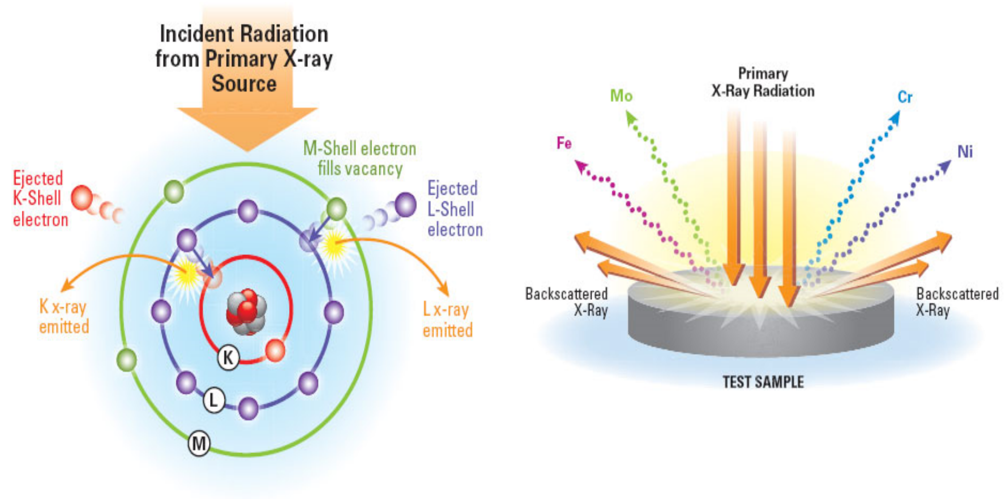


Figure 1. X-Ray Fluorescence
Source: (Thermo Scientific-Niton UK, 2003)

These x-rays are then measured and the amount of lead in an object is reported. Due to the radioactive source contained within the analyzer, a ring dosimeter was worn by the Lead Risk Assessor during this study while operating the XRF to ensure their safety. This ring was submitted to a laboratory (Radiation Detection Company, Gilroy, CA, 95020) on a quarterly basis to determine if the risk assessor was exposed to radiation from the XRF instrument.

The XRF is an instrument that is easy to operate, to take a paint reading the operator of the instrument would enter information in the instrument via the touch screen located at the top of the instrument. This information includes but is not limited to the substrate, color, condition, component of the item to be tested. The XRF is pressed up against the surface to be tested until the proximity button is depressed. Once depressed the trigger is pulled and the XRF releases a controlled radioactive beam to the substrate. The radioactive beam excites electrons causing electrons to be ejected from their shells and to be replaced by electrons in the outer shells. This causes an x-ray to be emitted and read by the instrument. The instrument then produces a reading within twenty seconds based on the emitted x-ray's signature.

Before the lead risk assessment began the XRF must have passed a calibration check using an XRF Performance Characteristic Sheet. The XRF must read a 1.0 mg/cm^2 lead paint standard three times to determine if the instrument is operating within the predetermined range of 0.8 mg/cm^2 and 1.2 mg/cm^2 in accordance with US EPA/HUD protocol. These calibration results were recorded on the XRF calibration sheet (Appendix 2). This process was performed and recorded at the beginning, end, and at every four hour interval of each risk assessment. The readings reported by the XRF, during the risk assessment, were recorded on a XRF readings sheet (Appendix 3). A diagram of the facility was drawn at the beginning of each risk assessment with the rooms that were not accessed labeled "No Access" (Appendix 4).

The exterior and interior painted surfaces and structural components were analyzed using the Niton XLp 300A series XRF (Niton ThermoFisher Scientific, Billerica, MA). Other components and structures were tested in each facility these included but were not limited to: mini-blinds, window frames, ceramic tile, painted bookcases, and anchored playground equipment. Items recording a positive value were photographed and photos were included in the final report.

<u>Soil Samples</u>

Soil sample composites were collected in accordance with US EPA/HUD guidelines using either the straight line drip line or X formation composite technique, this was at the risk assessor's discretion, and was dependent of the area of bare soil and location. The materials used for soil sampling are as follows: disposable gloves, non-sterilized polyethylene 50ml sample tubes and a soil corer. The location (i.e., drip line, front yard, or backyard), date, and case number were recorded on the sample tube soil data sheet (Appendix 5). Soil samples were collected from bare soil areas at a depth of ½ inch. The soil corer was inserted into the ground at a depth of ½ inch the corer was tilted and then withdrawn with the soil sample inside. The collected soil was then inserted into the plastic sample vial. This was repeated for the pre-established soil locations. Soil samples were collected from all facilities in the study, unless there were no bare soil areas present at the time of the assessment. The lack of bare soil areas were noted in the final report. Soil samples may also have been collected from sand box areas if they were present. These samples were sent to a National Lead Laboratory Accreditation Program (NLLAP)-accredited laboratory to be analyzed using Graphite Furnace Atomic Absorption Spectroscopy (GFAAS) or Inductively Coupled Plasma Mass Spectrometer (ICP/MS). These samples did not require refrigeration therefore they remained in the vials in a plastic bag with the case number labeled on the bag. The samples were stored in a cubicle until several sets of samples were collected and then were sent off to the laboratory. The longest hold time was about two weeks between sample collection and the time the samples were mailed.

Water Samples

Water samples were collected at all childcare facilities that were screened for this program except one. The facility operator or an employee of that facility was responsible for collecting the water sample. An AWWA water sample collection direction sheet (Appendix 6, AWWA/EPA, 1992) was provided to the facility and the directions were explained by the SNHD staff at the time of the inspection. The direction sheet also contained areas to record a signature, time and date of last water use, and the time and date of the water collection. The directions stated that water must be undisturbed in the pipes for 6-8 hours. Therefore the first draw of cold water from any tap in the facility was used. A one liter plastic sample bottle was provided to the facility by the SNHD for the sample collection. The water sample collection form (Appendix 7) and direction sheet was retrieved by SNHD personnel at a time and date agreed upon by SNHD staff and the childcare facility operator. Each water sample was sent to a NLLAP- accredited laboratory for analysis using a GFAAS. These samples did not require refrigeration therefore they remained in the one liter containers with the case number labeled on the bottle. The samples were stored in a cubicle until several sets of samples were collected and then were sent off to the laboratory. The longest hold time was about two weeks between sample collection and the time the samples were mailed.

Dust Wipes

Dust wipes were collected using US HUD/EPA and American Society for Testing and Materials (ASTM) (ASTM E 1728) dust technician standards for collecting dust samples (ASTM International, 2003). The materials used for sampling were disposable gloves, non-sterilized polyethylene 50ml sample tubes, Ghost Wipes (Environmental Express, Mt. Pleasant, South Carolina), masking tape, measuring tape, permanent black marker, trash bag, chain of custody form, collection bag for samples, pre-formed plastic templates measuring $0.5ft^2$ for floors and $0.25ft^2$ for window sills (BTS Laboratories, Richmond Virginia). Masking tape and measuring tape were used to mark off areas that were too small to accommodate the dust templates.

The non-sterilized polyethylene 50ml sample tubes, dust collection (Appendix 8) sheet and the Chain of Custody form had the following information recorded: date, case number, location sampled (room and windowsill or floor), and the dimensions of sample area. The collection bag also had the case number and date recorded in permanent marker.

An USEPA Certified Lead Risk Assessor began by labeling the sample tube and chain of chain of custody with the required information. The templates were used to determine and mark the area to be tested. Using disposable gloves the Risk Assessor made three passes with a dust wipe in the marked area. An S-shaped technique was used wiping the area from top to bottom then from side to side. The wipe was folded in half after each pass. Finally, the inside perimeter of the template was wiped. The wipe was folded once again and placed in the appropriately labeled sample tube. A blank dust wipe was taken from each facility for quality assurance purposes. A blank is a quality assurance wipe to determine if there are background lead levels in the air of the area being tested. The blank wipe was removed from the packaging, unfolded and waived in the air for approximately five seconds. The blank wipe was then folded as the rest of the dust wipes were folded and put into an individually labeled sample tube.

A minimum of two dust wipes were collected from the entryway and play area of each facility, these samples were from floors and window sills and other areas throughout the facility. Additional dust samples were collected based on positive XRF readings and at the discretion of the Risk Assessor. These samples were sent to a NLLAP accredited laboratory to be analyzed using (GFAAS) or (ICP/MS). These samples did not require refrigeration therefore they remained in the vials in a plastic bag with the case number labeled on the bag. The samples were stored in a cubicle until several sets of samples were collected and then were sent off to the laboratory. The longest hold time was about two weeks between sample collection and the time the samples were mailed.

Playground Equipment

Large pieces of anchored play ground equipment were tested using the XRF. When piece of equipment revealed lead content above the 1.0 mg/cm^2 standard for paint as determined by the XRF, a dust sample was collected from that area. The dust sample was then submitted to a NLLAP- accredited laboratory for analysis. These samples did not require refrigeration therefore they remained in the vials in a plastic bag with the case number labeled on the bag. The samples were stored in a cubicle until several sets of samples were collected and then were sent off to the laboratory. The longest hold time was about two weeks between sample collection and the time the samples were mailed. The standard of $40ug/ft^2$ for floors, set by the US EPA/HUD was used to determine if the piece of equipment were considered positive for this study.

