STUDY ON

Blood Lead Level for Children Living in Marka Area/ City of Amman -Jordan

Ministry of Health
Environmental Health Directorate

In Cooperation with World Health Organization

Amman - Jordan

September 2005

Contents

Acknowledgement

The valuable technical assistance and financial support made by the World Health Organization (WHO) are gratefully acknowledged and appreciated.

The study team thanks all institutions and individuals who have provided information and facilitated the implementation of the tasks and helped to make this study possible; particular thanks are due for the parents of the children who had participated in the study and for the contributions made by the principles and school staff of the following schools:

In Marka area:

- Kindi Elementary School
- Jumanah Bint Abi Talib Elementary School/1
- Jumanah Bint Abi Talib Elementary School/2
- Hind Bint Umayah Elementary School
- Um Kulthoom Bint Uqbah Secondary School

In Yarmook Area (Known also as Ashrafiyah):

- Abu Hanifa Elementary School
- Umm Hakeem Elementary School
- Khawla Bint Al Azwar Elementary School
- Shahdah Bint Abi Nasr Elementary School
- Huda Sha’arawi Elementary School
- So’da Bint Zama’ah Elementary School
- Moh’d Ikbal Elementary School

Summary

This Study was conducted by a team of investigators form the Ministry of Health (MoH), Ministry of Education and Department of Statistics. The study was sponsored by the World Health Organization. The study aimed to identify blood lead level (BLL) for children aged 6-14 years living in a suspected polluted area (Marka) where they are presumably exposed to various environmental sources of lead and comparing it with BLL for children living in a less polluted areas (Yarmook/Ashrafiyah).

The study comprised of collecting and analyzing blood samples from school children aged 6-14 for lead concentration determination.

Results of BLL were not supported by results of dust analysis for lead due to the interruption of the ambient air monitoring program implemented by MoH/Environmental Health Directorate.

The study indicated that there is a significant difference in BLL between males in the two areas but no significant difference between females in both areas. The results showed that there is a significant correlation between the concentration of lead and age for the males but no significant correlation between concentration and age for females.

The BLL results for males infer that males are exposed to a larger extent to environmental lead than females which can be attributed to their behavioral activities. In addition, it concludes that the additional sources of lead in Marka area contribute to the increased BLL.

1. Introduction

The toxicity of lead has been recognized for thousands of years. Health effects include intellectual and behavioral deficits in children. The most serious health effect is damage to a child's developing brain and nervous system and as a result affecting child's cognitive abilities. As knowledge about the effects of lead at various concentrations has grown, the defined level of intervention for children has been lowered steadily, to reach the current "level of concern" of 10 µg/dL.

This study, which is an effort that contributes to achieving the objectives of the Healthy Environments for Children initiative, comes as a succession to the study titled "Lead exposure of the population of high risk areas in Amman with focus on childhood exposure", which was conducted by the Ministry of Health/ Environmental Health Directorate (MoH/EHD) in December 2000. This study will assist in identifying blood lead level (BLL) in children in Jordan, compiling relevant and appropriate information, and serving as a guide to draw a roadmap to steer the work of the MoH/EHD to assess the extent of the problem and the needs, design further studies and to draw intervention policies.

1.1 Statement of Purpose

The main purpose of the study is to identify BLL in children aged 6-14 years living in a suspected polluted area where they are exposed to additional sources of lead by means of industrial activities in the vicinity and comparing it with BLL for children living in a less polluted areas.

The objectives of the study are:

- Establish a relationship between BLL for male and female children;
- Establish a relationship between BLL for children living in exposed areas and children living in less polluted areas;
- Interpretation of the gathered data, and comparison with previous results;
- Identify the nature and scope of the existing BLL for children to assist in identifying high-risk populations and housing, and future identification of the needed actions, effective surveillance programs and efficient measures.

1.2 Needs Assessment

Children are the most vulnerable group in the society to the adverse effects of lead as they are in a dynamic state of growth and their brain and nervous system are still forming. Children acquire lead from environmental sources principally through ingestion. There are many potential sources and pathways of lead which may contribute to a particular child's lead exposure. These sources are interior and exterior paint, soil and dust, drinking water, occupational exposure, hobbies, food, traditional folk remedies and cosmetics and household objects. In addition, leaded gasoline and industrial sources have been implicated as sources of lead in soil and dust which, with time, can contaminate house dust, yards and playgrounds.

1.2.1 Situation Analysis

Current national data on BLL in children and the prevalence of elevated blood lead levels are very limited and are drawn from the study on “Lead exposure of the population of high risk areas in Amman with focus on childhood exposure” conducted in 2000. There is a lack of sufficient data that can help the health authority assess the needs and design proper intervention policies. The available data on lead content of collected dust is very limited and it does not cover a wide geographic area. The interruption of this program due to the non-availability of spare parts for the high volume sampler, have led to total absence of lead concentration data since 2003. The results are not sufficient to interpret the relationship between environmental exposure and BLL in children.

A comparative study was conducted in 1996 by M. Khalil, S. Edwan, M. Dabbas, M. Zo’bi, from the MoH and the Royal Medical Services to estimate BLL in the non-occupationally exposed Jordanian population in accordance to age and sex. The sample size was 746, chosen on statistical basis to be a representative sample for the Jordanian community. The arithmetic mean for blood lead level in the whole sample was 2.18 µg/100ml $\pm$ 1.96 which was lower than the other means determined by international studies . There was no statistical significant difference between male and female BLLs. However, a statistically significant association was found between BLLs for those less than 5 years old and those aged 5-15 years and 15-25 years old. Such low BLL in Jordanian citizens can be attributed to low lead concentration in the ambient atmosphere and low lead levels in food.

There are different sources of lead, with leaded gasoline being the largest source of atmospheric lead. In Jordan, leaded gasoline is prominent. According to the Jordan Refinery Company, Jordan had consumed 625,376 tons of leaded gasoline in 2001. A new proposal for the assessment of the impacts of leaded gasoline on health, environment and economy in Jordan is being prepared by the Ministry of Environment and MoH. The proposed project includes measuring BLL and calculating the corresponding burden of disease in terms of DALYs (the disability adjusted life years) and loss of IQ points.

In addition, lead-based paint, which is another major contributor to environmental lead, has been, as is still being used. In August 2005, using lead in the manufacturing of paint has been banned by the Minister of Health. This banning is effective starting March 2006. Some of the paint manufacturers have limited the use of lead in paint voluntarily years ago. The dusting, flaking and peeling of leaded paint is a significant source of lead exposure in children.

Industrial sources that release lead into the atmosphere in Marka area include smelters and a battery production plant. The property formerly used for storing empty car batteries and as lead smelters in Marka may contain lead and can result in human lead exposure via precipitation, infiltration, surface water runoff, and air dispersion. This was indicated in the results of the study conducted in 1998 on the effect of lead smelters on the environment and the people living in the vicinities.

Another potential source of lead is “Kohl” which is a traditional folk remedy and cosmetics which is a black powder used by Middle Eastern cultures as an eye cosmetic and umbilical stump remedy. Furthermore, a wide variety of household objects may contain lead such as glassware and ceramic ware.

1.2.2 Risk Factors for Lead Exposure and Lead Poisoning

There are many risk factors for lead exposure in Marka area, namely, lead smelters, a battery plant, in addition to the heavy traffic. Over the past several years, two scientific studies have demonstrated an association between lead exposure and blood lead concentrations in adults and children. The study on the effect of lead smelters on the environment and the people living in the vicinities, have indicated that:

- The battery factory at Marka is contributing appreciably to the concentration of lead in the surrounding ambient air.
- The increase in lead concentrations in soil in Marka area is mainly due to air lead deposits.
- No evidence of water pollution due to air lead deposits was observed in all areas at the time of the study.

