Deanship of Graduate Studies
Al-Quds University

Risk Factors Associated with Lead Poisoning among Children Aged 2-6 Years in Gaza Governorates

Submitted by
Mohamed Jamal Safi

MPH Thesis

Jerusalem-Palestine
1432-2011

Deanship of Graduate Studies

Al-Quds University

Risk Factors Associated with Lead Poisoning among Children Aged 2-6 Years in Gaza Governorates

Submitted by:

Mohamed Jamal Safi

BSc. of Microbiology-Al-Azhar University-Palestine

Supervised by:

Dr. Yehia Abed
Associate Professor of Public Health
Al-Quds University

A Thesis Submitted in Partial Fulfillment of Requirements for the Degree of Master in Public Health/Environmental Health

Submitted in:

1432-2011

Deanship of Graduate Studies
Al-Quds University
School of Public Health

Thesis Approval

Risk Factors Associated with Lead Poisoning among Children Aged 2-6 Years in Gaza Governorates

Prepared by: Mohamed Jamal Safi

Registration No.: 20812749

Supervisor: Dr. Yehia Abed

Master thesis submitted and accepted date,

The names of signatures of the examining committee members are as follows:

1. Dr. Yehia Abed	**Head of committee**	....
2. Dr. Bassam Abu Hamad	**Internal examiner**	....
3. Prof. Dr. Majed Yassin	**External examiner**	....

Jerusalem – Palestine
1432/2011

بسم الله الرحمن الرحيم

"وَلَوْلاَ فَضْلُ اللَّهِ عَلَيْكَ وَرَحْمَتُهُ لَهَمَّت طَّآئِفَةٌ مِّنْهُمْ أَن يُضِلُّوكَ وَمَا يُضِلُّونَ إِلاَّ أَنفُسَهُمْ وَمَا يَضُرُّونَكَ مِن شَيْءٍ وَأَنزَلَ اللَّهُ عَلَيْكَ الْكِتَابَ وَالْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللَّهِ عَلَيْكَ عَظِيمًا"

صدق الله العظيم

سورة النساء– آية 113

Dedication

To my country

To my parents, my brothers and my sisters

To my wife, my sons and my daughters

Mohamed Jamal Safi

Declaration

I certify that this thesis submitted for the degree of master is the result of my own research, except where otherwise acknowledged, and that this thesis or any of its parts has not been submitted for higher degree to any other university or institution.

Signed

Mohamed Jamal Safi

Date: / /2011

Acknowledgment

First of all I would like to express my deepest thanks and gratitude to Professor Sari Nusseibeh, President of Al-Quds University for his great and kind help and continuous support during my study.

I would like to express my deepest thanks and gratitude to Professor Yehia Abed for his keen academic supervision, planning this study, brilliant suggestions, valuable advice, and friendly support.

Many thanks go to Dr. Bassam Abu Hamad and for the academic and administrative staff of School of Public Health for their guidance and support.

Many thanks are warmly extended to the brilliant team in the Environmental Protection and Research Institute, Gaza mainly Dr. Yasser El-Nahhal and Mr. Hassan Suleiman for their kind support and guidance during my master study.

I would like to acknowledge USAID-MERC for their grant number TA-MOU-06-M26-023.

Special thanks are to the nice group with whom I spent most beautiful days of my educational life, Asad Ashour, Abdullah Hamdona, Helmi Abu-Dalal, and Ramadan Hassan.

Finally, I would like to extend my warm thanks and gratitude to my beloved parents and grandfather, my brothers and sisters, my sincere wife, sons and daughters for their kind and continuous support, great efforts, encouragements and dedication during the study.

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
ALAD	Aminolevulinic Acid Dehydratase
ALA	Aminolevulinic Acid
BLL	Blood Lead Level
CDC	Centers for Disease Control and Prevention
CNS	Central Nervous System
EPA	Environmental Protection Agency
EPRI	Environmental Protection and Research Institute-Gaza
IRIN	Investor Relations Information Network
µg/dl	Microgram per deciliter
MOH	Ministry of Health
MEnA	Ministry of Environmental Affairs
NGOs	Nongovernmental Organizations
NIEHS	National Institute of Environmental Health Sciences
PCBS	Palestinian Central Bureau of Statistics
PCHR	Palestinian Center for Human Rights
PHC	Primary Health Care
SPSS	Statistical Package of Social Sciences
UNRWA	United Nations Relief and Works Agency for Palestine Refugees
WHO	World Health Organization

Abstract

Childhood lead toxicity is an international problem and the prevalence of lead toxicity is largely determined by age and proximity to environmental sources. Children are more vulnerable to lead exposure because of the frequency of pica and hand-to-mouth activities and because children have a greater rate of intestinal absorption and retention of lead. It has deleterious effects, not only on the gastrointestinal tract but also on the central nervous system and kidneys. Lead is damaging also to the red blood cells. These manifestations can be serious and can lead to coma and death in acute poisoning. Risk factors associated with lead poisoning among children aged 2-6 years in Gaza Governorates as case control study were studied. The overall aim of the study was to identify the common risk factors associated with lead poisoning among children and also aimed to protect human health and the environment from the adverse effects of lead. The study design was a quantitative analytical retrospective case control study. The study subjects were 240, in which 120 were cases selected from children with Blood Lead Level (BLL) ≥ 10 μg/dl and 120 were controls selected from children with BLL ≤ 9.9 μg/dl. These information are stored in a data base at the Environmental Protection and Research Institute (EPRI-Gaza). Socio-demographic variables illustrated that 152 (63.3%) were males and 88 (36.7 %) were females. The age of study subjects was classified into two groups. The first one (51.7 %) was 24-48 months, while the second one (48.3 %) was 49-72 months. The majority of study subjects were in Gaza Governorate (50%), while the smallest one was in Rafah Governorate (6.7 %). Data were statistically analyzed using SPSS version 16. Statistical analysis of capillary BLL of the samples indicated that the minimum and maximum was 3.2 and 65.1 μg /dl respectively with mean level of 10.19 μg /dl and median level 9.95 μg /dl. The study results demonstrated statistical significant relationship between BLL of the study subjects and some independent variables of risk factors such as familial exposure including kohl by child in long period; household location from exposure sources including smelter, battery recycling, radiator repair and other lead sources; household distance from exposure sources including smelter, battery manufacturing and recycling and gas station; occupational exposure including painting works; child feeding and day care including child out home; and child' health including child general health, child needs frequent medical care and child have anemia. The study results also pointed out that there are no statistical significant relationship between the BLL of the study subjects and variables of socio demographic, household exposure, period of occupational exposure, work clothes and showering (different protective occupational measures), tasks, crafts and hobbies at home (different familial exposure), and the child habits. Therefore, the study recommends childhood lead poisoning prevention policies to be initiated and implemented. Provide anticipatory guidance to parents of all infants and toddlers about preventing lead poisoning in their children. Removal of all nearby battery recycling and manufacturing plants/smelters, and auto radiator repair workshops located in the middle of highly populated urban areas, markets and dwelling zones is highly recommended. Children with high BLL more than 25 μg/dl should be treated and followed-up. Finally, decision-makers should introduce public awareness and educational programs to child sponsors and all levels of the interested personal about risk factors associated with lead poisoning and sources of lead exposure and its impact on human health.

Table of contents

Chapter 4: Results and discussions

Chapter 5: Conclusions and Recommendations

List of tables

List of Annexes

Chapter 1
Introduction

This chapter aims to give an introductory background about the study. This chapter includes the research background, research problem, justification of the study and research objectives. Moreover, this chapter presents the context of the study as well as operational definition.