The USEPA and HUD have set standards for lead in dust, soil, and water (Table 1). The clearance standards for dust vary for floors, window sills, and window troughs. This study used the standards for floors and window sills because widow troughs are difficult to test as the window units used in Las Vegas vary from the traditional windows with large troughs used in the Midwest and on the East Coast and instead are narrow and traditionally made of vinyl or metal not wood.

Table 1. Lead clearance standards set by the USEPA and HUD

Lead Environmental Investigation Standards	
Assessment Type	**Standards**
Visual Paint Inspection Criteria	• Intact = No damage • Fair = 2 ft^2 damage • Poor = 10 ft^2 damage
Sample Type	**Standards**
XRF Analysis and Paint Chip Samples	• 1 mg/cm^2 • Wet Weight = 600 ug/g or 600 ppm or 0.06% • Dry Weight = 5000 ug/g or 5000 ppm or 0.05%
Dust Samples	• 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 Samples	• Bare Play Area = 400 ppm • Bare Soil in Non-Play Areas = 1,200 ppm • Abatement Required = 5,000 ppm
Water Samples	• 15 ug/L or 15 ppb or 0.015 mg/L
Lead levels at or above these standards are considered unacceptable by the United States Environmental Protection Agency (EPA) and the Department of Housing and Urban Development (HUD).	

Source: (US EPA/HUD, 2001)

Risk Assessment Report

A final report was provided to the childcare centers participating in this study once all the data from samples submitted to the laboratory were received by the SNHD. The report explained the condition of the components tested and if they were an imminent lead risk hazard. This report also detailed the lead hazards found on the premises and furnished required course of action on how to remediate, contain or abate the lead hazards that were present.

Data Analysis

SPSS version 17.0 for Windows® was used to perform the statistical analyses for this project. Those analyses included the Mann-Whitney U Test, Pearson's Correlation, Linear Regression, a one way ANOVA, descriptive analyses, and an Independent T-test between two groups.

Quality Control Measures

Quality control measures were used for both the collection of XRF data and in the collection of dust samples.

A blank dust sample was submitted with each batch of samples collected from a facility. These blanks were submitted to capture the background lead dust concentrations in the air to ensure that the samples were not contaminated by using improper dust wipes or contaminated gloves. The laboratory utilized for this project followed in house quality assurance and control procedures that have been previously approved by NLLAP.

CHAPTER 5

RESULTS

A lead risk assessment was completed on a total of 94 childcare facilities during the course of this study. This included the entire population of pre-1979 childcare facilities that held active permits with the SNHD at the time of the study. In 2002, Jacobs et al. evaluated post-1978 housing for the first time to determine if there were lead-based paint hazards due to the use of lead-based paint reserves after the ban went into effect (Jacobs et al., 2002). For this reason all facilities constructed up until 1979 were also included in this study.

A total of 11465 XRF readings, 91 soil samples, 93 water samples, and 424 dust samples were collected as part of this study. All quality control XRF readings and laboratory quality control results were excluded from the reported data and were not used for analysis purposes. These data were not included in the data analyzed as they were quality control readings that did not contribute to the hypotheses being tested. They were data used to ensure that the instruments were working properly and that the sampling techniques used were not contaminating the samples. This included XRF calibration readings completed at the beginning and end of each facility that was tested, and blank samples for dust. XRF readings collected from non-structural items (i.e. garden hoses, garden pots) were excluded as the focus of this study was structural components not non-structural items. These types of items were not consistently tested therefore they were excluded from the reported data.

It should be mentioned that at the time of the study two childcare facilities were listed on the Clark County Assessor's website as being constructed pre-1978. However, at the time of the inspections the operators informed the risk assessors of certain events that may changed the construction date. The first operator reported that the facility had a fire and was rebuilt post-1978; and the second operator reported that the facility had been demolished and rebuilt post-1978. Although the inspectors were informed of these events the risk assessments were performed based on the information provided by the Clark County Assessor's website. These facilities were included in the data for this study because the risk assessors were not able to verify the events that were reported to have transpired. The Clark County Assessor's records are the official records for those parcels therefore the risk assessments were conducted and included in this study.

A total of 41Family Care Homes, 4 Group Care Homes, and 49 Commercial Childcare Facilities were assessed in this study. Figure 2 illustrates the profile of the childcare facilities by frequency of the year of construction.

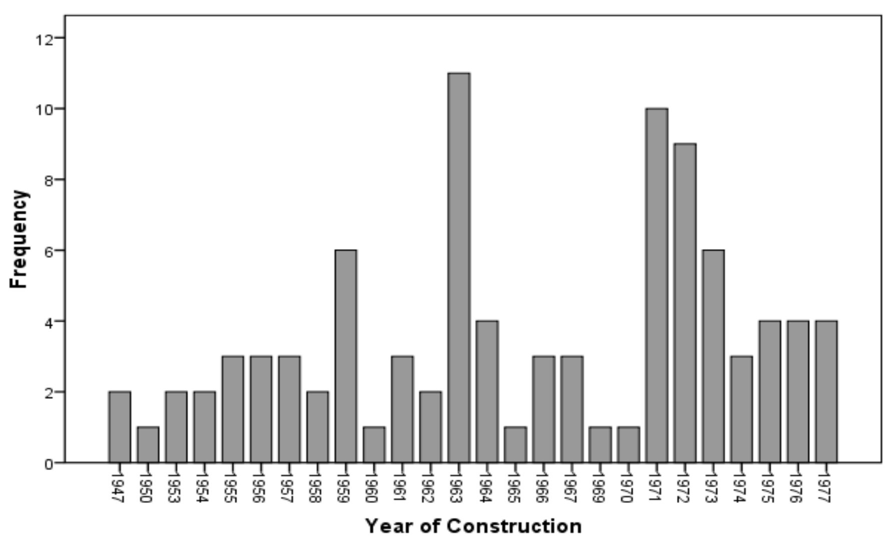


Figure 2. Frequency of Facilities per Year of Construction

Hypothesis I: Lead Hazard Concentrations Related to Age of Facility

Paint

The data were analyzed to challenge Hypothesis I and determine if there was a relationship between the mean lead concentrations in paint, soil, water, dust, and playground vs. the age of the facility. The means values for paints, soils, water, dusts and playground equipment were calculated per facility and were used in the Correlation and Simple Linear Regression analyses. This data was also used to determine if a facility's age could predict the lead concentrations in paints, soils, water, dusts and playground equipment for the childcare facilities tested.

A total of 194/9076 (2.1%) XRF paint readings were positive for lead-based paint. The total number (9076) of paint readings includes some required repeat readings; however the total for positive readings (194) did not include repeat readings. Repeat readings were excluded because they were duplicate readings used to determine if the XRF was functioning properly. A positive reading for lead-based paint on the XRF is defined as a result < 1.0 mg/cm^2. Quality control readings were excluded from this analysis; this included all calibration, repeat and null readings. These readings were excluded as they were for quality assurance and quality control and were not recording data to be counted in the analyses as they were not collecting data that was for use in this study. Values were determined to be paint readings by reviewing the substrate, component, color and notes that were recorded on the Excel spreadsheets and field forms. Both a Pearson's Correlation and a Linear Regression were executed using the mean of all positive paint values per facility and then grouped by year of construction. A Pearson's correlation was used and resulted in the following correlation coefficient, r =

0.004 which indicated no association between the year of construction and the mean lead concentrations in paint.

The Simple Linear Regression was conducted to explore the impact of a facility's age on the mean lead concentrations in paint. The Simple Linear Regression produced and a coefficient of determination of $R^2 = 0.000016$, $F = 0.000$ and $p = 0.983$ which indicated that this result was not a statistically significant and that a facility's age is not predictive of the lead concentrations in paint.

<u>Soil</u>

Soil samples were collected from each facility that had bare soil present; this resulted in a total of 91 soil samples being collected from 64 facilities. The range in the number of soil samples collected from the facilities was zero to eight samples. The number of soils was based upon the risk assessor's discretion. The number of soil samples depended upon the number of playgrounds or bare soil areas present. The soil values below the limit of detection (7 ppm) were adjusted to half of the limit of the detection value (3.5 ppm). Once these results were adjusted they were then added together and the mean was taken to represent the soil result for each individual facility. Both a Pearson's Correlation and a Linear Regression were performed using the mean soil results per facility and the year of construction for the facility. Then mean lead in soil result was 22.91 ppm with a standard deviation (SD) of $SD = 24.87$, $N = 64$. The Pearson's Correlation resulted in a correlation coefficient of $r = -0.078$ which indicates no association between the age of a facility and the mean lead concentration in soil. The Simple Linear Regression analysis produced a coefficient of determination of $R^2 = 0.006084$, $F = 0.384$, and a $p = 0.538$. This analysis produced a result that was not statistically significant and that the age of the facility is not a predictor of the lead concentration in soil.