The study conducted in 2000 on lead exposure of the population of high risk areas in Amman (Down Town area) with focus on childhood exposure, have indicated the following:

- Vehicles operated with leaded gasoline are contributing appreciably to lead concentration in ambient air at Downtown City of Amman.
- It is evident that lead concentration in ambient air is contributing appreciably in elevating lead concentration in blood of children living at Downtown City of Amman in comparison with those living at Al-Shmaisani (control area).
- Males are suspected to be affected by contaminated air with lead more than females.

There is a risk of elevated BLL in children living in exposed areas, with many sources of environmental lead. Yet, there is a lack of comprehensive information on the status of BLL and lead exposure. Initiating a surveillance program to monitor lead concentration in the environment, as well as, BLL in children is of paramount importance to fill the information gap and draw intervention policies.

2. Literature Review

2.1 Effects of lead exposure on children

Lead is neurotoxic and particularly harmful to the developing nervous systems of fetuses and young children. Extremely high blood lead levels (BLLs) (i.e., ≥70 µg/dL) can cause severe neurologic problems (e.g., seizure, coma, and death). Adverse health effects caused by lead exposure include intellectual and behavioral deficits in children and hypertension and kidney disease in adults. Exposure to lead is an important public health problem, particularly for young children.[1] A small number of adults occupationally exposed to lead have in the past shown increased risk of kidney damage, nerve damage, and infertility and, possibly, a small increase in blood pressure and the risk of contracting certain cancers at high levels of exposure. However, today such effects are rarely observed. The greatest concern for the general population is that lower levels of lead exposure, which some of the general population may receive; appear to cause a small decrease in the intellectual development of young children. Children are more vulnerable because their nervous system is developing; they absorb more lead than adults because of behavioral and physiological differences. The defined level of intervention for children has been lowered steadily over the past four decades, and recent findings of harmful effects at blood lead levels even below the current "level of concern" of 10 µg/dL have prompted discussion for potentially lowering acceptable blood levels even further [2]. The following table shows the changing definitions of acceptable BLL in the USA.[2]

Table 1. Changing definitions of acceptable blood lead levels in the United States

Year	Level of Concern
1960	60 µg/dL
1970	40 µg/dL
1975	35 µg/dL
1985	25 µg/dL
1991	10 µg/dL
2004	Discussions underway at CDC to determine if level should be further decreased to 5 µg/dL, in light of growing body of research demonstrating no "safe" threshold of exposure

Lead exposure adversely affects the cognitive development and behavior of young children [3]. For children aged <6 years, the Centre for Disease Control in USA (CDC) has defined an elevated blood lead level (BLL) as ≥10 µg/dL, but evidence exists for subtle effects at lower levels. [4] The literature review makes clear several related findings: 1) lead exerts harmful effects at concentrations commonly observed among young children, including at levels below 10 µg/dL, perhaps without any identifiable threshold of safety; 2) a large proportion of the population of young children in the USA currently have BLL between 5-10 µg/dL; 3) the cognitive effects of lead toxicity are believed to be irreversible; 4) children already at high risk for a range of health and developmental problems due to socio-economic disadvantage are the most likely to be exposed to lead, and may be most vulnerable to its debilitating effects. Based on this collective evidence, there is consensus among researchers, health care providers, and policymakers that comprehensive prevention strategies, and especially primary prevention strategies, must be strengthened to achieve elimination of childhood lead poisoning.

The Lead Exposure Abatement Plan for Egypt indicated that an extensive environmental sampling was conducted in Cairo to estimate the magnitude and extent of children's exposure to lead through various environmental media in the Greater metropolitan area. Results were used to estimate the blood lead levels in young children in June 1997. Modeling results based on data collected in Cairo indicate that approximately 64 % of young children (ages 0-6) may have blood lead levels higher than 10µg/dL, and approximately 14% may have levels higher than 20µg/dL. The actual average blood levels are likely to be higher in some group of children. The research has shown that blood lead levels as low as 10µg/dL are associated with learning disabilities and lowered IQ. Blood lead levels of 10µg/dL and higher are cause for concern and levels of 20µg/dL and higher justify actions to reduce the sources of exposure.

The following table is used to interpret the result of a blood lead test done on a child.

Interpreting blood lead levels in children

Very low	0-9 µg/dL	Not considered lead poisoning. Repeat test every 6 months until the age of 2 years. After that, have the child tested once a year until age 6.
Low	10-14 µg/dL	Rescreen every three to four months.
Moderate	15-19 µg/dL	Rescreen every three to four months. Healthcare professionals should provide dietary and lead prevention counseling. Identify and remove obvious lead hazards.
High	20-44 µg/dL	Complete evaluation. Find and get rid of lead hazards in the child's environment (home, daycare, school, and play areas).
	45-69 µg/dL	Medical treatment and inspection of environment within 48 hours.

Urgent	70 µg/dL or above	Medical emergency. Immediate medical treatment and inspection of environment.

Source: Nebraska Health and Human Services System, Regulation and Licensure.

2.2 Lead Exposure

The report on “Blood Lead Levels in Young Children in the United States and Selected States”, 1996—1999, has indicated that average BLLs of U.S. children aged 1-5 years have declined from the late 1970s through the early 1990s primarily due to phasing-out of leaded gasoline and the resulting decrease in lead emissions, although other exposures also decreased.[5] The same report indicated that despite the overall decline in average BLLs, data showed that the risk for elevated BLLs in children tested remains high in some counties and varies greatly among and within states. This variation most likely reflects geographic variation in the prevalence of risk factors for elevated BLLs such as residence in older housing and poverty. Elevated lead levels continue to be a particular problem among socially and economically deprived children. Poor people are more likely to live in substandard housing and be near industry and heavy traffic, to be exposed to lead dust brought home by lead workers, and to be nutritionally deprived and therefore susceptible.

The report on “Blood Lead Levels in the United States, 1999—2002 has also indicated a decline in BLLs which resulted from coordinated, intensive efforts at the national, state, and local levels beginning with efforts to remove lead from gasoline, food cans, and residential paint products. [6]

National surveys and surveillance data in the USA indicate children’s BLLs continue to decline throughout the United States. This decline reflects changes in national policies and laws implemented since the 1970s that have limited the use of lead, including removal of lead from 1) gasoline, 2) food and soft-drink cans, 3) paint for residential use, and 4) solder in household plumbing.[7] This is a clear indication that proper intervention policies regarding phasing out and limiting the use of lead will reduce exposure and will have effective results.

Much research has been conducted on children with moderately raised blood lead levels associated with environmental exposure. The potential for adverse effects of lead exposure in children is heightened because:

- Intake of lead per unit body weight is higher for children than for adults;
- Young children often place objects in their mouths, resulting in dust and soil being ingested and, possibly, an increased intake of lead;
- Physiological uptake rates of lead in children are higher than those in adults;

- Young children are undergoing rapid development, their systems are not fully developed and consequently they are more vulnerable than adults to the effects of lead.

There are many potential sources of lead which may contribute to a particular child's lead exposure:[8]

Interior and Exterior Paint:

Ingestion of lead derived from lead-based paint is the most common modality of high-dose lead exposure for children. Children are poisoned by mouthing objects with lead dust on them, such as fingers and toys and by chewing on surfaces such as window sills which are coated with lead paint or by eating paint chips.

Soil and Dust:

Over time, lead from a number of different sources has contaminated house dust, yards and playgrounds. In addition to lead-based paint, leaded gasoline and industrial sources have been implicated as lead in soil and dust.