1.1 Research Background

Gaza Strip is semi arid region with total area of 365 km^2 and considered as one of the most densely populated areas in the world with an estimated population of about 1.54 million Palestinian Central Bureau of Statistics (PCBS, 2010). Water shortage, overcrowding, poverty, overuse and uncontrolled use of pesticides, battery recycling and manufacturing as well as lead smelting are the most pressing environmental problems in Gaza Strip (Safi et al., 2006 and Safi 1998).

Lead is a toxic metal associated with neurological and intellectual impairment in children. Young children (6 months-6 years) are the group most exposed to lead because of their hand-to-mouth activity, especially those living in old houses with leaded paint or located near industrial facilities that do or did emit lead (Barbara et al., 2010). Lead poisoning is a serious medical condition resulting from exposure to extreme levels of lead from the environment. It can cause irreversible neurologic and multiple systemic complications and even death (Centers for Disease Control and Prevention, CDC, 2008). Children are more sensitive than adults to the effects of lead, young children under the age of five are particularly vulnerable for a variety of reasons, including the fact that their body and brain are still developing. Two year-olds tend to have the highest blood level concentration because they put many things into their mouth, including toys or other products that may become lead contaminated (National Institute of Environmental Health Sciences, NIEHS, 2008 and CDC, 2008). Lead poisoning is a medical condition caused by increased levels of the lead in the body.

Globally childhood lead toxicity is a serious problem. The presence of lead in blood has some crucial deleterious effects on the gastrointestinal tract, on the Central Nervous System (CNS) and on the kidneys. Lead is particularly damaging the CNS and the red blood cells. These manifestations can be serious and can lead to coma and death in acute poisoning (Yeoh, 2008; CDC 2007; Safi et al., 2006; CDC 2005; Rubin et al., 2002). Lead is especially dangerous for children. A child who swallows large amounts of lead may develop anemia, muscle weakness and brain damage. Even low levels of lead are linked to lower Intelligence Quotient Scores (CDC, 2008). Minor lead poisoning may cause in children milder effects such as sleep and behavioral problems, fatigue, shortened memory and anemia (Bellinger, 2008; Zhang and Dai, 2002). Many environmental lead contamination sources are responsible to these health problems.

In the Middle East today, the major reported sources of lead exposure are currently industrial sources including smelters, battery factories, radiator repair shops and used lead-based paints and gasoline (Safi et al., 2006; Safi, 2004; Rsocal et al., 1999 and El-Araby et al., 1995). Thousands of children living near smelting plants in China have been found with unsafe levels of lead in their blood in the latest health scandal to hit the country. A gradual build-up of lead in the bloodstream can damage the nervous system and lead to anemia, muscle weakness, arrested development and brain damage (Watts, 2009).

Managing childhood lead poisoning by chelation may save lives where BLLs are very high (Markowitz, 2003). Chelation therapy using Ca acetate and succimer, reduces BLLs and associated symptoms. Follow-up tests after an abnormal screening blood lead level are a key component of lead poisoning prevention (Kemper, 2005).

1.2 Research Problem

Due to the limited area of land and national organizations, industrial activities such as battery manufacturing and recycling are located among housing system. In addition, lead smelting to make fishing sinkers is being done inside houses. Due to these conditions, children and adults in those areas are exposed to lead poisoning. Because children are the more sensitive to lead poisoning than adults according to several publications, we selected the children of age 2-6 years old as a target group for this study. Also, there is a lack of enough studies, interest and information about lead toxicity in Gaza Governorates. Therefore, this study is designed to be carried out to assess childhood lead poisoning and related risk factors as a case control study in order to improve the health status in Gaza Governorates. The overall goal of the study is to protect human health and the environment from the adverse effects of lead.

1.3 Justification of the Study

Lead poisoning is an international and a serious health problem. It remains the most common and societal divesting environmental disease of young children. Lead is an environmental contaminant that threatens the health of all children everywhere. Children are exposed to lead from multiple sources such as batteries recycling and manufacturing, lead smelting, paints, leaded gasoline, lead solder, batteries and stationary sources via multiple pathways such as air, dust, soil, water and food contaminated with lead. Millions of US children from all geographical areas and socioeconomic strata have high BLL to be associated with adverse health effects (Agency for Toxic Substances and Disease Registry, ATSDR, 1993).

Lead is a developmental neurotoxin, children are most commonly exposed and they are most vulnerable. Lead exposure has been associated with many cognitive and motor deficits, as well as distractibility and other characteristics of attention deficit hyperactivity disorder. Children can still be exposed to lead from lead paint in older homes, toys, and other sources. Because post-exposure treatment cannot reverse the cognitive effects of lead exposure, preventing lead exposure is essential. Therefore, our study is needed for Gaza Governorates to identify risk factors associated with lead poisoning in order to control and prevent lead exposure.

1.4 Aim of the Study

The overall aim of the study is to identify the common risk factors associated with lead poisoning among children aged 2-6 years in Gaza Governorates. The present study also aims to protect human health and the environment from the adverse effects of lead.

1.5 Specific Objectives

1. To identify the main common risk factors associated with lead poisoning among children aged 2-6 years in Gaza Governorates.
2. To examine the association between socio-demographic variables and lead poisoning in Gaza Governorates.
3. To test the association between environmental variables and lead poisoning.

4. To examine relationship between child health status and lead poisoning.
5. To provide recommendations to improve professional and public awareness to the sources and to the potential effects of lead exposure, in order to develop an effective public health policy and measures to promote public health and safe environment.

1.6 Research Questions

1. Does lead uses in Gaza Governorates lead to childhood lead poisoning?
2. Is lead exposure a real threat to children in Gaza Governorates?
3. Which risk factors is a potential one for elevated BLL?
4. Does child habit and behavior associate with elevated BLL?
5. Does parents' occupation participate to elevate their children BLL?
6. Is there a relationship between socioeconomic factors and lead poisoning among children?

1.7 Context of the Study

1.7.1 Geographical Distribution:

Palestine is an Arabic Country, relatively small one. The total surface area of the historical Palestine is about 27.000 Km² (MOH, 2006). Gaza Strip is one of the most densely populated area in the world. The population in Gaza Strip are concentrated mainly in cities, small village and eight refugee camps, the refugee are more than two third of the population. Gaza Strip remains one of the weakest economic situations compared with the neighboring areas which adversely affect the public health (MOH, 2005). Gaza Strip is divided into five governorates: Gaza Governorate, North Governorate, Mid-zone Governorate, Khan-Younis Governorate, and Rafah Governorate.

1.7.2 Age and Sex Distribution:

According to the annual report of the Ministry of Health (2007), 45.7% of population is under 15 years, 48.8% in Gaza Strip and 43.9% in West Bank. The age group under five years old still the largest age group in Palestine which constitutes 17.3% of the whole Palestine population, 19.0% in Gaza Strip and 16.2% in West Bank. The age 60 years and over constitute 4.4% of the population (4.4% in Gaza Strip and 4.8% in West Bank), which means that Palestine population is still a society of young people.

1.7.3 Parent's Level of Education:

According to PCBS, it was established that 20.4 % of fathers and 11.1 % of mothers completed the first university degree, and the illiteracy percent among fathers was 0.2 % and 0.22 % among mothers. The main finding showed that the literacy rate is 92.9 % among individuals aged 15 years and over in Palestinian territory. This rate varies between males and females. It was 96.9 % for males and 88.9 % for females (PCBS, 2006).