Water

A water sample was collected from each of the 94 facilities except for one facility due to that facility's construction history. That facility's original structure had been demolished and rebuilt in the 2000s. The water results reporting below the limit of detection (< 5 ppb) were adjusted by using half of the of the detection limit value (2.5 ppb). Of the 93 facilities included in the study only five (5.3%) facilities had a detectable concentration of lead in the water ranging from 6 ppb to 11 ppb. Both a Linear Regression and Pearson's Correlation analysis was performed and produced the following results a mean of 2.83 ppb, SD = 1.441, N = 93. The Pearson's correlation yielded a correlation coefficient of r = -0.181 which indicates a small negative inverse relationship. The Simple Linear Regression produced a coefficient of determination of $R^2 = 0.033$, $F = 3.069$, $p = 0.083$. This analysis did not produce a statistically significant result however the result was approaching statistical significance.

Dust

A total of 424 dust samples were collected from the childcare facilities, 323 (76%) of these samples were collected from interior floors and 101 (24%) samples were collected from window sills. The range of the number of samples collected per facility was two to eighteen samples. As per the study design, at least two dust samples were collected from each facility. However, a set maximum number samples to be collected was not established as each facility differed in square footage and in the number of lead hazards present. This created the need to collect a varying number of samples per facility.

A Linear Regression and a Pearson's Correlation were performed using the mean of the total number of dust results, both interior floors and windowsills, against the year of construction per the facility. The dust results that were reported as below the limit of detection which was < 20 ug/ft^2 for floors, < 40 ug/ft^2 for window sills were adjusted to half of the detection limit of 10 ug/ft^2, 20 ug/ft^2 respectively. The results of the analyses performed are as follows a mean = 19.51 ug/ft^2, with a SD = 33.35, N = 94. The Pearson's correlation coefficient was r = -0.155 which indicates a small negative inverse relationship. The Simple Linear Regression produced a coefficient of determination of R^2 = 0.024, F = 2.27, p = 0.135. This result was not statistically significant and determines that a facility's age is not a predictor of the lead concentrations in dust.

Playground Equipment

A total of 98 pieces of playground equipment were tested in 50 childcare centers with an XRF using the lead-based paint positive standard of > 1 mg/cm^2. The level of detection is considered to be 1 mg/cm^2, anything below that value is considered to be below the threshold (Thermo Scientific, 2004, http://www.niton.com/portable-XRF-technology/literature.aspx?CntCatID=1aaa963a-8253-4fce-ac96-fde2c7fe4b59&sflang=en). There were a total of 394 playground equipment XRF readings collected and of those readings 23 (0.05%) readings were positive reporting a range of 1.0 mg/cm^2 to 7.7 mg/cm^2. Of the 98 individual pieces of playground equipment tested a total of 7 (2%) individual pieces of playground equipment were found to contain lead concentrations >1mg/cm^2. The substrates of these structures were classified as metal or plastics components. Of which 30.4% of the positive readings were from painted metal and 69.6% of the positive readings were from plastics.

A Linear Regression and a Pearson's Correlation were performed using the mean of the total number of playground equipment results against the year of construction for the facilities. The descriptive analyses produced the following results a mean of 2.05, SD = 1.51, p = 0.101. The Pearson's correlation coefficient was r = -0.276 which indicates a small negative relationship. The Simple Linear Regression produced a coefficient of determination of $R^2 = 0.076$, F = 0.1731, p = 0.202. This result was not statistically significant and illustrates that a facility's age is not a predictor of lead concentrations in playground equipment.

Hypothesis II: Number of Lead Hazards and Socioeconomic Status

All median income levels of households per zip code data were obtained from American Fact Finder an online tool provided by the U.S. Census Bureau (http://factfinder.census.gov/home/saff/main.html?_lang=en) except for one. This site provided median income levels for Clark County, Nevada for 2007. The U.S. Census Bureau did not have information available for zip code 89105. Therefore, these data were obtained from www.realestate.aol.com.

A Mann-Whitney U Test was used to determine if there was a difference in the continuous measure of number of lead hazards between two independent groups (i.e., high and low income groups) based in median household incomes per zip code. None of the zip codes had median household income below the poverty level of $22,025 for a family of four, in 2008 (U.S. Census Bureau, 2009). Therefore, the zip codes were classified into low (<$50,000) and high (>$50,000) income groups, $50,000 was the median for the income groups. The total number of lead hazards per zip code was calculated by combining all paint, tile, dust, water and soil found during the study.

This analysis revealed that there was no statistically significant difference in the number of lead hazards between low and high income zip codes. The analysis produced a z value of -1.769, U = 48.5, p = 0.077 with a range zero hazards per zip code to 35 hazards per zip code. The mean number of hazards per zip code was 12.85 with a SD=15.558. Table 2 lists the number of hazards, median incomes, and facilities per zip code.

Table 2. Number of facilities, hazards, and household median incomes per zip code.

Zip Code	Number Of Facilities per Zip Code	Total Number of Hazards	Median Household Income 2007
89005	2	4	62,523
89029	1	1	45,557
89030	6	9	39,964
89101	3	2	28,574
89102	8	30	40,302
89103	3	6	45,580
89104	8	29	42,248
89105	1	8	50,032
89106	9	35	35,187
89107	10	17	49,886
89108	4	20	54,524
89109	5	9	33,832
89110	1	1	53,128
89115	2	3	38,693
89117	1	0	64,554
89119	1	7	39,160
89120	4	5	63,460
89121	8	16	50,007
89122	2	0	43,761
89130	1	0	74,166
89131	1	4	76,201
89145	4	4	67,001
89146	6	3	55,283
89147	3	7	60,062

Source: U.S. Census Bureau - Nevada Median Income 2007 (http://factfinder.census.gov)

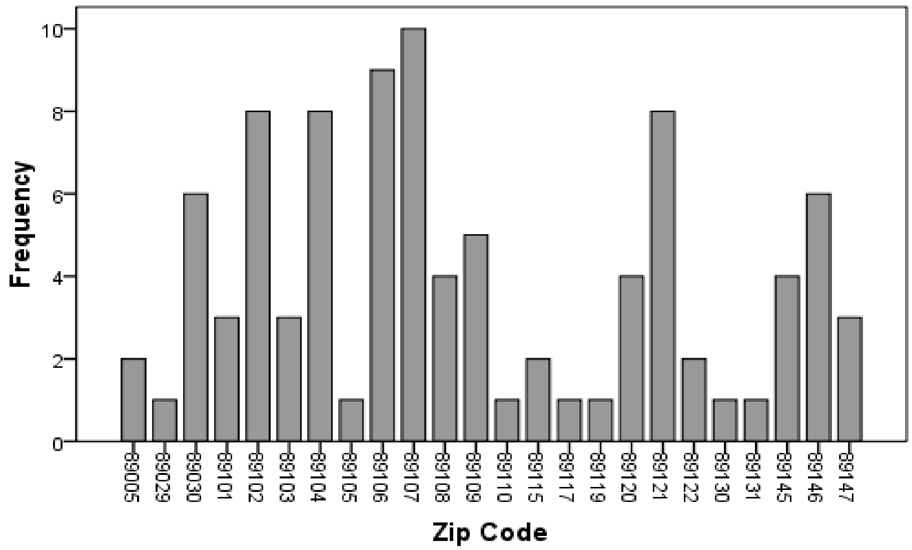


Figure 3. Frequency of childcare facilities tested by zip code.

Hypothesis III: Comparison of Mean tile Hazards to Mean Lead-based Paint Hazards

Comparison of the mean lead tile vs. lead-based paint was compared within the childcare facilities. An Independent T- test was used to compare the paint hazard mean to the tile hazard mean for all of the child care facilities that were assessed in this study.

Paint hazards were compiled on a room by room basis by classifying the substrate and then component and color. For example: If painted wooden window frames were positive in every room of the house (4 rooms) they were considered as one hazard per room. The same classification was used for tile, if tile was found on the floor in the bathroom and that tile was repeated on the kitchen floor because they were in two separate rooms representing one hazard each.

This test revealed a mean of 0.894, SD = 2.36 for paint hazards and a mean of 1.255 of and SD = 2.14 for tile hazards (n=94). Levene's Test for Equality of Variance was used to determine if the assumption of equal variances had been violated due to the small sample size. Levene's test checks that the variability of scores is similar for both groups tested. The result of Levene's test was not significant therefore it was not violated and equal variances were assumed, $T = -1.101$, $p = 0.272$. The results indicate that there is no statistically significant difference between the mean hazards for leaded paint and leaded tile.

Descriptive Statistics

Formal inferential statistical tests were not possible due to the limited number of samples exceeding clearance standards; therefore this section will present only the descriptive statistics for the variables in this section.

Soil

Originally comparing the different variables between FCHs and CCC was proposed. However these variables were not analyzed as the results for soil and water often did not exceed established standards. Although there were a few dust samples that exceeded set standards, there were fewer than the required number in order to make a statistical analysis possible.