For many years, automobile exhaust from leaded gasoline was the single largest source of atmospheric lead. There is a substantially higher lead content in soil along highways and roads with high traffic flow. This may contribute to lead dust in nearby housing.

Industrial sources of lead include smelters, battery production or recycling, some paint and pigment production facilities and solid waste sites. Lead vapor and dust can be released in stack emissions from municipal incinerators. Lead may also be present in incinerator ash. Modern municipal waste-to-energy incinerators and permitted hazardous waste incinerators can release lead into the atmosphere. This occurs when air pollution control devices are not maintained or operated correctly.

Property formerly used for lead smelters, lead manufacturing, chemical waste management, auto salvage yards, waste oil recycling, municipal landfills and construction/demolition debris sites may contain lead. Contamination from these sites can result in human lead exposure via precipitation, infiltration, surface water runoff and air dispersion.

Drinking Water:

Lead is more completely absorbed from drinking water than from food. Lead is not usually present in water at the source, but enters through the distribution system. The most likely sources of lead in drinking water are lead pipes, lead solder and brass fittings used in household plumbing. It was common practice to use lead pipes in the USA for interior plumbing and for service connections joining residences to public water supplies before 1930. Copper pipes have been widely used since the 1930's and lead solder used to join copper pipes has been a source of contamination in household water. Lead was banned in USA from solder in 1988. Brass used principally for valves is an alloy of copper and zinc with variable amounts of lead and other metals.[9]

Corrosion, a chemical reaction that dissolves metal, can dissolve or leach lead from plumbing into drinking water. The corrosivity of water is affected by natural conditions and by water treatment. Water that is hot or that sits in pipes for extended periods, such as overnight, will likely contain more leached lead than cold water from a tap that has been run recently.

Acidic "soft" water (low mineral content of calcium and magnesium) may leach lead from plumbing, particularly when the water is hot.

Occupational exposure:

Parents working in construction, home renovations, steel and bridge work and other industries using lead may bring home lead dust on their clothes, shoes, skin and hair. Lead dust may contaminate their cars. Such occupations result in lead exposure to the adult and sometimes "take home" lead exposure to their children.[10]

Occupations associated with lead exposure:

- Lead production or smelting
- Demolition of ships and bridges
- Production of illicit whiskey
- Battery manufacturing
- Brass, copper and lead (foundries)
- Matching and grinding lead alloys
- Radiator repair
- Welding of old painted metals
- Scrap handling of old buildings
- Thermal paint stripping of old buildings
- Sanding of old paint
- Ceramic glaze mixing
- Cable stripping
- Electronics welding
- Instructor or janitor at a firing range

Food:

Regulating lead contamination in foods is the responsibility of the United States Food and Drug Administration (FDA). The FDA has set a goal of less than 100 µg/dL as the maximum lead intake by children one-to five years of age. About 5 percent of children ingest enough lead from food and beverages to be at risk for adverse health effects. Lead enters the food chain from soil, deposition from the air, containers or dishes and from food processing equipment.

The FDA has estimated that about 20 percent of all dietary lead in the USA comes from canned food and two-thirds of that results from lead solder in cans. Acidic foods can leach lead from the solder in the seams of cans. The number of food cans that are lead-soldered continues to decline. In 1979, more than 90 percent of all food cans were lead soldered; in 1986, this figure was 20 percent or less than about two million cans. It is important to note that imported canned foods are not included in these figures and may still contain lead. Although the FDA has required the use of unleaded solder in baby food cans and has requested a phase out of leaded solder in all food cans produced in the United States, some still remain on the market. The FDA phase out does not apply to imported foods.

Imported glazed ceramics and lead-containing pottery are also potential sources of dangerously high levels of lead. Lead glazed ceramics and lead crystal glassware can release lead into food and drink. Since ancient times, lead has been used in glazes for ceramic dishware. If lead glazed pottery is not fired to a high enough temperature for a long enough time, lead may subsequently be released from the glaze into food. Holding acidic foods and beverages such as tomato sauce, fruit juice, coffee, wine or vinegar, in inadequately fired ceramics, can leach this lead. Lead free glaze should be used on glazed ceramics.[11]

Dishes and pottery made commercially in the United States since 1971 are generally safe to use. However, antiques and collectibles, dishes and pottery made in foreign countries and pieces made by amateurs for gifts or craft fairs may contain lead that could be a source of exposure if used for storing or serving food and drink.

Leaded crystal glassware may leach lead into food or beverages. The FDA recommends avoiding the use of leaded crystal glassware to store foods and beverages for extended periods of time.

Traditional Folk Remedies and Cosmetics:

A number of remedies and cosmetics that contain lead have been identified. Alkohl (also known as kohl, surma): a black powder used by Middle Eastern, African and Asian cultures as an eye cosmetic and umbilical stump remedy.

Azarcon (also known as reuda, liga, coral, alarcon and maria luise): a bright orange powder used by hispanic cultures to treat gastrointestinal upset and diarrhea.

Bali goli: a round, flat black bean which is dissolved in gripe water and used by Asian Indian cultures for stomach ache.

Ghazard: a brown powder used by Asian Indian cultures to aid digestion.

2.3 Protecting Children from Lead

Parents can use several interventions to reduce children's exposure to lead, as follows:[12]

- Make sure the child does not have access to peeling paint or surfaces with lead-based paint;
- Clean surfaces at least once a week, using damp mop.
- Wash children's hands and faces before they eat and before bedtime.
- Wash toys and pacifiers frequently.
- Soil around older homes is likely to be contaminated with lead. Plant bushes and grass around the outsides of houses, so that children are less apt to play in areas where soil may be contaminated.
- Make sure children eat regular meals with plenty of iron and calcium.
- People whose occupations expose them to lead should change clothes and remove shoes before entering their home after work.
- Keep children and pregnant women away from areas of the home undergoing renovation, remodeling or repair.
- Never sand, dry scrape or burn off above 700° F possible lead-based paint.
- Children can be screened for lead during routine checkups at the doctor's office. Usually finger sticks are used to collect the blood for measuring lead levels.

3. Study Design and Environmental Scan Methodology

Exposure to lead is associated with a range of serious health effects on children, including detrimental irreversible effects on cognitive and behavioral development with serious personal and social consequences. Exposure to lead can be reduced. The purpose of testing or screening for blood lead levels, is to evaluate the BLL for children in Jordan and to provide for the early identification of children with elevated blood lead levels, and, once identified, coordinate intervention policies and services.

3.1 Design of study

The study was designed taking into consideration the results of the previous studies on “Lead exposure of the population of high risk areas in Amman with focus on childhood exposure”, and “The effect of lead smelters on the environment and the people living in the vicinities,” focusing on children aged 6-14 years.

The target and comparative areas were selected to compare BLL’s in children living in an exposed area with children living in a non-exposed area.

The target group is school children, with the following conditions:

- aged 6-14 years;
- distributed with respect to gender;
- should have lived in the area for not less than 5 years;
- should not have used Alkohl;
- should not have had any vocational exposure to lead.

Some children who have used kohl before, or have been living in the area for less than 5 years, were included in the study to meet the sample size of 240 children.

3.1.1 Study area

The target area has been selected according to the objectives of the study, which is based on the outcome of previous studies.

Marka, the target area, is located at the north-east corner of Greater Amman. It is an industrial area with various sources of exposure to environmental lead. The industrial activities encompass a battery factory and several smelters. Furthermore, it is heavily populated and is characterized with heavy traffic.