1.7.4 Environmental Health Situation:

The Gaza Strip has a subtropical climate with four seasons. It is float and sandy with little fertile soil. The average rainfall is 405.1 mm per year (PCBS, 2007). Gaza Strip altitude is 0- 40 meters above sea level. The environment of Gaza Governorates suffers from considerable constrains. Shortage and pollution of resources, coupled with very high population growth, few job opportunities and long years of negligence have created many environmental health hazards (MEnA, 2000). The partially treated waste water and raw sewage end up in Mediterranean Sea. Some of partially treated sewage end up in the ground also, in some cases reaching the aquifer, polluting Gaza's already poor drinking water supply (IRIN, 2009).

The main source of water in Gaza Governorates is the underground water in the coastal aquifer. The groundwater is used for domestic, as well as for irrigation and industrial purposes. A water shortage, water pollution with high salinity and micro-pollutants, lack of sewage and solid waste treatment, marine pollution, overcrowding, poverty and uncontrolled use of pesticides are the most pressing environmental health problems in Gaza Strip (Safi, 1998). In general, these environmental problems have multiplied the Palestinian human environment socioeconomic problems while increasing health hazards (Safi, 1998).

1.7.5 Economical Situation:

Gaza Strip is a very poor area; its economy is mainly dependent upon agriculture, livestock rising, fishing, small industry and governmental employments. The conditions in the Gaza Strip had exacerbated the humanitarian situation for Palestinian civilians. Unemployment and poverty rates have increased dramatically. The Gaza economy has been greatly affected during the last six years due to a combination of unemployment, closures, and restrictions placed on workers and industries. Unemployment in Gaza reaching alarmingly high levels (PCHR, 2006). It was reported that unemployment rates in Gaza Strip reached 65 %, and that poverty rates get up to 80%, due to the ongoing Israeli-led siege and repeated assaults (Bannoura, 2009). Furthermore, 80 % of the residents in Gaza depend on humanitarian aid provided by different relief groups such as the World Food Program and the UNRWA. The ongoing siege forced 96 % of the factories and industrial areas in Gaza Strip to shut down as the closure of border terminals blocked exports and also blocked imports of tools and equipment needed by the factories to continue the production process (Bannoura, 2009).

1.7.6 Health Care System:

Ministry of Health has been fully responsible for the management of health services in the Palestinian Territories since the transfer of responsibilities from the Israeli civil administration to the Palestinian Authority in 1994 (World Health Assembly, 2005). UNRWA and other nongovernmental organizations (NGOs) are considered as second hand providers of health services in Palestine (MOH, 2003). Palestinian health care system mainly includes eight components, which are primary health care, laboratories and blood banks, hospitals, health human resources, health finance, governmental health insurance, treatment abroad, and health projects (MOH, 2005).

In Palestine, the crude birth rate (CBR) in 2006 was 36.7 births per 1000. In Gaza Strip, the CBR is 41.7 per 1000, but in West Bank was 33.7 per 1000 (PCBS, 2008). The crud death rate (CDR) in 2006 was 3.9 deaths per 1000. The CDR in Gaza Strip was 3.8 and 4.0 in West Bank (PCBS, 2008). The leading causes of adult death are similar to developed countries including cardiovascular diseases and cancers with a high prevalence of stress and psychological trauma related diseases. On the other hand, diseases of poverty are still prevalent such as respiratory infections and diarrhea diseases that remain important causes of child mortality and morbidity (MOH, 2005).

1.7.6.1 Hospitals in Palestine

In Palestine, the secondary healthcare services are provided by governmental, non-governmental, UNRWA, and private sector. MOH is the main provider of secondary health care services and some of the tertiary care (MOH, 2003). The MOH owns and operates 22 hospitals, 10 in Gaza Strip and 12 in West Bank (MOH, 2005).

1.7.6.2 Primary Health Care (PHC):

Primary Health Care (PHC) is one of the most important components of the Palestinian health care system. PHC centers provide accessible and affordable health services for all Palestinians, especially for children and other vulnerable groups. MOH is working with other health sectors in providing the primary health services, mainly UNRWA and NGOs (MOH, 2005).

The total number of registered PHC centers in Palestine is 731 centers. Distribution by provider shows that, there are 413 centers owned and supervised by the MOH, 53 centers by the UNRWA and NGOs have 265 centers. In Palestine, the average ratio of persons per center is 4.976 (MOH 2004).

1.7.6.3 Non-Governmental Organizations (NGOs):

NGOs are considered as second providers of health services in Palestine (MOH, 2003). In 2004, the health sector in NGOs owns and operates 265 mini PHC centers in Palestine. Some centers include medical laboratories to perform simple diagnosis, and many pharmacies that provide the attendants with low cost medication (MOH, 2004).

1.8 Operational Definition

CDC guidelines (1991) set the lead poisoning at a confirmed blood lead level greater than or equal to 10 μg/dl.

Case subjects are children with BLL more than or equal to 10 μg/dl.

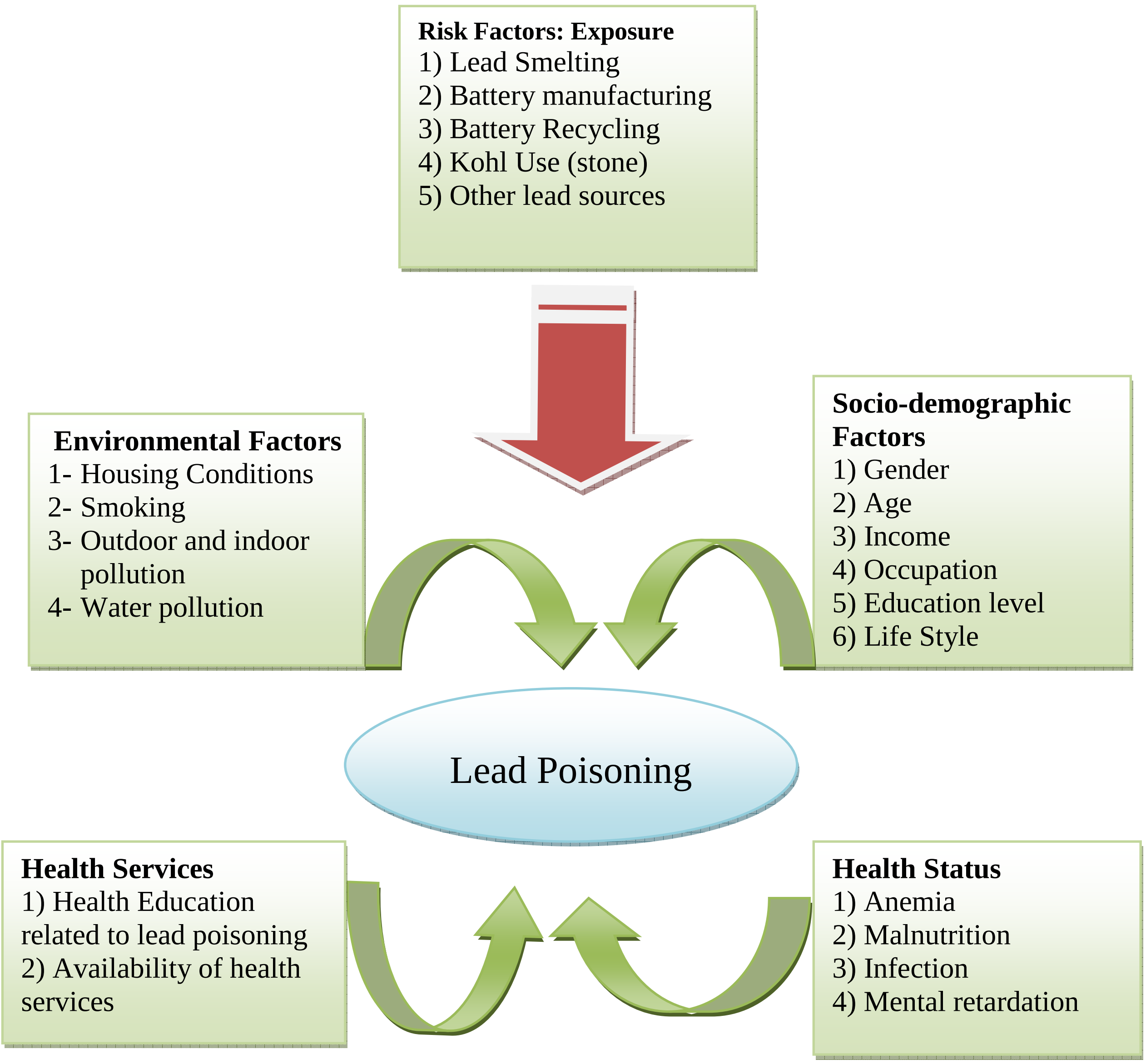
Control subjects are children with BLL less than 10 μg/dl.