A total of 91soil samples from 64 childcare facilities were collected from childcares that had bare soil present on the property. None of the samples collected exceeded the USEPs hazard standard of 400 ppm lead in soil for child play areas. This standard was used as it is the lowest standard established for soils.

Even though there were no lead exceedences over the set hazard standards for soil, some facilities were found to have elevated lead soil concentrations. The mean lead concentration for the 91 soil samples collected was 35.89 ppm, SD = 40.77, Range = below the LOD (<7) – 160 ppm. A total of 12 (12.7%) childcare facilities had elevated soil lead concentrations (≥ 40 ppm) but none exceeded the hazard standard (400 ppm) for lead in child play areas (Figure 4).

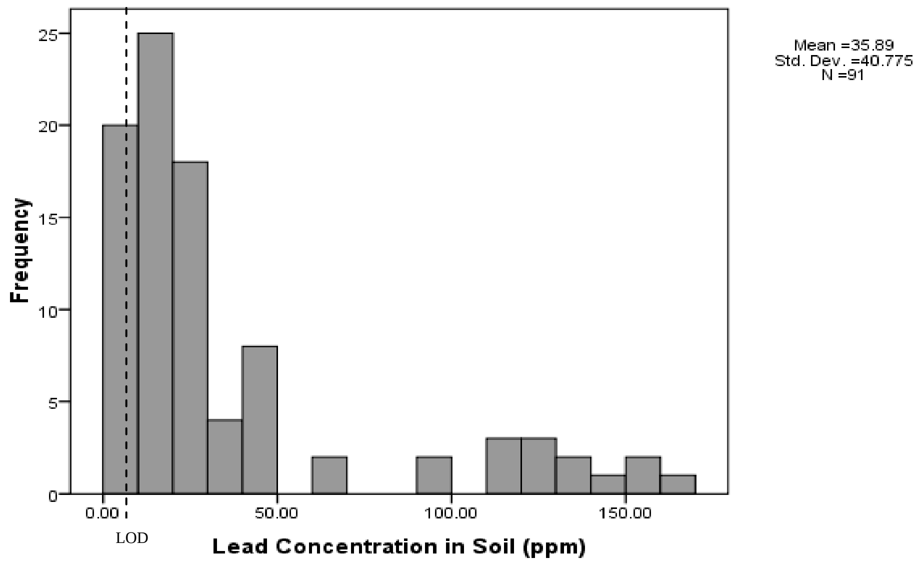


Figure 4. Lead concentrations (ppm) in soil from Clark County Nevada licensed childcare facilities.

Water

A total of 93 water samples were collected over the duration of this study. One facility did not have a water sample collected as it was remodeled in early 2000. None of the drinking water samples collected exceeded the USEPA Action Limit of 15 ppb lead in water, as established by the National Primary Drinking Water Standards.

Samples that read below the limit of detection of 5 ppb were adjusted to 2.5 ppb. Figure 5 shows a minimum concentration of 2.5 ppb lead, but actually 2.5 ppb is below the detection limit. The concentration of lead found in water had a range of below the detection limit (<5 ppb) to 11 ppb.

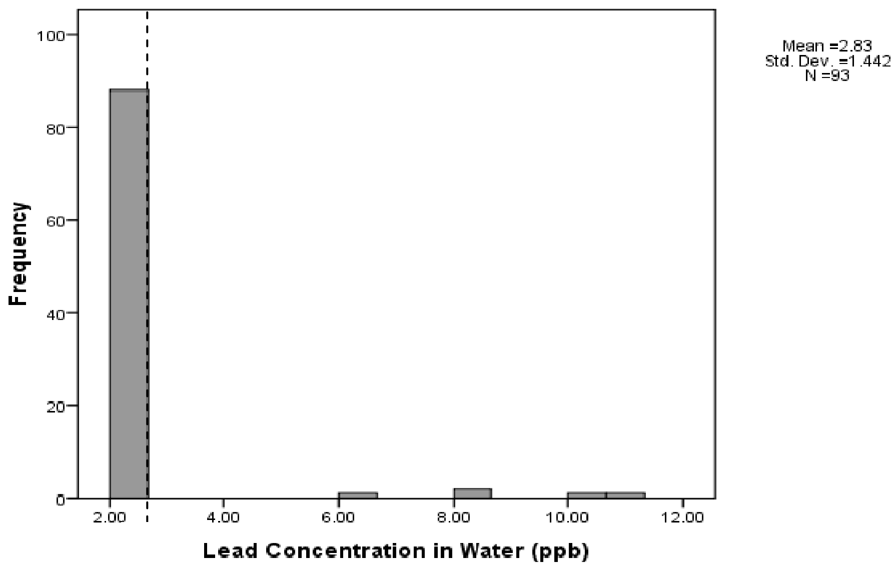


Figure 5. Lead concentrations in water (ppb) collected from Clark County, Nevada licensed childcare facilities.

Dust: Floors and Windowsills

A total of 424 dust samples were collected in this study, of those 323 (76%) were dust collected from the floor and 101 (24%) were collected from windowsills. The dust samples that read below the limit of detection (LOD for floors 20 µg/ft^2, LOD for windowsills 40 µg/ft^2) were adjusted to half of the level of detection (10µg/ft^2) for the floors and (20 µg/ft^2) for the window sills.

Eleven (3.4%) floor dust samples were over the clearance standard of 40µg/ft^2 for interior floors; and only 2 (1.9%) of the samples from the window sills exceeded the clearance standard of 250 µg/ft^2 for window sills (Figure 6). The range of positive lead concentrations results for the interior floor samples was 40µg/ft^2 to 1200 µg/ft^2 with a mean of 15.33, SD = 66.76.

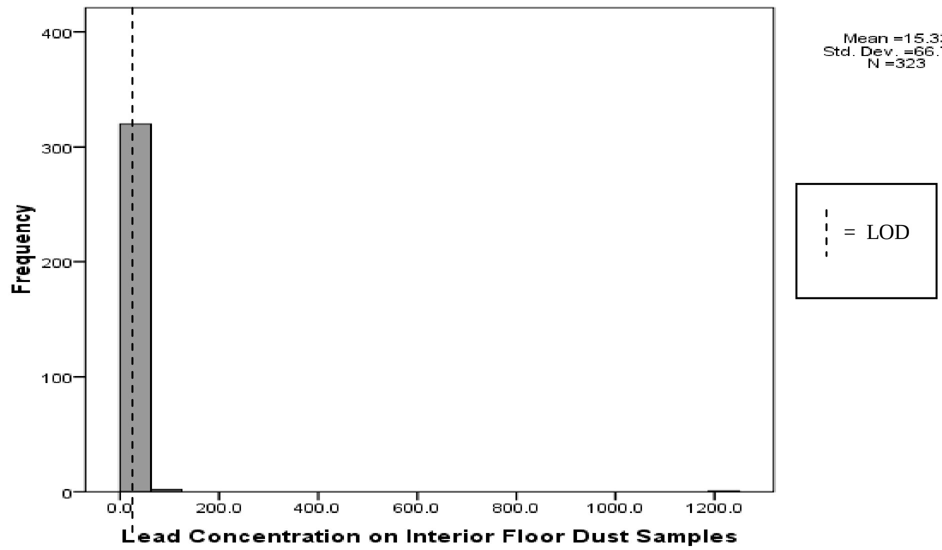


Figure 6. Lead concentration in floor dust (ug/ft^2)from Clark County, Nevada licensed childcare facilities.

The two samples were collected from areas other than windowsills, but were included in the window sill analyses for two reasons: these samples were 1) collected using the window sill template (0.25 ft^2), and 2) collected from areas that were comparable in height to a window sill. The range of the lead concentration in dust samples from window sills was below LOD to 740 µg/ft^2, and had a mean of 42.48 µg/ft^2, SD = 96.32, N = 101.

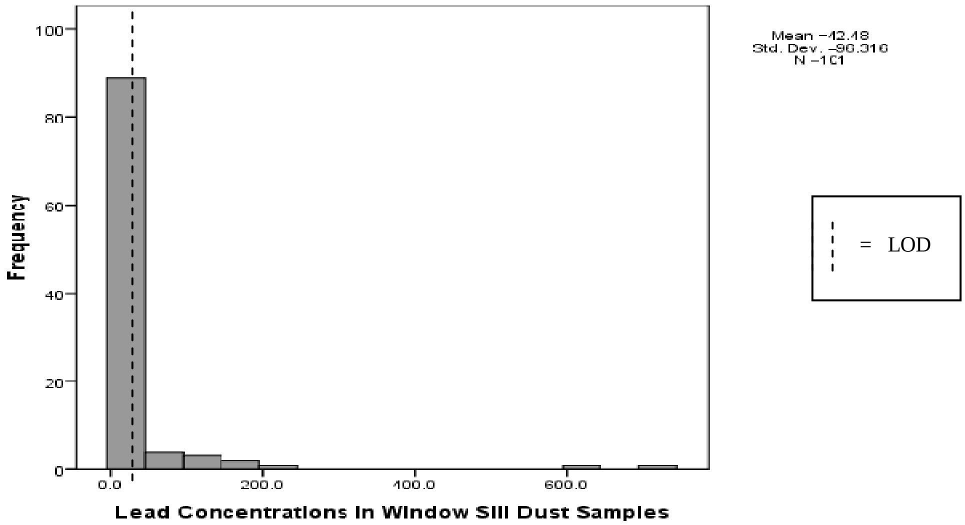


Figure 7. Lead concentrations in window sill dust (ug/ft^2) collected from Clark County, Nevada childcare facilities.