Yarmook, also known as Ashrafiyah, is the comparative area. It is located at the south-west tip of Marka and is densely populated and is characterized with heavy traffic. Yarmook is a non-industrial area, thus, lead exposure from industrial sources are insignificant. A map of the Greater Amman in Annex 1 shows Marka and Yarmook areas.

3.1.2 Methodology

The study was implemented according to the following steps:

- Short listing schools in the target area and the comparative area. This was accomplished by the concerned directorate in the Ministry of Education (MoE) through its representative in the study team. Selection of schools covered in the study is based on satisfying the requirement of including exposed schools (Marka) and non-exposed schools (Yarmook/Ashrafiyah).
- Selection of students in the elementary schools to be the community of the study. This selection was adopted because it covers the childhood age ranging from (6) to (14) years. The sample size was 120 students from each area with a total of 240 students.
- Preparation of a questionnaire that was simple and consisted of basic questions to fulfill the goals of the study.
- The questionnaire consists of two parts: the first part contains a briefing to the students' parents about the study. It also aims at getting written consent or disagreement for participation of the student in the study. The second part contains demographic data: age, sex, father's and mother's occupation, location of resident, and duration of living at the same address.
- Distribution of the questionnaire the eligible students in each grade in the schools. Before distribution, the students were briefed about the study and blood sampling.
- Collection of questionnaires from students.
- After analyzing the information included in the response to the questionnaire, the student was accepted or excluded as a sample in the study according to previous exposure to other sources of lead (Kohl) in early childhood, and any recent exposure to lead other than the polluted ambient air lead.
- Tabulating the available data for each school to reflect sex and age distribution of students and notes on lead exposure.
- Collection of blood samples from the students in schools, transportation and preservation of samples in the laboratory.
- Analysis of blood samples for lead content in the Environmental Health Directorate Laboratory/MoH.
- Statistical analysis of results.
- Preparation of the final report.

3.1.3 Questionnaire

The questionnaire that was distributed to school children in the selected areas was very simple and contained basic questions to be answered by the parents of the child. A consent form was attached to the questionnaire to obtain parent's approval for his/her child to participate in the study as shown in Annex 2.

The location of the dwelling relevant to lead sources, namely, the battery plant and the lead smelters in Marka and the duration of residency in the same address, are very important questions. It should provide relevant information to arrive at correlations between environmental exposure and BLLs. This question was answered improperly or neglected.

The occupation of the parents is another important question to enable investigating "take home" lead exposure to their children. Again, this question was inadequately answered.

Whether the child used Alkohl at birth and the continued use is a question that was sometimes neglected by parent.

3.1.4 Sampling design

The main objective of sampling design is to have a representative sample from the two communities under study to know the BLL for children at the age of 6-14 years and attending public elementary (basic) schools in both exposed area and non-exposed area (comparative) for both males and females.

The schools in both areas were determined and the number of students attending grades 1 through 8 was obtained form the Ministry of Education. The sample size was chosen based on the statistical analysis of this data.

3.2 Sample Collection and Laboratory Analysis

The following instruments and laboratory equipment were used for the collection, preservation, preparation and analysis of blood samples:

- 250 ml glass bottles
- 5 ml polypropylene lead free syringes
- 5 ml heparinized lead free vacutainers
- Ice box
- Vortex mixer
- Laboratory glassware
- Flame/flameless atomic absorption spectrophotometer - Shimadzu Model AA-680
- Lead free nitric acid 66%

- Deionized water
- Lead stock standard 1000 mg/l

3.2.1 Preservation and preparation of sample

The following standard procedure was followed for the preservation, preparation and digestion of blood samples:

- Collected blood samples were stored frozen at –20 ºC.
- Samples were defrosted.
- 0.5 ml of blood sample was transferred into a glass tube and diluted to 2.5 ml using 1% Triton x -100 solution.
- Samples were mixed well using a vortex mixer.
- Deionized water blanks for each batch of samples were prepared in the same manner.

3.2.2 Analysis of sample

- Blood samples were analyzed for lead using Graphite Furnace Atomic Absorption Spectrophotometer with control correction working under the conditions mentioned below.
- 5.0, 10.0, 15.5, 20.0 µg/l standard lead solutions were prepared from the commercially available stock lead standard using deionized water.
- The previously prepared working standards were used for plotting the calibration curve.
- Concentration of lead in the digested samples was determined automatically by the data processor of the equipment. Results were expressed in µg/100ml.

Equipment conditions:

Lamp source	Hollow cathode lamp
Wave length	283.3 nm
Current	5mA
Slit width	1.0 nm

Graphite furnace heating program:

Stage 1	Temp 120 ºC	Time 20 sec.
Stage 2	Temp 300 ºC	Time 20 sec.
Stage 3	Temp 2300 ºC	Time 3 sec.
Stage 4	Temp 0 ºC	Time 10 sec.
Stage 5	Temp 2500 ºC	Time 2 sec.

4. Results and Statistical Analysis

4.1 Blood lead level (BLL) results

BLL results for the 240 school children (sample size) are presented in Annex (3) in microgram/100ml.

4.2 Statistical analysis of results

After the tabulation of data, results at stratum level were as shown in the table below.

Table showing results of statistical manipulation of data at stratum level

Stratum No.* Area-gender	Average lead concentration in blood µg/dL	No of observations	Coefficient of variation, % (CV%)	95% Confidence Interval	
				Lower limit µg/dL	Upper limit µg/dL
1-1	1.75	59	5.467	1.559	1.933
1-2	1.52	61	4.937	1.376	1.670
2-1	2.39	60	5.603	2.130	2.656
2-2	1.60	60	7.482	1.366	1.836
Total	1.81	240	3.209	1.701	1.929

** Area 1= comparative area (Yarmook/Ashrafiyah)   Area 2 = Exposed/target area (Marka)*
1 = Male children   2= Female children

The coefficient of variation (CV) is 3.2%, which means that the precision of the sample is high. The highest lead concentration is at the third stratum (exposed area, male) in Marka which contains both manufacturing (point pollution) and traffic (non-point pollution). The second stratum is males in Yarmook/Ashrafiyah (comparative area), followed by females in the exposed area and the lowest concentration is for females in the comparative area.
To test the significant difference between Marka (area2) and Yarmook/Ashrafiyah (area 1), the compared mean of two areas by t- test was applied. The results show a significant difference between the two areas. The calculated t-value 3.2 means the difference is significant at .01 level.

The comparison between males in both areas shows also a significant difference between males. The calculated t-value 3.9 means the difference is significant at .01 level.

On the other hand the comparison between females in both areas shows non-significant difference.

Therefore, the results show that there is a significant difference between males in the two areas but no significant difference between females in both areas. These results could be attributed to the outdoor activities of males in the area exposing them to environmental lead to a larger extent than females.

In addition, the results show there is a significant correlation between concentration and age for male children but no significant correlation between concentration and age for female children.

It can be inferred from the results that there is no significant difference between the children who have used, or are still using, Kohl, and the children who never did for the same area. The same applies for children living in close proximity to sources of lead and those who do not in Marka (the exposed area).The table below shows the t-test results.

T-test results

Item	Calculated t-value	Result
Area 1 versus area 2	4.563	Highly significant
Area 1 versus area 2 for male children	-3.92	Highly significant
Area 1 versus area 2 for female children	-.553	Not significant

The detailed statistical analysis is shown in Annex (4).