Chapter 2

Literature Review

In this chapter, the researcher provides the conceptual framework and previous publications, which identify the main concepts and variables related to the study.

2.1 Conceptual Framework



2.2 Lead as Public Health Problem

To evaluate the magnitude of lead as a public health problem, three key elements must be addressed: the potential sources of exposure, the indicators to evaluate health effects and environmental exposure and sampling methods for the population at risk (Romieu, 2003). BLL measurements should be integrated in an overall strategy to prevent lead toxicity in children.

Lead exposure nonetheless remains a public health concern because exposure is still high in developing countries, increasing evidence indicates effects at any levels below 100 μg/L and even a possible steeper dose-response relationships at very low levels (Glorennec et al., 2010). In countries with a low prevalence of BLLs >100 μg/L, the implication of this absence of threshold is that very low levels account for most of the lead burden because they are more frequent the BLL distribute lognormally (Glorennec et al., 2010).

Lead is a toxic metal associated with neurological and intellectual impairment in children. Young children (6 months–6 years) are the group most exposed to lead because of their hand-to-mouth activity, especially those living in old houses with leaded paint or located near industrial facilities that do or did emit lead (Barbara et al, 2011). Lead is a developmental neurotoxin, interfering with neurotransmission, cellular migration, and synaptic plasticity during central nervous system development. Epidemiologic studies show associations between even low BLL and lowered intelligence quotient (Alan and Margaret, 2010).

Sanna et al. (2011) evaluated the correlations between the concentrations of lead in blood, urine, and hair in children in Italy and suggested that blood is the preferred biomarker to ascertain lead exposure in human populations, whereas hair can be used as a tool screening when an area is exposed to medium or high lead pollution. Wang et al (2011) studied Benchmark dose approach for low-level lead induced haematogenesis inhibition and associations of childhood intelligences with delta-aminolevulinic acid dehydratase (ALAD) activity and delta-aminolevulinic acid (ALA) levels. It was concluded that blood ALAD activity is a sensitive indicator of early haematological damage due to low-level Pb exposures for children.

2.3 Lead Exposure

Lead poisoning is one of the most common and preventable pediatric health problems of environmental origin today. Managing childhood lead poisoning by chelating may save lives where BLL are very high (Markowitz, 2003). Chelating therapy using Ca acetate and succimer reduces BLL and associated symptoms. Follow-up tests after an abnormal screening BLL is a key component of lead poisoning prevention (Kemper 2005).

Childhood lead toxicity is an international problem and the prevalence of lead toxicity is largely determined by age and proximity to environmental sources. Children are more vulnerable to lead exposure because of the frequency of pica and hand-to-mouth activities and because children have a greater rate of intestinal absorption and retention of lead (Yeoh 2008, Safi et al 2006, CDC 2005, Safi 2004, Rubin et al 2002). Since the first reports on the lead poisoning, there has been much research bringing to light the relationship of lead absorption into the body and its deleterious effects, not only on the gastrointestinal tract but also on the central nervous system and kidneys (Bellinger 2008, Rengold et al 2005, Shen et al 2001 and Lanphear et al 2000).

Lead is a common environmental pollutant and causes of environmental contamination include industrial use of lead, such as is found in plants that process lead-acid batteries or produce lead wire or pipes, and metal recycling and foundries (Ragan and Turner, 2009). Children living near facilities that process lead, such as smelters, have been found to have unusually high blood lead levels (Sanborn et al., 2002). In many countries including the US, household paint and dust is the major route of exposure in children (Dart et al., 2004).

Llop et al (2011) evaluated the prenatal exposure to lead in Spain and concluded that lead levels to which newborns are exposed are low. Mobilization of lead from bones may be the main contributor to the cord blood levels. Khan et al (2011) evaluated the synergistic effects of iron deficiency and lead exposure on BLL in children and concluded that Iron deficiency in combination with lead exposure synergistically elevates BLL and susceptibility to its harmful effects in children.

2.3.1 Lead Exposure in the Middle East:

In the Middle East today, the major reported sources of lead exposure are currently used lead-based paints, gasoline and industrial sources including smelters, battery factories, and radiator repair shops and flour from the stone mills (Safi et al., 2006, Safi 2004, Rsocal et al 1999, El-Araby et al 1995, Hershko et al 1989, Abdullah 1984,). The children of the lead-exposed workers are also at high risk for lead poisoning. In addition, some women in the Middle East are using a traditional homemade cosmetic called KOHL on their eyes and on the eyes of their young children (Parry & Eaton 1991). These women are unaware of the dangers of making and using homemade Kohl. Isolated cases of lead poisoning have been reported as a result of the use of dental powders such as Saoot and Cebagin, which may contain as high as 51% of lead (Ner et al 1992).

In 2006 & 2004 Safi have reported the results of a pilot study of BLL measurements in children (n=435) age 2-6 years in the Gaza Strip. This study was accompanied with an effort to locate potential sources of lead contamination. Using a two-stage cluster probability design, augmented by searches for hot spots, BLL were measured. Blood samples were collected by finger stick and tested on a Portable Lead Care, Blood Lead Testing System and Lead Care Kits. The results revealed a mean BLL of 8.6µg/dl with a high peak of ≥65 µg/dl. 17.2% of the examined children (n=435) had BLL higher than 10 µg/dl. The main lead contamination source was found to be the nearby battery plant/smelter located in the middle of a highly populated urban area and markets. Point exposures have been occupational and industrial sources as well as the use of "Kohl" in cosmetics. Children of the lead-exposed workers are also at high risk for lead poisoning. These findings state the case for investigation targeted at hot spots and special situations rather than routine population-wide surveillance and screening.

At present, the researcher estimate that in Gaza Strip at least several thousand children are living in neighborhoods close to hot spots for lead contamination. This estimation means that there is a case for a larger follow-up research study in Gaza Strip with the goal of mass screening of children. There is a need to gain access to children at risk of lead exposure from industrial sources, either through proximity to point sources, or as children of workers.