<u>Playground Equipment</u>

A formal inferential statistical test was not possible due to the limited number of samples exceeding clearance standards. Therefore, the descriptive statistics for the playground equipment tested are presented.

A total of 50 childcare facilities had playground equipment that was tested for lead content using XRF techniques. Of the 50 facilities, a total of 98 individual pieces of playground equipment were tested which resulted in 394 XRF readings. Of the 98 pieces of playground equipment tested a total 7 (7%) pieces of playground equipment were found to contain lead concentrations > 1 mg/cm^2 when tested with the XRF data not shown. The substrates of these structures were categorized as metal or plastics of which 30.4% of positive readings were painted metal and 69.6% were plastic. The range of these lead concentrations was from 1.0 mg/cm^2 to 7.7 mg/cm^2 with a mean of 2.02 mg/cm^2.

Not all pieces of playground equipment found to contain lead were evaluated with a dust wipe sample to confirm if lead was bioavailable via dust from the equipment. The dust samples that were collected from playground equipment were included in the dust analysis.

CHAPTER 6

DISCUSSION AND CONCLUSIONS

Lead Hazard Concentrations Related to Facility Age

Of the 94 facilities assessed for this study 30 (31.9%) contained lead-based paint, 41 (43.6%) contained leaded tile, 9 (9.5%) had dust exceeding USEPA clearance standards, and 7 (7.4%) facilities had positive playground equipment using the paint standard of > 1.0 mg/cm^2. None of the facilities contained lead concentrations in soil over hazard standards or had lead concentrations exceeding the Action Limit set for lead in water.

There are many factors that contribute to the presence of lead hazards. Studies have shown a direct correlation between age of facility, socioeconomic status, to an increase in the number of lead hazards (Jacobs et al., 2002; Levin et al., 2008). This study was unable to duplicate those results.

Past research shows a strong correlation between the age of a structure and the likelihood that lead-based paint hazards exist (Jacobs, Clickner, Zhou, Viet, Marker, Rogers 2002; Levin et al., 2008). This study was unable to establish a relationship between the age of a childcare facility and the lead concentrations in paint, soils water and dust. The study results also left researchers unable to use the age of a childcare facility to predict lead concentrations in paint, soils water and dust for Clark County.

It should be noted that the Simple Linear Regression conducted for lead concentrations in water was approaching statistical significance for lead concentrations in water as a result of a facility's age. This result suggests that the age of the facility may predict the concentration of lead in the water and could be determined if a larger sample size was used.

Most lead hazards occur due to the natural process of aging of paints and substrates. However, poor maintenance practices also play a role. If paints and substrates are not properly maintained, over time they can result in deteriorating paint that can lead to elevated lead concentrations in surrounding dust and soils. If there is an absence of lead-based paint it expected that the lead concentrations in soil would be similar to national background lead soil concentrations of < 10 ppm to 30 ppm (ATSDR, 2007).

One specific, and unique, potential problem was discovered in conducting this study. This discovery was that artists' paints were used in several childcare facility murals. This would not be so interesting if artist's paints were included in the lead-based paint ban, however they were not. These murals were a popular decoration in childcare centers assessed in this study. Most of the centers used commercial paints to create these features. However, some of the positive lead-based paints identified during risk assessments were artists' paints. Artists' paints are exempt from the lead ban in paints and contain higher concentrations of lead than commercial paints (16 CFR 1303.3, Current as of March 23, 2010). SNHD recommends that childcare facilities ensure that the paint they use is of commercial grade that adheres to the standard set for lead in paints (600 ppm) (16 CFR 1303.3, Current as of March 23, 2010).

Lead Hazards and Socioeconomic Status

The median income information for this study was obtained by accessing data from the U.S. Census Bureau, American Fact Finder web site. The median income range for this study was estimated at $28,574 to $76,201 which was above the weighted average threshold poverty level of $22,025 for a family of four, in 2008 (U.S. Census Bureau, 2009). Research has shown that most lead poisonings occur in areas that economically challenged (McLoyd, 1998). This usually is a result of not having the financial means to maintain the integrity of substrates and lead-based paint, or other factors like living in close proximity to industrial facilities (Massey, 1994; Crooks, 1995; McLoyd, 1998). Although this information traditionally only includes residential structures, this information is pertinent to this study as at least 48% of the facilities studied were childcare centers operating out of residential structures.

The Mann - Whitney U Test revealed a result that was approaching statistically significant difference in the number of lead hazards for each zip code (n= 26) ranked as households with high income (> $50,000) compared to those ranked as low income (<$50,000). It would be beneficial to expand this study to determine if a larger sample size may produce a statistically significant result for the Mann- Whitney U Test result. As of 2008 there were a total of 74 zip codes in Clark County of which 26 zip codes had pre-1978 childcare facilities that were assessed for this study (Clark County Department of Comprehensive Planning, 2008).

An important factor to take into consideration is that of the children and their socioeconomic status in this study. It is highly possible that the children that attend these childcare centers are doing so in a zip code other than the one in which they reside. Their parents may decide to send them to a facility that is close their office, on the way home, near a relative, or down the street from their residence. Another variable to take into consideration is that most people who choose to send their children to a childcare facility are able to afford to do so. Therefore, they are not necessarily associated with the median household income of that zip code, and in fact may be from a higher socioeconomic class than others in that zip code. It is most likely that the unpermitted childcare facilities cater to the families that reside in that specific zip code. However this was not evaluated in this study. This could be due to the lack of transportation and lower childcare fees than permitted facilities. The unpermitted childcare facilities are not held to the same safety or health regulations because they are under the radar and unknown to the regulating agencies.

Leaded Tile Hazards vs. Lead-based Paint Hazards

The Independent T-test conducted for this analysis, showed that there is not a significant difference between the mean lead paint hazards and lead tile in the population of childcare centers that were assessed. The analysis revealed that 30 (31%) of the facilities had lead based paint while 41(44%) had leaded tile.

It was hypothesized and supported that leaded tile would be more prevalent than lead-based paint as a result limited regulations for the tile industry. The tile industry uses lead in their products without any guidelines or restrictions controlling lead concentrations. Intact leaded tile does not present an immediate lead hazard; but when tile is removed during renovation leaded dust may be produced creating such a hazard. At this time, research does not exist either to confirm or deny that leaded tile is an actual source of exposure, unlike paint. Although, guidelines and rules for remodeling and renovating residential structures with lead-based paint exist, they do not exist for work with leaded tile. In conducting EBLL investigations with the SNHD, it has become apparent that leaded tile may be present in homes built well after 1978. The tile’s country of origin and age do not appear to be factors in the tile's lead concentrations. Therefore, the post-1978 childcare facilities in Clark County, NV may be unaware that they have potential lead hazards in the form of tile.

This is an opportunity to educate these post- 1978 childcare facilities about "Lead Safe Work Practices" to prevent undo lead exposure if the removal of leaded-tile is found to be hazardous to health. Leaded tile may have been under-represented due to the assessment team's limited access to the majority of the childcare facilities operating out of private residences. It is possible that tile existed in the other areas of the residence and could have contributed to this body of data. There may have been more leaded tile in the areas of the home that were not assessed, most likely in extra bathrooms.

Should a facility decide to remove leaded tile it is recommended that they do so using Lead Safe Work Practices during times when children are not present. A clearance test should be conducted and results must report below set standards for lead in dust prior to allowing children to return. This simple inexpensive test could prevent unnecessary exposure to the children that are cared for in the facility.

Soil, Water, Dust

Soil

Fortunately, lead concentrations in the soil do not seem to be a major route of exposure in Clark County, Nevada. Most of the soils collected correlated with the national background lead levels of <10 ppm to 30ppm (Agency for Toxic Substances and Disease Registry, 2007). The factors that may have contributed to this phenomenon are the lack of structures that had used lead-based paint and the lack of lead industries within the urban areas of Clark County. Although, lead mines do exist in Clark County Nevada they are not in the vicinity of the urban areas where the majority of the childcare facilities are located. Clark County is not host to lead smelters which have been known to cause lead contamination in soils around the country.

Second, because the housing stock is mainly post-1978 it is possible that leaded paint may not have been widely used as the housing stock grew in the late 1960s-1978. By the 1960's lead-based paint was being phased out due to the known human health effects. Another possible reason that lead-based paint does not appear to be prevalent in this area is because it was expensive and used in coastal towns to prevent mildew mold growth. Nevada is an arid environment and thus negated the need to spend the extra money for that specific paint characteristic. Finally, the sample size used in this study was small even though the whole pre-1978 child care population was surveyed this could have affected the results of the analysis. A larger study evaluating the general housing stock of Clark County could be useful and would contribute to the growing body of data for this area. A study by Torres (2009) also examined lead concentrations in the soil near pre-1978 residential structures in Clark County. That study produced the similar results to this study.