5. Conclusion and Recommendations

By examining the results of lead concentration in blood at both areas, and the conducted statistical manipulation, it is apparent that:

- The highest BLLs is for male children living in Marka (target/exposed area).
- The second highest BLLs is for male children living in Yarmook (comparative area), followed by female children living in Marka, with the lowest BLLs for female children living in Yarmook.
- BLLs of children at Marka (target area) are higher than that of children at Yarmook (comparative area). There is significant difference between the two areas, confirming the effect of point pollution (industry) and non-point pollution (traffic).
- The comparison of BLLs for female children did not show significant difference.
- There is a significant correlation between age and BLL for male children but non for female children.
- The BLL results did not show significant difference between children who have been exposed to lead (used Kohl or are still using it) and those who have never used it.
- The BLL results did not show significant difference between children living in a close proximity to the battery factory or smelters and those who live farther away from these lead sources in Marka area.
- The highest BLL is 6.07microgram/100ml (male child/Marka), the second highest is 5.44 microgram/100ml (male child/Marka), the third is 4.90 (female/Marka).

Conclusion

- It is evident that lead concentration in ambient air and in the dust precipitating on the ground in the exposed area, Marka, resulting from the industrial sources and from vehicle using leaded gasoline is contributing to the higher BLLs for children living in Marka.
- It is clear that male children are affected to a larger extent by lead-contaminated air than female children.
- It is apparent that male children outdoor activities, and hence, intake of air and exposure to dust, and the extended length of exposure to lead is the cause for higher BLLs in male children than female children.

- It is obvious that vehicles operated with leaded gasoline contribute to lead concentration in ambient air and in dust precipitating on the ground.
- The results of BLLs in Marka (exposed area) manifest that there is no correlation between children living close to a lead source and those who live farther away. This raises an issue to be investigated further in future studies.

Recommendations:

Based on results and conclusions of the study, it is recommended to:

- Initiate a national surveillance program for screening BLL for children to identify the nature and scope of the problem, assist in identifying high -risk populations and housing, monitor the scope of the problem and evaluate the effectiveness of interventions.
- Design and implement a continuous lead monitoring program in ambient air to establish correlations between BLLs and lead concentration in the environment.
- Use of an array of interventions to minimize the probability of continued exposure among populations with high rates of exposure (high risk areas) such as the gradual phasing out of leaded gasoline.
- Increase public, including families and physicians, awareness on the sources of lead, common methods to decrease lead exposure, the dangers of lead, and the importance of lead screening.
- Dissemination of educational material to all physicians caring for children that includes information on recent medical literature demonstrating the adverse effects of lead on children.
- Adopt national guidelines for limiting the use of lead in household items, whether imported or manufactured locally.

6. References

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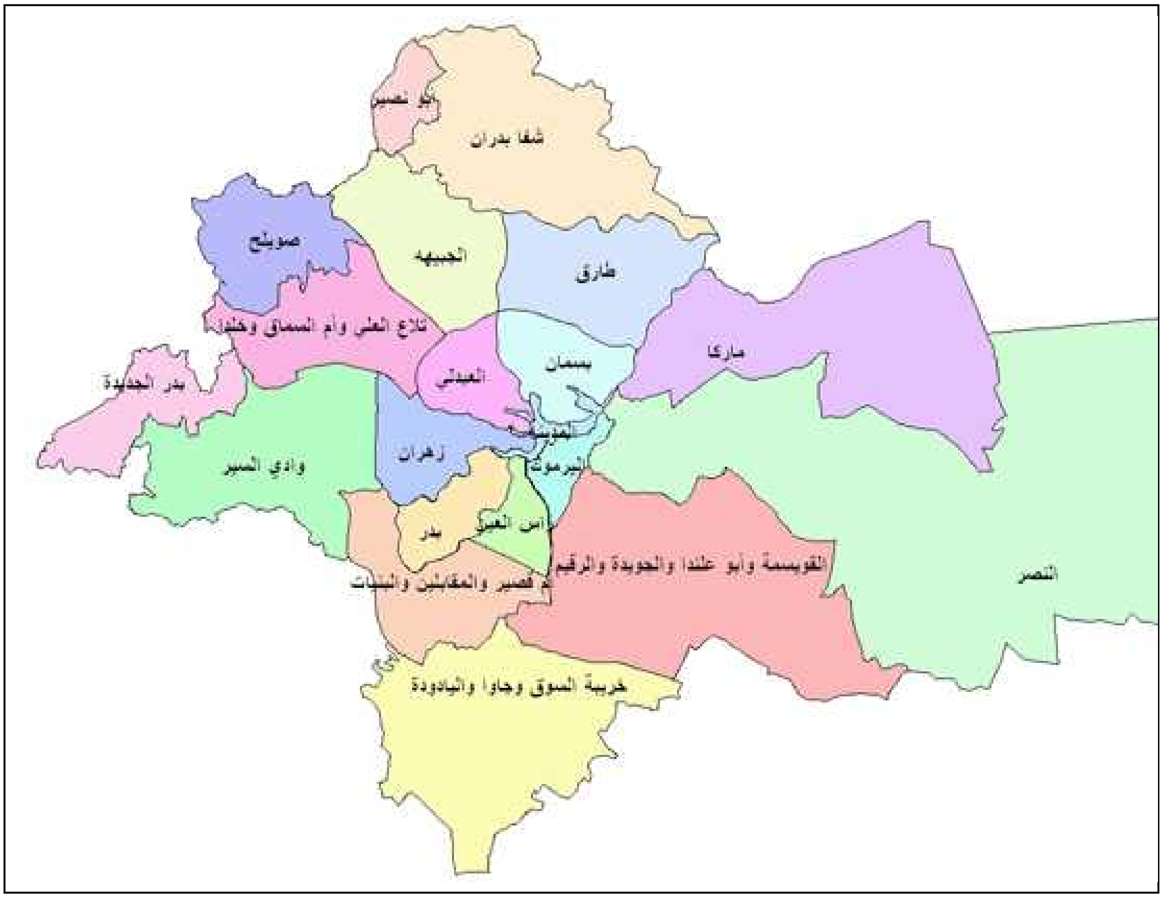
7. Annexes

Annex 1 Maps of the study area



Annex 2 Questionnaire used for obtaining parent's approvals

بسم الله الرحمن الرحيم
وزارة الصحة

الموضوع: دراسة تحديد مستوى الرصاص في الدم

السيد الفاضل ولي أمر الطالب/الطالبة: ....

السلام عليكم ورحمة الله وبركاتة وبعد ،،،

يقوم فريق من وزارة الصحة ومن وزارة التربية والتعليم بإجراء دراسة ميدانية على طلاب المدارس في عدة مناطق من عمان لتحديد مستوى الرصاص في الدم كون الأطفال أكثر الفئآت تأثرا بالرصاص، حيث يحتاج ذلك إلى أخذ عينة دم من ابنكم / ابنتكم.

يرجى منكم التكرم بالموافقة على اخذ عينة دم من قبل لجنة مختصة في وزارة الصحة وبإشراف طبي بوجود طبيبة من الصحة المدرسية . وتعبئة الاستبيان المرفق.
يرجى في حالة الموافقة على مشاركة ابنكم/ابنتكم للدراسة المشار إليها أعلاه أن يتم وضع إشارة (√)على كلمة نعم كما هو مبين أدناه.
وإعادته مع ابنكم/ابنتكم وسوف يتم إعلامكم بنتيجة التحليل لعينة الدم من خلال المدرسة لاحقا.

شاكرين لكم حسن تعاونكم ...

هل توافقون على مشاركة ابنكم/ابنتكم في الدراسة : ( ) نعم ( ) لا

إسم ولي الأمر: ....
التوقيع: ....
التاريخ: ....

وزارة الصحة

استبيان مستوى الرصاص في الدم لدى الأطفال

التاريخ: / /٢٠٠٥

اسم الطفل: ....

اسم المدرسة: ....