2.4 Routes of Lead Exposure

Exposure to lead occurs through inhalation, ingestion or occasionally skin contact. Lead may be taken in through direct contact with mouth, nose, and eyes (mucous membranes), and through breaks in the skin. Tetra-ethyl lead, which was a gasoline additive and is still used in fuels such as aviation fuel, passes through the skin; however inorganic lead found in paint, food, and most lead-containing consumer products is only minimally absorbed through the skin (Patrick, 2006).

Study carried out by Karri et al., (2008) indicated that the main sources of absorption of inorganic lead are from ingestion and inhalation. When ingested inorganic lead, about 15% is absorbed, but this percentage is higher in children, pregnant women, and people with deficiencies of calcium, zinc, or iron. Children and infants may absorb about 50% of ingested lead, but little is known about absorption rates in children (Grant, 2009).

The main body compartments that store lead are the blood, soft tissues, and bone; the half-life of lead in these tissues is measured in weeks for blood, months for soft tissues, and years for bone (Karri et al., 2008). However, in adults, 94% of absorbed lead is deposited in the bones and teeth, but children only store 70% in this manner, a fact which may partially account for the more serious health effects on children (Barbosa et al., 2005). The estimated half-life of lead in bone is 20–30 years, and bone can introduce lead into the bloodstream long after the initial exposure is gone (Patrick, 2006). The half-life of lead in the blood in men is about 40 days, but it may be longer in children and pregnant women, whose bones are undergoing remodeling, which allows the lead to be continuously re-introduced into the bloodstream (Barbosa et al., 2005).

2.5 Sources of Lead Exposure

Lead is naturally occurring, blush-grey metal that has no taste or smell. Lead can be found in food, ambient air, drinking water, gasoline, battery factories, smelters, flaking and chipping paint, dust and chips from improper removal of exterior / interior paint and lead-contaminated soil (Mushak & Crocetti, 1989 and Benin, 1999).

Lead is a common environmental pollutant. Causes of environmental contamination include industrial use of lead, such as is found in plants that process lead-acid batteries or produce lead wire or pipes, and metal recycling and foundries (Ragan and Turner 2009).

Lead exposure can occur from contact with lead in air, household dust, soil, water, and commercial products (Rossi, 2008).

Occupational exposure is the main cause of lead poisoning in children and adults (Patrick, 2006). Children of workers in battery manufacturing and recycling are at risk for lead exposure; this worker ladles molten lead into billets in a lead-acid battery recovery facility (Brodkine, et al., 2007). Other occupations that present lead exposure risks include welding, manufacture of rubber, printing, zinc and copper smelting, combustion of solid waste, and production of paints and pigments. Parents who are exposed to lead in the workplace can bring lead dust home on clothes or skin and expose their children (Dart, et al., 2004). Needleman (2004) studied how people exposed to lead and found that people can be exposed when working in facilities that produce a variety of lead-containing products; these include radiation shields, ammunition, certain surgical equipment, fetal monitors, plumbing, jet engines, and ceramic glazes. Choudhari et al. (2010) conducted a lead exposure study in a total of 452 school children in the age group of 9-14 years residing near a lead-zinc mine (situated within a 2.5 km radius). They revealed that BLL in about 80% of the children were less than10 μg/dl.

Tetraethyl lead, which used to be added to gasoline, contributed to soil contamination. Residual lead in soil contributes to lead exposure in urban areas (Guidotti and Ragain, 2007). Lead content in soil may be caused by broken-down lead paint, residues from lead-containing gasoline or pesticides used in the past, contaminated landfills, or from nearby industries such as foundries or smelters. Although leaded soil is less of a problem in countries that no longer have leaded gasoline, it remains prevalent, raising concerns about the safety of urban agriculture (Woolf et al., 2007).

Lead from the atmosphere or soil can end up in groundwater and surface water. It is also potentially in drinking water, e.g. from plumbing and fixtures that are either made of lead or have lead solder. In the US, 14–20% of total lead exposure is attributed to drinking water (Mass et al., 2005). In Australia, collecting rainwater from roof runoff used as potable water may contain lead if there is lead contaminates on the roof or in the storage tank. The Australian Drinking Water Guidelines allow a maximum of 0.01 mg/L lead in water (Rossi, 2008).

Vinyl mini-blinds, found especially in older housing, may contain lead (Ragan and Turner 2009). Guidotti and Ragain, (2007) indicated that lead can be found in products such as kohl, a South Asian cosmetic, and in some toys. Patrick, (2006) reported that ceramic glaze often contains lead, and dishes that have been improperly fired can leach the metal into food, potentially causing severe poisoning. In some places, the solder in cans used for food contains lead.

2.6 Epidemiology of Lead Poisoning

Since lead has been used widely for centuries, the effects of exposure are worldwide (Payne, 2008). Environmental lead is ubiquitous, and everyone has some measurable BLL (Karri et al, 2008). Lead is one of the largest environmental medicine problems in terms of numbers of people exposed and the public health toll it takes (Pokras and Kneeland, 2008). Although regulation reducing lead in products has greatly reduced exposure in the developed world since the 1970s, lead is still allowed in products in many developing countries (Pokras and Kneeland, 2008).

Poor children in developing countries are at high risk for lead poisoning (Meyer et al, 2003). In all countries that have banned leaded gasoline, average blood lead levels have fallen sharply which is the primary source of lead exposure in most developing countries (Meyer et al, 2003 and 2008). However, some developing countries still allow leaded gasoline (Payne, 2008). About 7% of North American children have blood lead levels above 10 μg/dl, whereas among Central and South American children, the percentage is 33–34% (Payne, 2008). In addition, about one fifth of the world's disease burden from lead poisoning occurs in the Western Pacific, and another fifth is in Southeast Asia (Payne, 2008). In developed countries, nonwhite people with low levels of education living in poorer areas are most at risk for elevated lead (Pokras and Kneeland, 2008).

Risk factors for elevated lead exposure include alcohol consumption and smoking (possibly because of contamination of tobacco leaves with lead-containing pesticides) (Hu, et al, 2007).

Adults with certain risk factors might be more susceptible to toxicity; these include calcium and iron deficiencies, old age, disease of organs targeted by lead (e.g. the brain, the kidneys), and possibly genetic susceptibility (Kosnett et al, 2007). Bellinger, (2004) found differences in neurological damage between males and females due to lead exposure and emphasize that males to be at greater risk than females.

Children of below 6 years old are more sensitive to elevated blood lead levels than adults (Murata et al., 2009). Children may also have a higher intake of lead than adults; they breathe faster and may be more likely to have contact with and ingest soil (Dart et al., 2004). In adults, BLL steadily increase with increasing age and also adults of all ages, men have higher blood lead levels than women do (Rossi, 2008).

Children ages one to three years tend to have the highest BLL, possibly because at that age they begin to walk and explore their environment, and they use their mouths in their exploration (Bellinger, 2004). Blood levels usually peak at about 18–24 months old (Pearson and Schonfeld, 2003). Cox et al. (2010) evaluated BLL in Mississpi children and found that the percentage of 1-5-year-old children with BLL >10 μg /dl in Mississippi is less than those seen nationally, and mean levels are comparable to national ones.

Srinivasa et al (2011) assessed the prevalence of sub-clinical Pb toxicity and trace element deficiencies (Fe), (Zn), (Cu) (Mg). Their results suggest higher prevalence of sub-clinical Pb toxicity and trace element deficiencies in urban children. Further, high blood Pb levels appear to be correlated with reduced δ -aminolevulinate dehydratase activity and iron status in Pb exposed children.