Water

Lead in plumbing materials was banned in 1986. However, this was not a complete ban; lead is permitted in certain plumbing materials up to specific allowable concentrations (Bryant, 2004). Furthermore, this ban did not address all of the service lines contained lead and copper lines installed prior to that date. This is important because some of these facilities may have leaded solder or lead service lines present that could be leaching lead. The SNWA applies treatment techniques to control lead leaching from service lines; however an unreleased study by the CDC suggests that partial lead service line replacement may cause lead to leach regardless of treatment techniques (CDC, 2010). If a childcare facility was to have leaded service lines replaced they could unknowingly dose a child with lead by giving them a glass of water or preparing food.

In 1991, the USEPA set regulations requiring water purveyors to apply treatment techniques to control corrosion of plumbing materials in water service lines.
This may explain why none of the water samples collected exceeded the Action Limit of 15 ppb lead in water. Only five of the 93 water samples collected reported lead concentrations above the laboratory's detection limit of 5 ppb. These results ranged from 6 ppb to 11 ppb of lead in water. These low concentrations could be attributed to the corrosion control techniques used by Southern Nevada Water Authority (SNWA) or the possibility that some of these facilities have completely replaced outdated water lines and fixtures that may have contained large amounts of lead.

Dust

A total of 424 dust samples were collected, these samples consisted of 323 floor dust samples and 101 window sill dust samples. High lead dust concentrations are thought to be caused by environmental lead being tracked inside and of lead-based paint in poor condition (Lanphear, Winter, Apetz, Eberly, & Weitzman, 1996). Paint is considered to be in poor condition when it is chipping, flaking, peeling or is abraded. Most of the facilities in this study did not have leaded paint present or if leaded paint was found it was in good condition, which typically does not produce leaded dust.

Lead-based paint does not need to be present to create leaded dust on an interior floor. Leaded dust or small soil particles on an interior floor can be a result of take home lead or environmental lead (Levin et al., 2008). One facility did not have any leaded paint present but had a interior floor dust sample return with a result of 50 µg/ft^2. This sample was collected at the front entrance under a rubber welcome mat. Lead is used in a variety of consumer goods such as vinyl, polyvinyl chloride (PVC) therefore it is possible that the mat itself was leaded and was creating dust above the clearance standard (Levin et.al., 2008). No other samples collected from this facility reported results above the floor clearance standard. There was also a positive interior floor sample result of 1200 µg/ft^2 that was collected from a painted threshold and was found in poor condition this positive component was ordered to be removed from the facility.

The laboratory was only able to detect a lower limit of 40 µg/ft^2 based on the sample area that was provided. Therefore any results reported below the detection limit were halved to a value of 20 µg/ft^2. These samples should be considered below the level of detection.

The highest dust result reported was sampled from a slide on the playground. In reality the area sampled on the slide was not as accessible as an interior floor, but the height of the sidewall was still very accessible to children. The sample collected from the side of the slide stairs contained 740 µg/ft^2 lead. The second highest dust wipe was a window sill sample containing 600 µg/ft^2, and was collected from a set of mini-blinds in a pre-school. The mini-blinds are in the same location as the window sill. Therefore because of the location and the template used it was classified as a window sill sample. All of the other dust samples collected were below the USEPA lead clearance standard of 250 µg/ft^2 set for window sills. Both the leaded mini-blinds and the slide were removed from the facilities as required by the SNHD.

Playground Equipment

With the increased awareness of the use of lead in consumer products, namely children's toys, it was hypothesized that large playground structures would contain lead in the paints and plastics helping them to maintain their color and integrity in extreme outdoor environments. The pieces of playground equipment tested contained both plastic and metal components. Lead was discovered in seven large playground structures, of which, 30.4% of positive readings were from painted metal and 69.6% of the positive readings were from plastics.

Although there were only a few pieces of equipment that were found to contain lead, dust wipes taken from one of these structures showed that it produced enough dust to have the potential to raise a child's blood lead level significantly. This piece of equipment produced a dust wipe result of 740 $\mu g/ft^2$.

Clark County, Nevada is known for its extreme heat and intense sunlight during the summer months. These factors could contribute to the breakdown of substrates or painted materials causing the release of leaded dust if lead is present. This has also been postulated for lead in artificial turf. If children play on the leaded equipment in its deteriorating state they may be exposed to lead dust. Furthermore, if good hand washing techniques are applied it is possible that they could be constantly dosing themselves when they play on the equipment. Health Departments having jurisdiction over schools and childcare facilities may want to screen playground equipment for post-1978 facilities and any new playground equipment that is added to a childcare facility.

The CPSC is charged with the task of enforcing standards for lead in consumer products, especially lead in products intended for children. It was initially thought that older facilities would have more pieces of leaded playground equipment than newer facilities. This was not the case and it is probably due to the constantly changing regulations for children's playground equipment. Safety issues are constantly being researched to address fall hazards, head entrapment, impalements and other safety concerns, which cause regulations on children's playground equipment to constantly change. Some older playground equipment cannot meet the changing playground equipment safety standards. If a piece is found to be unsafe by today's standards the operator is instructed to remove the equipment from service by the childcare inspectors at the SNHD. Most of the playground equipment tested appeared to be newer structures.

Regulating Agency Response to Lead Hazards

As the permitting agency, SNHD has the authority to require the childcare remove or remediate hazards found as a result of the lead risk assessment. The required actions vary with nature and severity of the hazard discovered. If the required actions are not adhered to it is possible that the childcare permit could be suspended.

Any potential lead hazards, which are lead hazards that are found intact, are recorded into the facility's file and must be monitored on a regular basis by the operator. The assigned SNHD childcare inspector will follow-up on these hazards twice a year during the course of their normal childcare inspections. Should the potential hazard become an actual hazard the facility will be ordered to address these issues in a manner recommended by the SNHD.

Actual lead hazards, which are hazards that are causing an adverse health effect, are ordered to be remediated, abated or have an interim control applied to the hazard. SNHD will record the hazard in the facility's file and provide a list of recommendations on how to address the hazard. The facility will submit a compliance schedule to address the hazard, and the childcare inspector will follow up to see that the hazard is addressed. The recommendations range from daily mopping of an area to total abatement of a component, such as the removal of playground equipment, or the removal of a threshold.

Study Limitations

The sample size (N=94) for this study is maybe considered small however this was the entire population of pre-1978 childcare facilities as of January 2009 in Clark County, Nevada. Since that time new facilities operating out of pre-1978 structures have opened for business and have been assessed by the SNHD, but these facilities were not included in this report. This study was not able to account for childcare facilities operating without a required SNHD permit. It is speculated that if unpermitted facilities were included in the childcare facility population they could have markedly increased the number of facilities that had lead hazards.

When each FCH or GCH was screened they were given the option to have the entire facility/house screened or only the child occupied areas. As per the SNHD health permit, only the areas that the children have access to are regulated by SNHD; therefore the inspectors did not have the authority to assess the entire facility/house without the owner's permission. Commercial childcare centers did not have this option as they operate out of a structure that is not used a private residence. There were a few FCH and GCH operators that chose to have the entire facility screened however most denied that offer. This is considered a limitation because there may have been lead hazards in the unscreened areas of the FCH and the GCH facilities. Although the child occupied areas are approved by SNHD there is always the possibility that the operator may use unapproved areas that may contain lead hazards that could impact a child's health.

The median income data collected were data that were estimated and based on the 2000 census. There has been large increase in the population within Clark County over the last few years, it very likely that the median income for households per zip code has changed drastically. Another limitation is that the zip code boundaries within Clark County have changed since 2000 as a result of the increase in population.

Some zip codes had more pre-1978 child care facilities than others and the sizes of the childcare facilities differed which could have contributed to substantially more hazards per zip code. When the number of facilities is increased the chance of finding lead hazards increases as well. The age of the facility tested also plays a significant role in the number of lead hazards that may be present. A majority of the facilities tested were constructed after 1950 when the lead concentrations in paint were voluntarily being reduced by industry (Mushak and Crocetti, 1990).

There were six USEPA Certified Lead Risk Assessors that contributed to completing this study. With the increase in the number of risk assessors comes the questioning of reliability in the way assessments were conducted. The assessors may have different approaches to an assessment, one such difference is the evaluation of outdoor playground equipment. An ideal assessment would have been to use the XRF to identify a positive component and then follow up with a dust wipe to determine if the hazard is an actual hazard or a potential hazard. It is important to know if lead is bioavailable not just accessible to the children who are climbing in, on, and around these structures.

It is possible that more pieces of playground equipment were positive because the standard for lead in products intended for children was 600 ppm at the time of the assessments (U.S. Consumer Product Safety Comission, 2009). This analysis was based on XRF results in mg/cm^2 not in parts per million, halfway through the project the assessment team obtained a XRF Plastics analyzer that could produce results in parts per million. The team chose to continue using the XRF that reports in mg/cm^2 in order to remain consistent. It is possible that a reading on the XRF below 1.0 mg/cm^2 could be above the 600 ppm standard set by the CPSC, as there is not a conversion formula. The best way we have to measure lead in playground equipment would be to dust wipe a an area of playground equipment use the XRF Plastics analyzer to take a reading and then take a dust wipe sample to determine if lead dust is being generated. It is recommended that the equipment that tested positive be retested in the future with the plastics XRF and followed up with a dust wipe.