جنس الطفل: ١ ٢ ١- ذكر ٢- أنثى

ضع إشارة (x) في المربع المخصص للعمر

٥	٦	٧	٨	٩	١٠	١١	١٢	١٣	١٤

معلومات تخص العائلة:

مهنة الوالد: اسم الجهة (المؤسسة التي يعمل بها):

مهنة الوالدة: اسم الجهة (المؤسسة التي تعمل بها):

مهنة الأخوة العاملين: اسم الجهة (المؤسسة التي يعمل بها):

مكان السكن:

مدة الإقامة:

هل يوجد قرب السكن مصنع للبطاريات **السائلة أو مسكبة؟** ....

إذا كان الجواب نعم، حدد بعدها عن المنزل ....

معلومات تخص الطفل:

هل استعمل الطفل مادة الكحل في **السابق**:

هل يستعمل الطفل مادة الكحل حالياً:

معلومات تعبأ بواسطة فريق العمل:

اسم جامع المعلومات: اسم جامع العينة:

تاريخ التحليل: / /٢٠٠٥ نتيجة التحليل:( ) **مكغم**/١٠٠ مليلتر

Annex 3 Blood lead level (BLL) in microgram/100 ml for the selected sample of children living in Marka and Yarmook (Ashrafiyah) Areas

جدول رقم(١) مدرسة خولة بنت الازور

الصف الثالث/إناث/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١	انثى	٨		١.٩٦
٢	=	٨		١.٧٥
٣	=	٨		١.٨١
٤	=	٩		١.٤٣
٥	=	١١		١.٢٧
٦	=	٩		٣.١٠
٧	=	١٠		٢.٠٤
٨	=	٩		٢.٠٣
٩	=	٩		١.٦٥
١٠	=	٩		٢.٢٢

جدول رقم(٢) مدرسة خولة بنت الازور

الصف الثاني/ذكور/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠مل
١١	ذكر	٧		١.٩٥
١٢	=	٨		٢.٢٥
١٣	=	٨		١.٧٠
١٤	=	٨		٢.١٦
١٥	=	٨		٢.٨٧
١٦	=	٩		٣.٠٠
١٧	=	٨		٢.٢٦
١٨	=	٨		١.٨٢
١٩	=	٨		٢.٢٧
٢٠	=	٧		٢.٣٦

جدول رقم(٣) مدرسة ام حكيم الاساسية

الصف السادس/إناث/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٢١	انثى	١١		١.٩٩
٢٢	=	١٢		٢.٩٨
٢٣	=	١٢		١.٩٠
٢٤	=	١٢		١.٤٥
٢٥	=	١٢		٢.٠٠
٢٦	=	١١		١.٧٨
٢٧	=	١٣		١.١٥
٢٨	=	١١		١.١٤
٢٩	=	١٢		٢.٠٠
٣٠	=	١١		١.٧٥

جدول رقم(٤) مدرسة الاشرفية الثانوية

الصف الثامن/إناث/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠مل
٣١	إنثى	١٣	والدها يعمل في مصنع البطاريات	٢.٦٤
٣٢	=	١٤		١.٣٠
٣٣	=	١٤		١.١٣
٣٤	=	١٤		١.٠٤
٣٥	=	١٣		٠.٩٧
٣٦	=	١٤		٠.٥٨
٣٧	=	١٤		٠.٥٤
٣٨	=	١٣		٠.٤٧
٣٩	=	٣١		١.٠٠
٤٠	=	١٤	استعمل الكحل في صغره	١.٣٠

جدول رقم(5) مدرسة سؤدة بنت زمعة الاساسية

الصف الثاني/ذكور/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٤١	ذكر	٨		١.55
٤٢	=	٧		١.٨٧
٤٣	=	٨		٠.5٠
٤٤	=	٨		٢.٢٨
٤5	=	٨		٠.٩١
٤٦	=	١٠		١.٣٢
٤٧	=	٨		٢.٣١
٤٨	=	٨		١.٣٧
٤٩	=	٨	توجد مسكبة بجانب السكن	١.١٣
5٠	=	٨		١.٣٨

جدول رقم (٦) سؤدة بنت زمعة الاساسية

الصف الخامس/إناث/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٥١	انثى	١١		١.٨٥
٥٢	=	١١		١.٦٢
٥٣	=	١١		١.٨٦
٥٤	=	١٢		١.٢٥
٥٥	=	١١		١.٤٣
٥٦	=	١٠		٠.٩٠
٥٧	=	١١		١.٠٣
٥٨	=	١١		١.٢٠
٥٩	=	١٠		٠.٦٧
٦٠	=	١١		١.٠٤

جدول رقم (٧)سؤدة بنت زمعة الاساسية

الصف الثاني/إناث/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٦١	انثى	٨		١.٦٠
٦٢	=	٧		١.٣٠
٦٣	=	٨		٠.٤١
٦٤	=	٨		١.١٤
٦٥	=	٧		٢.٠٣
٦٦	=	٨		١.٥٠
٦٧	=	٨		٢.٢٧
٦٨	=	٨		١.٧٨
٦٩	=	٨		٠.٨٠
٧٠	=	٨	يوجد مشغل ذهب على بعد٣٠٠م من منزل الطالب	١.٥٠

جدول رقم (٨) مدرسه ابو حنيفة الأساسية

الصف الثالث/ذكور/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠مل
٧١	ذكر	١٠		١.٢٧
٧٢	=	٩		١.٧٠
٧٣	=	٩		١.١٦
٧٤	=	٩		١.٠٨
٧٥	=	٩		٢.٠٠
٧٦	=	٨		١.٠٣
٧٧	=	٨		٢.٦٢
٧٨	=	٨		١.٦٢
٧٩	=	٨	استعمل الكحل سابقا	١.٨٤
٨٠	=	٨		١.٠٦

جدول رقم(٩) مدرسة ابو حنيفة الأساسية

الصف السادس/ذكور/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٨١	ذكر	١٢		٠.٨٠
٨٢	=	١٢	استعمل الكحل سابقا	٠.٦٥
٨٣	=	١٢	استعمل الكحل سابقا	١.٤٤
٨٤	=	١٢		١.٣١
٨٥	=	١٢		١.٣٤
٨٦	=	١١		٢.٧٦
٨٧	=	١٢		٠.٨٧
٨٨	=	١٢		٠.٢٥
٨٩	=	١٢		٠.٦٠
٩٠	=	١٢		٠.٩٠

جدول رقم(١٠) مدرسة شهدة بنت نصر

الصف الاول /إناث/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٩١	انثى	٧		١.٢٠
٩٢	=	٧		١.٧٧
٩٣	=	٧		١.٦٠
٩٤	=	٧		٠.٦٢
٩٥	=	٧		٢.٦٧
٩٦	=	٧		٠.٩٠
٩٧	=	٧		٢.٠٠
٩٨	=	٧		١.٢٦
٩٩	=	٧		١.٨٨
١٠٠	=	٧		١.٥٠

جدول رقم(١١) مدرسة هدى الشعراوي

الصف الاول والصف الثاني والصف الثالث/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١٠١	ذكر	٨		١.٤٣
١٠٢	=	٨		١.٩٥
١٠٣	=	٨		٢.٧١
١٠٤	=	٨		٣.٤٢
١٠٥	=	٨		٠.٩٣
١٠٦	=	٩		١.٩٢
١٠٧	=	٩		٢.٠٤
١٠٨	=	٧		٣.١٨
١٠٩	=	٧		٣.٠٠
١١٠	=	٨		١.٩٨