2.7 Classification of Lead Poisoning

Lead poisoning may be acute (from intense exposure of short duration) or chronic (from repeat low-level exposure over a prolonged period), but the latter is much more common (Rossi, 2008). Lead poisoning has been defined as exposure to high levels of lead typically associated with severe health effects (Grant, 2009). Authorities such as the American Academy of Pediatrics define lead poisoning as blood lead levels higher than 10 μg/dl (Ragan and Turner, 2009).

Diagnosis and treatment of lead exposure are based on BLL measured in micrograms of lead per deciliter of blood (μg/dL). The CDC and the WHO stated that a blood lead level of 10 μg/dL or above is a cause for concern; however, lead may impair development and have harmful health effects even at lower levels, and there is no known safe exposure level (Rossi, 2008 and Barbosa et al., 2005).

2.7.1 Acute Lead Poisoning:

In acute poisoning, typical neurological signs are pain, muscle weakness, par aesthesia, and, rarely, symptoms associated with encephalitis (Pearce, 2007). Abdominal pain, nausea, vomiting, diarrhea, and constipation are other acute symptoms. Lead's effects on the mouth include astringency and a metallic taste (Brunton, 2007). Gastrointestinal problems, such as constipation, diarrhea, poor appetite, or weight loss, are common in acute poisoning. Absorption of large amounts of lead over a short time can cause shock (insufficient fluid in the circulatory system) due to loss of water from the gastrointestinal tract (Brunton, 2007). Hemolysis (the rupture of red blood cells) due to acute poisoning can cause anemia and hemoglobin in the urine, damage to kidneys can cause changes in urination such as decreased urine output. People who survive acute poisoning often go on to display symptoms of chronic poisoning (Brunton, 2007).

2.7.2 Chronic Lead Poisoning:

Chronic poisoning usually presents with symptoms affecting multiple systems (Kosnett, 2007). But is associated with three main types of symptoms: gastrointestinal, neuromuscular, and neurological; central nervous system and neuromuscular symptoms usually result from intense exposure, while gastrointestinal symptoms usually result from exposure over longer periods (Brunton, 2007). Signs of chronic exposure include loss of short-term memory or concentration, depression, nausea, abdominal pain, loss of coordination, and numbness and tingling in the extremities (Pearce, 2007). Fatigue, problems with sleep, headaches, stupor, slurred speech, and anemia are also found in chronic lead poisoning. Children with chronic poisoning may refuse to play or may have hyperkinetic or aggressive behavior disorders (Pearce, 2007).

2.8 Signs and Symptoms of Lead Poisoning

Lead poisoning can cause a variety of symptoms and signs which vary depending on the individual and the duration of lead exposure (Karri et al, 2008). Symptoms are nonspecific and may be subtle, and someone with elevated lead levels may have no symptoms (Mycyk et al, 2005). Symptoms usually develop over weeks to months as lead builds up in the body during a chronic exposure, but acute symptoms from brief, intense exposures also occur (Dart and Boyer, 2004).

Children may also experience hearing loss, delayed growth, drowsiness, clumsiness, or loss of new abilities, especially speech skills. Symptoms may appear in children at lower blood lead levels than in adults (Marshall and Bangert, 2008).

Symptoms may be different in adults and children; the main symptoms in adults are headache, abdominal pain, memory loss, kidney failure, male reproductive problems, and weakness, pain, or tingling in the extremities (Pearce, 2007). The classic signs and symptoms in children are loss of appetite, abdominal pain, vomiting, weight loss, constipation, anemia, kidney failure, irritability, learning disabilities, and behavior problems (Pearce, 2007).

2.9 Effects of Lead Poisoning on Human Health

Ringold et al. (2005) reported that lead is damaging the red blood cells. These manifestations can be serious and can lead to coma and death in acute poisoning. Minor lead poisoning may cause in children, milder effects such as sleep and behavioral problems, fatigue, shortened memory and anemia (Campbell and Osterhoudt 2000 & Mendelsohn et al 1998). Lead poisoning may have serious and even fatal consequences at any age, but young children are especially vulnerable. This environmental toxicant may deleteriously affect the nervous, hematopoietic, endocrine, renal, and reproductive systems (Bellinger 2008, Rengold et al 2005, and ATSDR, 1993).

Lead crosses the placenta and can cause permanent neurological impairment to the fetus (Garbo et al, 1998). Indeed, lead poisoning was reported in newborn and infants in an epidemiological study carried out in northern Italy (Garbo et al, 1998). Effects of low- lead level exposure on neurobehavioral development in 1-3 year-old children were reported, accompanied with Intervention Guideline (Bellinger 2008, Zhang and Dai 2002). Until recently, a BLL of 10 μg/dl was considered as a threshold for intervention (CDC 2005, 2000, 1997, 1991), but new data suggest that there is no such threshold and any lead blood level is dangerous for children (Bernard, 2003). As a result, lead poisoning is the presence of an elevated level of lead in the blood. In a recent study, Ringold et al. (2005) have estimated that about 2% of children younger than 6 years in the US have elevated BLL. Another study evaluated childhood lead poisoning in Latin America (Romieu 2003).

2.9.1 Effects of Lead Poisoning on CNS:

Bellinger (2004) illustrated that lead affects the peripheral nervous system (especially motor nerves) and the central nervous system. Peripheral nervous system effects are more prominent in adults and CNS effects are more prominent in children. The brain is the organ most sensitive to lead exposure (Cecil et al. 2008). Lead poisoning interferes with the normal development of a child's brain and nervous system; therefore children are at greater risk of lead neurotoxicity than adults are (Sanders et al., 2009). Guidotti and Ragain (2007) found that BLL below10 μg/dl have associated with lower IQ and behavior problems such as aggression, in proportion with BLL. The study carried out by Cleveland et al. (2008) showed that increased BLL in children has been correlated with decreases in intelligence, nonverbal reasoning, short-term memory, attention, reading and arithmetic ability, fine motor skills, emotional regulation, and social engagement. Also, the effect of lead on children's cognitive abilities takes place at very low levels. Another study about lead exposure carried out by Meyer et al. (2003) revealed that lead exposure in young children has been linked to learning disabilities, and also, children with blood lead concentrations greater than10 μg/dl are in danger of developmental disabilities.

Lanphear et al., (2005) reported that lead affects every one of the body's organ systems, especially the nervous system, but also the bones and teeth, the kidneys, and the cardiovascular, immune, reproductive systems, also, hearing loss and tooth decay have been linked to lead exposure. Kasten-Jolly et al., (2011) evaluated the harmful effects of lead to the CNS of children and found that the deleterious effects of Pb on learning and long-term memory are posited to result from excessive astrocyte growth and/or activation with concomitant interference with neural connections.

Bellinger (2008) reported that lead exposure in children is correlated with neuropsychiatric disorders such as attention deficit hyperactivity disorder and antisocial behavior. Needleman, (2004) found that elevated lead levels in children are correlated with higher scores on aggression and delinquency measures. Also, revealed that countries with the highest air lead levels have been found to have the highest murder rates, after adjusting for confounding factors. Eubig et al (2010) evaluated the Lead as risk factor for attention deficit/hyperactivity disorder. They speculated that exposures to environmental contaminants, including lead and PCBs, may increase the prevalence of lead and PCBs as risk factors for attention deficit/hyperactivity disorder.