Recommendations for Further Research

This study confirmed that lead can be found in traditional and non-traditional sources in Clark County, Nevada and should be investigated further. It does not appear to be a question of pre- or post 1978 structures but more of what hazards can be found within them. Upon completion of this study many possibilities for future research that could benefit not only Clark County, NV but the entire nation presented themselves.

The addition of lead to consumer products is regulated by the Consumer Products

Safety Commission. However lead in tile is not one of those regulated products. While intact leaded tile does not present a lead hazard, but not enough in known about the hazard that is created when leaded tile is chipped, cracked, or broken upon removal. Lead Safe Work Practices (LSWP) is a set of guidelines that were created to be used when working with lead-based paint. No guidelines currently exist for work with leaded tile. Therefore, LSWP generally aren't employed when removing tile because the general public is not aware of the potential hazard. These guidelines could possibly help landlords, homeowners, and construction workers if lead tile removal is deemed to be hazardous to health. It would be beneficial to conduct a study to determine the hazards created from working with leaded tile are severe enough to push to enact regulation. The question to answer is simply, could removing tile be hazardous to the worker or inhabitants, children of the residence? Would blood lead levels raise enough to trigger a risk assessment from the local Health Department?

In conjunction with the tile study, research should be conducted on post-1978 childcare facilities because as it has been demonstrated in this study that lead is not found only in paint, it has also been found in playground equipment, murals, and artificial turf. By investigating these items in childcare facilities we can decrease the chances of children, the highest risk group for lead poisoning, from being exposed. The Independent T-test that was performed for the leaded tile vs. lead-based paint hypothesis produced a result that was reaching statistical significance. A larger sample size is needed to in order to determine if this is the case.

The elementary schools in the Clark County School District are also permitted by the SNHD. These schools provide pre-kindergarten and kindergarten programs where children under the age of six attend on a regular basis. A natural progression of the childcare study would be to assess the permitted schools in Clark County that offer these programs. This action would provide a service to those children attending those schools by preventing their exposure to lead, and subsequent IQ loss.

This action would also benefit the SNHD in investigating EBLL cases. A major component of the EBLL investigations is to perform assessments of other locations where the child spends a large amount of time. These locations could be school, childcare facility, or a relative's house. If an assessment has already been performed on the school we can either rule out that school as a source of exposure or investigate further based on their assessment history.

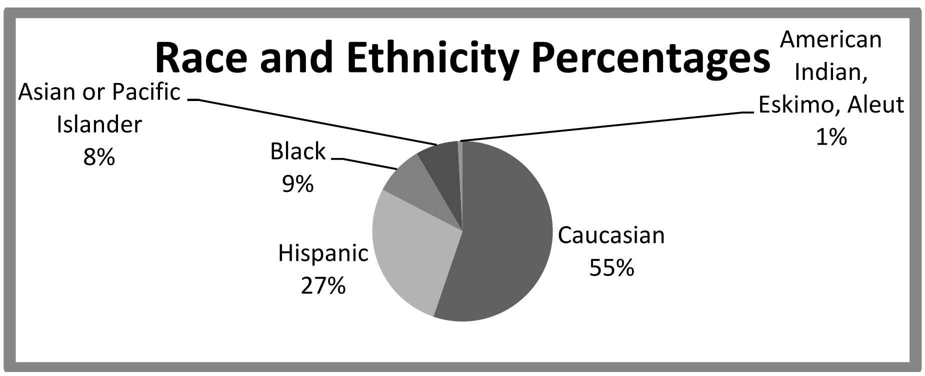
Preliminary data are indicating that the common exposures in Clark County are not from lead based paint, but non-traditional sources (Rothweiler, Cabb, Gerstenberger, 2007). This increases the need to employ primary prevention efforts focusing on cultural practices and other non-traditional exposures, not lead-based paint.

Two of the analyses that were conducted were approaching statistical significance and may have produced significant results had there been a larger population of pre-1978 childcare facilities. With a larger sample size the Simple Linear Regression conducted may produce a significant result that would enable researchers to use the age of a childcare facility to predict lead concentrations in water.

Summary

As the housing stock of Clark County, Nevada is evaluated for the presence of lead-based paint it may become more obvious that this county needs to take a different approach to primary prevention, direct its focus to non-traditional sources. The population of Clark County may benefit more from primary prevention efforts that focus on non-traditional cultural sources with less emphasis on traditional sources like paint, water, soil and dust.

Providing education on lead-based paint exposure should not be dismissed either, as it does have an important role to play in eliminating lead poisoning. The tendencies and characteristics of the population must be considered. The races and ethnicities contributing to Clark County's population are presented in Figure 8.



Source: Clark County Comprehensive Planning/Nevada State Demographer 2008
Figure 8. Race and ethnicity profile of Clark County, Nevada, USA in 2008.

Clark County is inhabited by a large transient population with different cultural backgrounds. With the differences in cultural background come the differences in cultural practices, some of which put people at risk for lead poisoning. Clark County has a large population of people from Hispanic descent. This culture is rich with tradition some of which is known to expose people to lead. The traditions are not only practiced in Clark County but around the U.S. These practices include cooking in leaded bean pots, administering home remedies, eating candies with a chili pepper or tamarind component, all of which have contributed to elevated blood lead levels in the past (Levin, 2008).

Education should be a major component of Clark County's crusade against lead exposure, education of the non-traditional exposures along with the traditional paint, dust, water, and soil. Although a child may not be poisoned by lead-based paint in their current residence, it is possible that the child may move to another city or state that has a heavy burden of lead-based paint in its housing stock. It could be beneficial for these people to learn about lead and take that knowledge with them as they move away from Clark County, Nevada.

Education could also benefit those moving into Clark County from the other areas of the country that have a heavy lead-based paint burdens. This knowledge may enlighten and empower a parent to ask their family's physician to have their child tested for EBLL. If the child should have an elevated blood lead level the parents will know how to proceed in treating and accommodating the child's special needs if any.

Lead-based paint is still poisoning children across the country, however new sources of exposure are coming to light every day. In this area of the country, the hazards are more of the non-traditional varieties that need to be explored further. Clark County Nevada is unique in this way; this requires a completely different approach to lead poisoning prevention and secondary prevention efforts. Preliminary data suggest that Clark County, Nevada does not have the same prevalence of lead-based paint hazards as the East Coast and Midwest where their housing stock is burdened with lead-based paint. These results coincide with research conducted by Jacobs et al. (2002), and Levin et al. (2008) where they found twice the lead-based paint hazards exist in the Northeast and Midwest (Jacobs et al., 2002; Levin et al., 2008).

Clark County, Nevada does not appear to have elevated lead concentrations in soil as does most of the country. This may be attributed to the relative young age of the county and highways, the lack of lead industries, and the absence of a housing stock with a burden of lead-based paint. These variables would also influence lead dust concentration, whether it was dust from deteriorating paint or environmental lead. Lead concentrations in water should be controlled by treatment techniques applied by the water purveyor, but as Washington D.C. has demonstrated this isn't always the case (Renner, 2004).

Clark County, Nevada appears to have other sources of lead exposure that need to be explored. Lead exposure through cultural practices, lead in consumer products, and lead in tile. By exploring these possible lead sources the county may be able to achieve success in reducing the number of children with elevated blood lead levels there by helping them avoid complications brought about by lead exposures.

APPENDIX 1

CHILDCARE NOTIFICATION LETTER

Dear Childcare Operator,

The Southern Nevada Health District (SNHD) along with our partners at the University of Southern Nevada, Las Vegas (UNLV) will be conducting FREE risk assessments and toy surveys for lead at the childcare facilities built before 1978. Lead is an environmental contaminant found in many materials from paint to toys to candy. Exposure to lead has been shown to have a detrimental effect on children six years old and younger. We will be conducting these risk assessments and surveys using the latest technology for measuring elemental lead in materials. After all data has been analyzed from the assessment, you will receive a comprehensive report that identifies where both the potential lead hazards (such as intact paint containing lead) and the immediate lead hazards (such as peeling paint containing lead) exist within your facility and what you need to do to prevent additional exposure to the children. If an immediate lead hazard is found to exist in your facility, SNHD will also offer blood lead screening to the children you serve.

SNHD and UNLV will conduct assessments only on child care facilities that were built before 1978. SNHD staff will notify your facility approximately two weeks in advance of the visit to discuss what the assessment will entail, how long the assessment may take, and answer any questions you may have. The visit should be no more disruptive to you and your facility than a routine health inspection. If your facility was built after 1978, you may contact UNLV at (702) 895-1250 to discuss the possibility of scheduling a survey of the toys in your facility.