جدول رقم(١٢) مدرسة محمد إقبال

الصف الثامن /ذكور/الاشرفية

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١١١	ذكر	١٤		١.٣٤
١١٢	=	١٤		٢.٤٥
١١٣	=	١٤	استعمل الكحل سابقا بشكل قليل	٢.٢٩
١١٤	=	١٤		٠.٩٠
١١٥	=	١٤		٢.٢١
١١٦	=	١٣		٢.٤٨
١١٧	=	١٤		١.٩٢
١١٨	=	١٤	إستعمل الكحل اول اسبوع من ولادته	١.٥٥
١١٩	=	١٣		٢.٥٤
١٢٠	=	١٤		١.١٧

جدول رقم (١٣) جمانة بنت ابي طالب

الصف الثامن/إناث/ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١٢١	أنثى	١٤	استعمل ويستعمل الكحل	٤.٩٠
١٢٢	=	١٤	استعمل الكحل سابقا	١.١٠
١٢٣	=	١٤	استعمل الكحل سابقا المنزل قريب من مصنع البطاريات وقريب جدا من مسكبة	٠.٥٤
١٢٤	=	١٤		٠.٢٣
١٢٥	=	١٤	يوجد خلف البيت مصنع او مسكبة	٠.٢١
١٢٦	=	١٣	يبعد منزل الطالب حوالي ٥٠٠ م عن مصنع البطاريات او مسكبة	٠.٥٠
١٢٧	=	١٤	استعمل الكحل سابقا	٢.٧٠
١٢٨	=	١٤		١.٣٣
١٢٩	=	١٣	استعمل الكحل سابقا	٢.٣٥
١٣٠	=	١٤	مدة السكن في ماركا ٤ أشهر فقط	٢.١٠

جدول رقم (١٤) مدرسة جمانة بنت ابي طالب

الصف السادس/إناث/ ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١٣١	أنثى	١٢	لستعمل الكحل سابقا	١.١٨
١٣٢	=	١٢	لستعمل الكحل سابقا يبعد منزل الطالب حوالي ٢٠ م من مصنع البطاريات او مسكبة	١.٣٠
١٣٣	=	١٢	لستعمل الكحل سابقا	٠.٤٤
١٣٤	=	١٣		٠.٩٣
١٣٥	=	١١		٠.٨٤
١٣٦	=	١٢		٠.٦١
١٣٧	=	١٢		٢.٦١
١٣٨	=	١٢	يبعد منزل الطالب حوالي ٢٠ م عن مصنع البطاريات اومسكبة	١.١٠
١٣٩	=	١٢	مدة السكن ٣سنوات فقط في ماركا	١.٣٦
١٤٠	=	١٢	مدة السكن ٥سنوات يبعد منزل الطالب حوالي ٥٠٠م عن مصنع او مسكبة	١.٢٤

جدول رقم (١٥) مدرسة هند بنت امية

الصف الرابع/إناث /ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١٤١	أنثى	١٠		٢.٧٧
١٤٢	=	١٠		١.٢٩
١٤٣	=	١٠		٠.٣٤
١٤٤	=	٩		٠.٣٢
١٤٥	=	١٠		١.٢٠
١٤٦	=	١٠		٠.٦٠
١٤٧	=	١٠		١.٢٠
١٤٨	=	١٠		٢.٢٧
١٤٩	=	١٠		٠.٧٦
١٥٠	=	١٠		١.٦٥

جدول رقم (١٦) مدرسة هند بنت أمية

الصف الثامن/ إناث ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١٥١	أنثى	١٤		٣.٣٣
١٥٢	=	١٣		٣.٢١
١٥٣	=	١٤		١.٣٣
١٥٤	=	١٤		٢.٤٣
١٥٥	=	١٤		١.٢٧
١٥٦	=	١٤		١.٧٠
١٥٧	=	١٤		١.٢٥
١٥٨	=	١٤		١.٤٠
١٥٩	=	١٣		٠.٨٥
١٥٠	=	١٣		٣.٢٢

جدول رقم (١٧) مدرسة الكندي الاساسية

الصف الخامس / ذكور / ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١٦١	ذكر	١٠	يبعد منزل الطالب حوالي ٣ كم عن مصنع البطاريات او مسكبة	٣.٢٧
١٦٢	=	١٠	يبعد منزل الطالب حوالي ١٣٠م عن مسكبة او مصنع البطاريات	٢.٦١
١٦٣	=	١١		٢.٧٥
١٦٤	=	١٠		١.٩٧
١٦٥	=	١١		١.٧٥
١٦٦	=	١٠		١.٦٥
١٦٧	=	١١		٢.٢٧
١٦٨	=	١٠		٤.٨٥
١٦٩	=	١١		٣.٢٢
١٧٠	=	١١		٣.٤٥

جدول رقم (١٨) مدرسة الكندي الاساسية

الصف الاول / ذكور / ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
١٧١	ذكر	٨		٢.٠٠
١٧٢	=	٧		٢.٤٨
١٧٣	=	٧		١.٦٦
١٧٤	=	٦		٢.١٠
١٧٥	=	٦		١.٥٥
١٧٦	=	٧		٢.١٠
١٧٧	=	٧		١.٣٨
١٧٨	=	غير مذكور		١.٥٥
١٧٩	=	غير مذكور		٢.١٠
١٨٠	=	غير مذكور		٦.٠٧

جدول رقم(١٩) مدرسة الكندي الاساسية

الصف الثالث/ذكور/ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠مل
١٨١	ذكر	٨		١.٨٠
١٨٢	=	٨		٢.٦٢
١٨٣	=	٩		١.٤٤
١٨٤	=	٩		١.٨١
١٨٥	=	٩		٢.٣٨
١٨٦	=	٨		٢.١٦
١٨٧	=	٨		٣.٦٧
١٨٨	=	٩		١.٠٣
١٨٩	=	٨	توجد مسكبة او مصنع بطاريات على بعد حوالي ٢كم شرقا	٢.٤٩
١٩٠	=	٨		٣.٧٠

جدول رقم (٢٠) مدرسة الكندي الاساسية

الصف/السابع/ذكور/ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠مل
١٩١	ذكر	١٣	توجد مسكبة او مصنع على بعد حوالي ١كم من المنزل	١.٦١
١٩٢	=	١٣		١.٥٠
١٩٣	=	١٣	توجد مسكبة اومصنع على بعد حوالي ١كم من المنزل	٠.٨٨
١٩٤	=	١٢		٠.٧٧
١٩٥	=	١٣	توجد مسكبة اومصنع على بعد حوالي ١كم من المنزل	١.٦٥
١٩٦	=	١٣		٢.٣٧
١٩٧	=	١٣		١.١٥
١٩٨	=	١٣		١.٧٥
١٩٩	=	١٣		١.٧٨
٢٠٠	=	١٣		١.٩٥

جدول رقم (٢١) مدرسة أم كلثوم بنت عقبة

الصف الرابع إناث ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٢٠١	أنثى	١٠		١.١٥
٢٠٢	=	١٠		١.٣٥
٢٠٣	=	١٠		١.٠٠
٢٠٤	=	١٠	توجد مسكبة اومصنع قريب من منز ل الطالب	١.٤٣
٢٠٥	=	١٠	توجد مسكبة او مصنع على بعد حوالي ٢٥٠م من منزل الطالب	٢.٥٠
٢٠٦	=	٩	توجد مسكبة او مصنع على بعد حوالي ٥٠٠م من منزل الطالب	١.٣٦
٢٠٧	=	١٠	توجد مسكبة او مصنع على بعد حوالي ٢٥٠م من منزل الطالب	١.٨٨
٢٠٨	=	١٠		٢.٨٠
٢٠٩	=	١٠		٣.١٠
٢١٠	=	١٠	توجد مسكبة اومصنع قريب من منزل الطالب	٢.٤٧