2.9.2 Effects of Lead Poisoning on Renal System:

Kidney damage occurs with exposure to high levels of lead, and evidence suggests that lower levels can damage kidneys as well. The toxic effect of lead causes nephropathy and may cause Fanconi syndrome, in which the proximal tubular function of the kidney is, impaired (Grant, 2009). Ekong et al., (2006) showed that long-term exposure at levels lower than those that cause lead nephropathy have also been reported as nephrotoxic in patients from developed countries that had chronic kidney disease or were at risk because of hypertension or diabetes mellitus.

2.9.3 Effects of Lead Poisoning on Cardiovascular System:

Evidence suggests lead exposure is associated with high blood pressure, and studies have also found connections between lead exposure and coronary heart disease, heart rate variability, and death from stroke, but this evidence is more limited (Navas-Acien et al., 2007). People who have been exposed to higher concentrations of lead may be at a higher risk for cardiac autonomic dysfunction on days when ozone and fine particles are higher (Park et al., 2008).

2.9.4 Effects of Lead Poisoning on Reproductive System:

Cleveland et al., (2008) reported that a pregnant woman's elevated BLL can lead to miscarriage, prematurity, low birth weight, and problems with development during childhood. Lead is able to pass through the placenta and into breast milk, and BLL in mothers and infants are usually similar (Dart et al., 2004). Bellinger (2005) studied birth defects and indicated that a fetus may be poisoned *in utero* if lead from the mother's bones is subsequently mobilized by the changes in metabolism due to pregnancy; increased calcium intake in pregnancy may help mitigate this phenomenon.

2.10 Risk Factors Associated with Lead Poisoning Worldwide

Children living near facilities that process lead, such as smelters, have been found to have unusually high BLL. In August 2009, parents rioted in China after lead poisoning was found in nearly 2000 children living near zinc and manganese smelters (Watts, 2009). Sanborn et al. (2002) reported that lead miners and smelters, plumbers and fitters, auto mechanics, glass manufacturers, construction workers, battery manufacturers and recyclers, firing range instructors, and plastic manufacturers are at risk for lead exposure.

Pears (2007) revealed that deteriorating lead paint and lead-containing household dust are the main causes of chronic lead poisoning. Gilbert and Weiss (2006) showed that some lead compounds are bright colors and are used widely in paints, and lead paint is a major route of lead exposure in children. Deteriorating lead paint can produce dangerous lead levels in household dust and soil also, exposed children to dangerous lead.

Many young children display pica, eating things that are not food. Even a small amount of a lead-containing product such as a paint chip or a sip of glaze can contain tens or hundreds of milligrams of lead. Eating chips of lead paint presents a particular hazard to children, generally producing more severe poisoning than occurs from dust (Kosnet, 2006).

Lead is commonly incorporated into herbal remedies such as Indian Ayurvedic preparations and remedies of Chinese origin. There are also risks of elevated BLL caused by folk remedies like *azarcon* and *greta*, which each contain about 95% lead (Karri et al., 2008). CDC (2006) revealed that ingestion of metallic lead, such as small lead fishing lures, increases BLL and can be fatal. Hunt et al. (2009) showed that people who eat animals hunted with lead bullets may be at risk for lead exposure. Also, bullets lodged in the body rarely cause significant levels of lead poisoning. Childhood lead poisoning associated with spices used in food preparation was also reported by Woolf et al (2005).

Chapter 3

Methodology

This chapter indicates the research methodology, which was used to conduct this study. The chapter presents study design, study population, study setting, and the ethical procedures that were considered in the study. Tools and instruments, data collection and analysis processes are presented in this chapter. The chapter also presents the selection criteria and the limitations of the study.

3.1 Study Design

The design of the present study is a quantitative analytical retrospective case control study, which is very useful to investigate the possible environmental risk factors associated with lead poisoning among children aged 2-6 years in Gaza Governorates. This type of study selected cases from children in Gaza Governorates with blood lead level 10 μg/dl or higher and controls selected from children living in the same community and proved to have low blood lead level (less than10 μg/dl).

3.2 Period of the Study

The study started in the period from the first of January to the end of June, 2011.

3.3 Study Population

The study was performed on children living in Gaza Governorates and their information is stored in a data base in Environmental Protection and Research Institute (EPRI-Gaza). This study is targeted children, aged 2-6 years. The study design and sampling methods aimed to take into account differing population distributions, age patterns, residential distribution, anticipated prevalence, patterns of clustering of high blood lead and percent responders. According to this study design cases and controls are selected from the census population.

3.4 Sample Size

The EPI Info 6 (Epidemiological Information Statistical Program) statistical calculator was used to calculate the sample size. Based on assumption that prevalence of exposures for cases among cases is 25 % and the occurrence of the same exposures among control is 10 % at 95 % confidence interval and 80 % power and based on one control for each case, the sample size were 120 cases and 120 controls.

3.5 Selection of Cases

The cases were 120 children selected from children who have blood lead level 10 μg/dl or higher and registered in EPRI data base.

3.6 Selection of Controls

The controls were 120 children selected from children who have blood lead level less than 10 μg/dl and registered in EPRI data base.

3.7 Eligibility

3.7.1 Inclusion Criteria:

- **Cases:** Children aged 2-6 years and have blood lead level 10 μg/dl or higher and living in Gaza Governorates was eligible for the study.
- **Controls:** Children aged 2-6 years and have blood lead level less than 10 μg/dl and living in Gaza Governorates was eligible for the study.

3.7.2 Exclusion Criteria:

All children whether cases or controls reported in hot spots are excluded and will not be included in this study

- **Cases:** Any Children who have blood lead level less than 10 μg/dl, less than 2 years old, more than 6 years old and is not living in Gaza Governorates was excluded from the study**.**
- **Controls:** Any Children who have blood lead level 10 μg/dl or higher, less than 2 years old, more than 6 years old and is not living in Gaza Governorates was excluded from the study**.**

3.8 Ethical Considerations

This study carried out in accordance with the directions of the Helsinki Committee in the Ministry of Health and under its approval. An informed consent was attached to each questionnaire obtained from each participant parent in the study. All participants parents in the study received a complete explanation about the research purpose, full disclosure about the nature of the study, length of investigation, the subject's right to refuse participation, risks and benefits, how they have been selected, confidentiality and sponsorship.

3.9 Research Instrument

Personal questionnaires was abstracted and completed. The researcher used these questionnaires because they are easy for the participants and since this is the gold standard method of data collection. Quantitative approach provides wide coverage and characterized by high validity and reliability.

3.10 Questionnaire Design

The questionnaire for the study is specially designed and prepared to compile information relating to the objectives of the study. The questionnaire includes information on the background characteristics of household members, socio-economic characteristics, household information, household exposure, familial exposure, smoking, cosmetics, occupational exposure, hobbies exposure and child health and habits.

3.11 Data Collection

The researcher completed by himself and identified the cases and controls and abstracted available information from EPRI and completed all variables needed by contacting the cases and controls in Gaza Governorates.

3.11.1 Estimation of Lead Contamination Hazards:

Lead contamination sources were screened in these areas, in parallel. Information was gathered from municipality, governmental and industrial sources. The parents (mother or father) of each child involved in the study and interviewed, and questionnaires filled out. These questionnaires provided the required information concerning environmental lead hazards, such as distance from industrial areas, closeness to battery manufacture stores, or to petrol stations. In addition, information concerning parents' profession and the possible exposure to lead contamination related to their occupation collected. The questionnaires included also information about the possible use of kohl as cosmetic in the family, and general environmental and living conditions.