In case you decide to remodel your facility before SNHD can conduct the assessment, please contact your routine health inspector before work begins. We can discuss with you the possible options available in identifying and abating a possible lead hazard. Improper remediation of lead contaminated paint can unintentionally increase the lead hazard in your facility.

If you have any questions about these risk assessments please call your routine health inspector at (702) 759-0677. We look forward to your cooperation in this innovative program.

Sincerely,
Environmental Health Division

XXXXXX

APPENDIX 2

XRF CALIBRATION SHEET

CALIBRATION CHECK TEST RESULTS

Address: ____
____

Case #: ______________________

Unit No: Device: XLp-303A **XRF Serial No:**

Inspector Name: ______________________ **Signature:** ___________________________

Date: ______________________ **E-Scale Value**: ________________________

NIST SRM Used: 1.04 mg/cm^3 **Calibration Check Tolerance Used**: 0.06 mg/cm^3
Acceptable Average: 0.8 – 1.2 mg/cm^3

First Calibration Check (*Before*)

NIST SRM P/N 500-534			First Average	Difference Between First Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Second Calibration Check (*After*)

NIST SRM			First Average	Difference Between First Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Third Calibration Check (*Every 4 Hours*)

NIST SRM			First Average	Difference Between First Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Fourth Calibration Check (*if required*)

NIST SRM			First Average	Difference Between First Average and NIST SRM*
First Reading	Second Reading	Third Reading		

* If the difference of the Calibration Check Average from the NIST SRM film value is greater than the specified Calibration Check Tolerance for this device, consult the manufacturer's recommendations to bring the instrument back into control. Retest all testing combinations tested since the last successful Calibration Check test.

APPENDIX 3

XRF PAINT RESULTS FORM

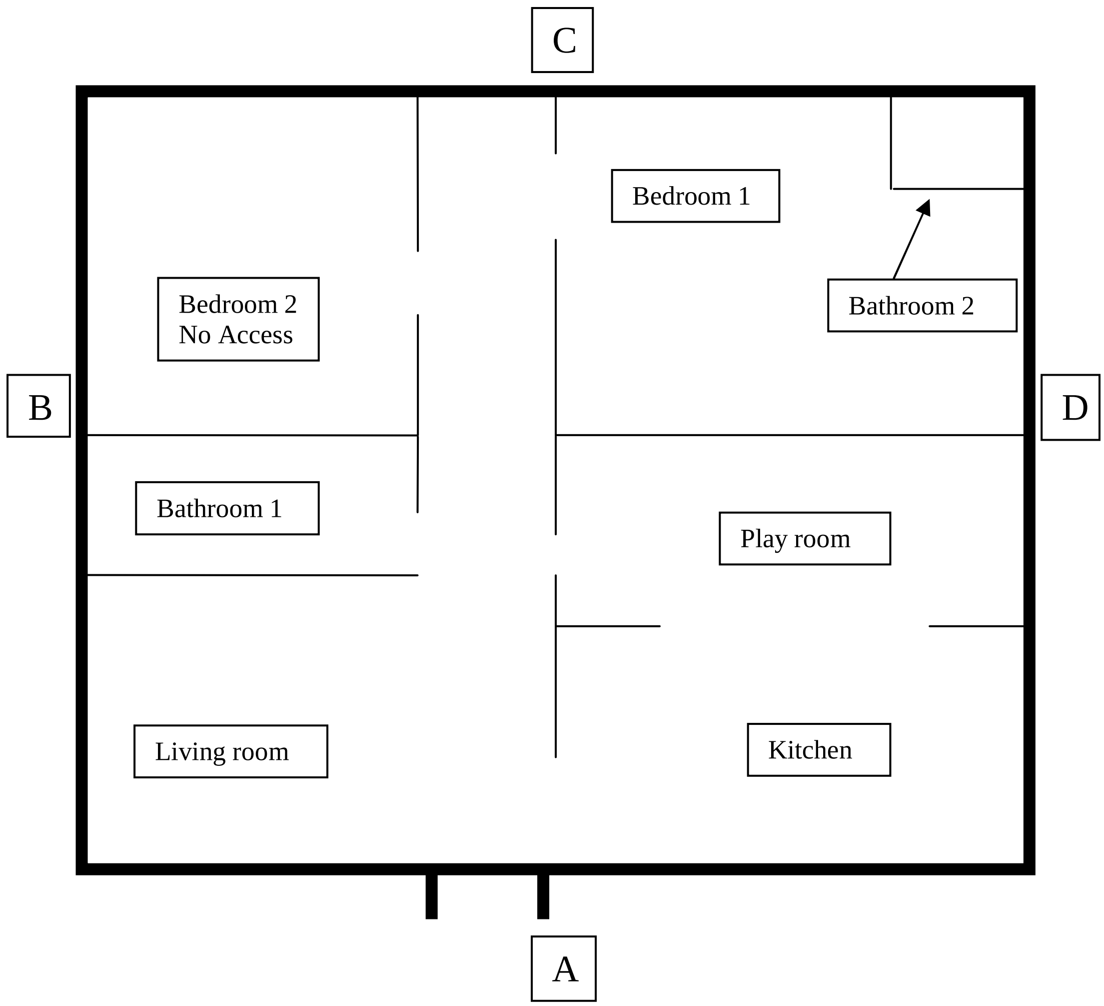
XRF READINGS						Case Number:		
Address:			Date:				Page _____ of _____	
Sample #	Substrate	Component	Color	Condition	Location	XRF Reading (mg/cm^2)	RESULTS	NOTES
							+ -	
							+ -	
							+ -	

Clearance Standards:

- XRF = 1 mg/cm2; Wet Weight = 600 ug/g or 600 ppm or 0.06%; Dry Weight = 5000 ug/g or 5000 ppm or 0.05%

APPENDIX 4

FACILITY MAP EXAMPLE



APPENDIX 5

SOIL SAMPLE FORM

SOIL SAMPLES **Address:**			**Case Number:** **Date:**	
SAMPLE #	**LOCATION**	**Bare or Covered**	**Lab Result (ug/g)**	**NOTES**

Procedure:
- X pattern in play area (composite) every 2–3 ft
- Drip line – no more than 10 ft
- Sample top 0.5 in

Clearance Standards:
- Bare Play Area Soil = 400 ppm
- Bare Soil, Rest of the Yard = 1200 ppm

APPENDIX 6

DIRECTIONS FOR WATER SAMPLE COLLECTION

This sample is being collected to determine the lead levels in your tap water. A sample is to be collected after water has been sitting in the pipes for an extended period of time (i.e. no water use during this period). Due to this requirement early morning is the best time for collecting a sample. The collection procedure is described in more detail below.

1. A minimum 6-hour period during which there is no water use throughout the house must be achieved prior to sampling. The Southern Nevada Health District (SNHD) recommends that the sample be collected during the early morning to ensure that the necessary stagnant water condition exists.
2. A kitchen or bathroom cold-water faucet is to be used for sampling. Place the sample bottle (open) below the faucet and gently open the cold water tap. Fill the sample bottle to the top and turn off the water.
3. Tightly cap the sample bottle.
4. Please fill out all the required information at the bottom of this instruction sheet, including your signature and the date.
5. SNHD staff will return to pick up the sample and this instruction sheet. If you have already agreed with SNHD staff to leave the sample outside in a designated area please do so by 8:30am.

Should you have any questions or if you were not able to collect the water sample as instructed please call SNHD Special Programs at (702) 759-0677 and leave a message. An SNHD representative will contact you to answer questions or to set up another pick up appointment.

PLEASE COMPLETE

Water was last used**:** Time____________ Date______________

Sample was collected: Time____________ Date______________

I have read the above directions and have taken a tap sample in accordance with these directions.

____ _______________________

Signature Date

Adopted from AWWA Guidelines on Lead and Copper Sample Collection.

APPENDIX 7

WATER SAMPLE FORM

WATER SAMPLE		**Case Number:**		
Address:		**Date:**		
SA MP LE #	**LOCATION**	**Lab Result**	**6 – 8 Hour Stand Time?**	**NOTES**
			[]Yes []No	
			[]Yes []No	
			[]Yes []No	

Procedure:

- Take 1 liter cold water
- 6-8 hour stand time before the first draw
- After running for about 1 minute, sample the water from the rest of the house

APPENDIX 8

DUST WIPE SAMPLE FORM

DUST WIPE SAMPLES					**Case Number:**		
Address:			**Date:**			**Page _____ of____**	
SAMPLE #	**Room and Location**	**Surface Type (Floor, Interior Window Sill, Window Trough, etc.)**	**Dimensions of Sample Area (inches)**	**Area (ft^2)**	**Result of Lab Analysis (ug/ft^2)**	**Actual Results (Converted from Lab Results)**	**NOTES**

Procedure:

- Wipe 0.10 ft^2 minimum otherwise +/- only

Clearance Standards:

- Interior Floors (carpeted and uncarpeted) = 40 ug/ft^2
- Interior Window Sills = 250 ug/ft^2
- Window Troughs = 400 ug/ft^2
- Exterior Concrete and Other Rough Surfaces = 800 ug/ft^2

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