جدول رقم (٢٢) مدرسة أم كلثوم بنت عقبة

الصف الثامن/ إناث/ ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٢١١	أنثى	١٣	توجد مسكبة اومصنععلى بعد حوالي ٢٥٠م من منزل الطالب شمالا	٢.٧٠
٢١٢	=	١٤	توجد مسكبة اومصنع على بعد حوالي ٤٠٠م إستعمل ويستعمل الكحل حاليا	١.٧٠
٢١٣	=	١٣		١.٢٢
٢١٤	=	١٤	أستعمل الكحل مرة واحدة فقط	١.١٠
٢١٥	=	١٤	استعمل الكحل سابقا	١.٤١
٢١٦	=	١٤		٠.٩٥
٢١٧	=	١٤	توجد مسكبة اومصنع على بعد حوالي ٧٠٠م من منزل الطالب	١.٨٢
٢١٨	=	١٤	توجد مسكبة اومصنع على بعد حوالي ١٠٠م من منزل الطالب شرقا	٢.٥٦
٢١٩	=	١٥		٢.١٠
٢٢٠	=	١٥		١.٤٩

جدول رقم (٢٣) مدرسة ام كلثوم بنت عقبة

الصف الثالث/ذكور/ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٢٢١	ذكر	٩	توجد مسكبة اومصنع بطاريات على بعد ٢كم من منزل الطالب	٤.٢٨
٢٢٢	=	٨		٥.٤٤
٢٢٣	=	٩		٢.١٩
٢٢٤	=	٩		٢.٦٢
٢٢٥	=	٩		٣.٠٥
٢٢٦	=	٩	قريب من مصنع البطاريات	٢.٣٤
٢٢٧	=	٩	توجد مسكبة اومصنع البطاريات على بعد ٥٠٠م من منزل الطالب شرقا	٣.٤٨
٢٢٨	=	٩	توجد مسكبة اومصنع البطاريات على بعد ٢كم من منزل الطالب	٣.٤٥
٢٢٩	=	٩		٣.٥٠
٢٣٠	=	٨		٢.١٤

جدول رقم (٢٤) مدرسة أم كلثوم بنت عقبة

الصف الاولى ذكور ماركا

الرقم	الجنس	العمر	ملاحظات	تركيز الرصاص ميكروجرام/١٠٠ مل
٢٣١	ذكر	٧		٢.٧٣
٢٣٢	=	٧	يبعد منزل الطالب حوالي ٢٠٠م من مسكبة اومصنع	١.٦٣
٢٣٣	=	٧		٢.٠٤
٢٣٤	=	٧	يبعد منزل الطالب حوالي ٨٠٠ م من مصنع البطاريات	١.٥٨
٢٣٥	=	٧		٢.٠٠
٢٣٦	=	٧	استخدم الكحل سابقا	٢.٢٣
٢٣٧	=	٦		١.٣٩
٢٣٨	=	٧	يقع مصنع البطاريات على بعد٥٠٠م من منزل الطالب	٣.٢٩
٢٣٩	=	٦		٢.٣٩
٢٤٠	=	٦	توجد مسكبة او مصنع بطاريات على بعد ٥٠٠ من منزل الطالب	٢.٥٣

Annex 4 Detailed Statistical Analysis

T-Test

	Area	N	Mean	Std. Deviation	Std. Error Mean
Concentra-tion	1	120	1.6327	.66968	.06113
	2	120	1.9970	1.05826	.09661

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Concentration	Equal variances assumed	13.907	.000	-3.187	238	.002	-.3643	.11432	-.58955	-.13912
	Equal variances not assumed			-3.187	201.136	.002	-.3643	.11432	-.58976	-.13891

T-Test

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
Concentra-tion	1	119	2.0724	.95353	.08741
	2	121	1.5616	.77277	.07025

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Concentration	Equal variances assumed	2.069	.152	4.563	238	.000	.5108	.11195	.29025	.73132
	Equal variances not assumed			4.555	226.676	.000	.5108	.11214	.28981	.73176

T-Test

Group Statistics

	USE	N	Mean	Std. Deviation	Std. Error Mean
Concentra-tion	1	49	1.9104	.97638	.13948
	2	191	1.7903	.88341	.06392

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Concentration	Equal variances assumed	1.458	.228	.831	238	.407	.1201	.14459	-.16475	.40494
	Equal variances not assumed			.783	69.504	.436	.1201	.15343	-.18595	.42614

Correlations

SEX = 1
Correlations (a)

		concentration	AGE
Concentration	Pearson Correlation	1	-.231(*)
	Sig. (2-tailed)	.	.012
	N	119	116
AGE	Pearson Correlation	-.231(*)	1
	Sig. (2-tailed)	.012	.
	N	116	116

* Correlation is significant at the 0.05 level (2-tailed).
a SEX = 1

SEX = 2
Correlations (a)

		concentration	AGE
concentration	Pearson Correlation	1	-.043
	Sig. (2-tailed)	.	.637
	N	121	121
AGE	Pearson Correlation	-.043	1
	Sig. (2-tailed)	.637	.
	N	121	121

T-Test

Notes

SEX = 1

Group Statistics (a)

	AREA	N	Mean	Std. Deviation	Std. Error Mean
Concentra-tion	1	59	1.7461	.73326	.09546
	2	60	2.3932	1.03863	.13409

a SEX = 1

Independent Samples Test (a)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Concentration	Equal variances assumed	2.055	.154	-3.920	117	.000	-.6471	.16507	-.97397	-.32016
	Equal variances not assumed			-3.931	106.211	.000	-.6471	.16460	-.97339	-.32074

a SEX = 1

SEX = 2

Group Statistics (a)

	AREA	N	Mean	Std. Deviation	Std. Error Mean
Concentra-tion	1	61	1.5230	.58721	.07518
	2	60	1.6008	.92781	.11978

a SEX = 2

Independent Samples Test (a)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Concentration	Equal variances assumed	9.916	.002	-.553	119	.582	-.0779	.14092	-.35691	.20115
	Equal variances not assumed			-.551	99.467	.583	-.0779	.14142	-.35848	.20271

a SEX = 2

Annex 5 Study Team

Eng. Salah Al-Heyari	Main Supervisor -Team leader Ministry of Health
Eng. Maysoon Bseiso	Coordinator Ministry of Health
Dr. Abdul Fattah Abusweilem	Supervision of blood Sample collection Ministry of Health
Mr. Khamees Rhaddad	Sample design & Statistical analysis Department of Statistics
Eng. Moh'd Al Joban	Field facilitator Ministry of Education
Abdulla Hiyasat Ameen Tahboob Eng. Mohammad Batayneh Adel Weshah	Facilitators and Field investigators Ministry of Health
Akram Salahat Salwa Hattab Wesal El-Basheer Adlah Salah Fadi Nafe'a Maha Alsardiyah	Chemical Analysis of blood samples Ministry of Health
Nabeelah Makkawi	Collection of blood samples Ministry of Health
Ahmad Jubeilat	Accountant Ministry of Health
Hani Hulayel	Driver Ministry of Health

Annex 6 Budget

World Health Organization (WHO) Contribution

The total allocated budget for this study is US $ 3,000 distributed as follows:

1. Report printing, photocopying and hard covering US $ 357.

2. Incentives for study team US $ 2643.

Ministry of Health (MoH) Contribution

Ministry of Health has contributed in kind through allowing the utilization of the laboratory analytical equipment during the study, and through providing transportation for the team during field investigation and sample collection.