3.11.2 Blood Lead Levels Determination:

Blood lead levels were determined in all studied children. Blood samples were taken from the children by the finger stick procedure. BLL tested on a portable Lead Care Analyzer apparatus, USA, using Lead Care Kits. Calibrations for the blood lead equipment done prior to beginning the field testing. Split samples for quality assurance considered.

3.12 Statistical Analysis

The collected data was introduced to the computer using SPSS (Statistical Package for Social Sciences, version 16). Data was checked for entry errors using a frequencies and logical checks on all variables by using simple frequency. Data analysis was carried as follows: descriptive analysis to examine the distribution of different factors among the study population. The dependent variable in the study is the blood lead level among the participants, the independent variables includes socio-demographic factors, environmental factors, variables related to exposure to lead and child health status as stated in the questionnaire. Cross tabulation was used to count the frequency of intersection of variable categories. Chi square test was conducted. P value was considered statistically significant when it is lower than 0.05. The relationship between the dependent variable and the independent variables was tested.

3.13 Limitations of Study:

- Limited scientific resources like books and journals.
- Continuous electrical current cutting.

Chapter 4

Results and Discussion

This chapter presents the results of the study and shows the descriptive and statistical analysis of the study findings in general.

In general, 240 questionnaires had been abstracted and completed by the researcher, of which 120 were case samples (children with BLL ≥ 10 μg/dl) and 120 were control samples (children with BLL ≤ 9.9 μg/dl).

Results of Statistical Analysis:

4.1 Distribution of the study population

4.2 BLL distribution among cases and controls

4.3 Risk factors of lead poisoning

4.1 Distribution of the Study Population

Table (4.1): Distribution of study subjects by socio demographic variables

Variables		Case (n=120) (≥ 10 μg/dl)		Control (n=120) (≤ 9.9 μg/dl)		Total	
		No.	%	No.	%	Number	Percent
Total sample		120	50.0	120	50.0	240	100.0
Sex	Male	76	50.0	76	50.0	152	63.3
	Female	44	50.0	44	50.0	88	36.7
Age	(24-48)	61	49.2	63	50.8	124	51.7
	(49-72)	59	50.9	57	49.1	116	48.3
Governorates	North	15	50.0	15	50.0	30	12.5
	Gaza	60	50.0	60	50.0	120	50.0
	Mid-Zone	22	50.0	22	50.0	44	18.3
	Khanyounis	15	50.0	15	50.0	30	12.5
	Rafah	8	50.0	8	50.0	16	6.7

Sociodemographic variables are shown in Table 4.1. The total number of study subjects were 240, in which 120 (50 %) were case samples (children with BLL ≥ 10 μg/dl) and 120 (50 %) were control samples (children with BLL ≤ 9.9 μg/dl). It was found that majority of them, 152 (63.3%) were males and 88 (36.7 %) were females. The age of study subjects was classified into two groups. The first group (51.7 %) was 24-48 months, while the second group (48.3 %) was 49-72 months. Table 4.1 also revealed that 12.5 %, 50.0 %, 18.3 %, 12.5 % and 6.7 % of study subjects (240) were lived in North, Gaza, Middle Zone, Khan-Younis and Rafah Governorates respectively.

Children below 6 years are more sensitive to elevated BLL than adults (Murata et al, 2009). In general BLL is higher for younger children than older ones and our findings are in agreement with other studies done by Barbara et al, (2010); Payne (2008); Brody et al. (1994) and Trotter, (1990). Two year-olds tend to have the highest BLL because they put many things into their mouth, including toys or other products that may become lead contaminated (NIEHS, 2008 and CDC, 2008). BLL tend to reach its peak concentration around 2 years of age and then steadily and consistently declined (Pocock et al., 1994 and Baghurst et al., 1992). Children may also have a higher intake of lead than adults; they breathe faster and may be more likely to have contact with and ingest soil (Dart et al, 2004). Ringold et al. (2005) have estimated that about 2% of children younger than 6 years in the US have elevated BLLs. Blood lead data were used by Romieu (2003) to evaluate and prevent childhood lead poisoning in Latin America.

Comparing BLL with sex, it was found that males have BLL more than females. These results are in accordance with that reported by Safi et al. (2006); Baghurst et al. (1992), Nir et al. (1992) and WHO (1977). Children ages one to three tend to have the highest BLL, possibly because at that age they begin to walk and explore their environment, and they use their mouths in their exploration (Bellinger, 2004). He found differences in neurological damage between males and females due to lead exposure and emphasizes that males to be at greater risk than females.

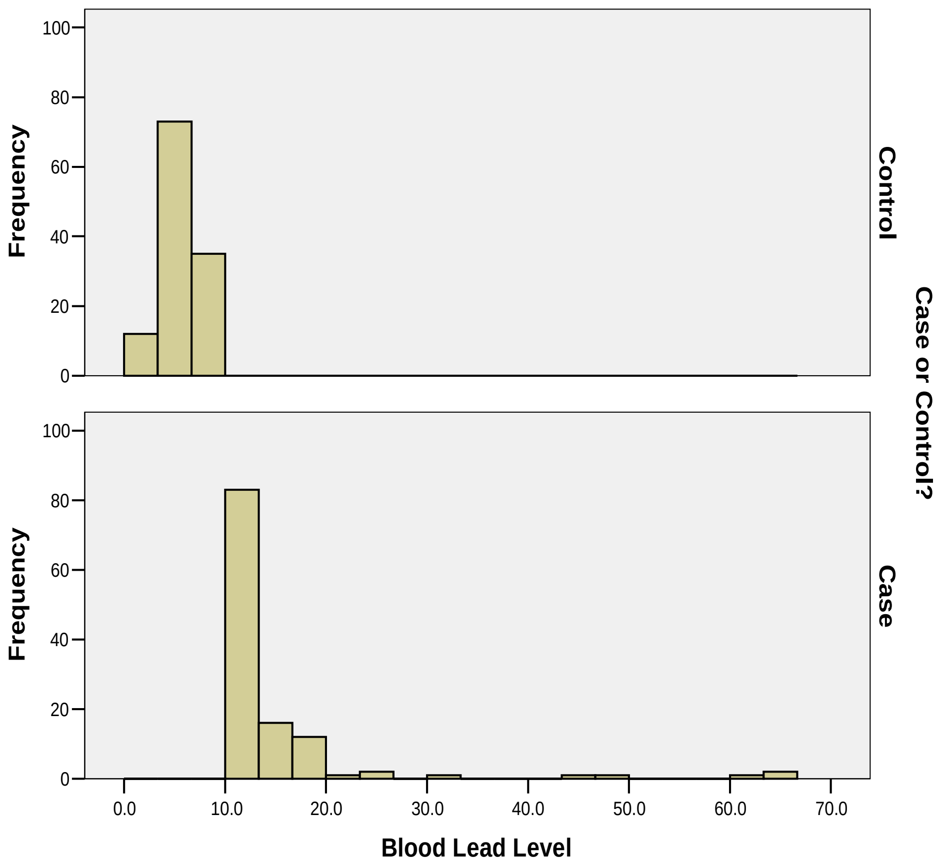
Childhood lead toxicity is an international problem and the prevalence of lead toxicity is largely determined by age and proximity to environmental sources. Children are more vulnerable to lead exposure because of the frequency of pica and hand-to-mouth activities and because children have a greater rate of intestinal absorption and retention of lead (Yeoh 2008, Safi et al., 2006, CDC 2005, Safi 2004, Rubin et al., 2002, Nriagu et al 1996., EPA, 1991 and CDC 1991).

4.2 Capillary BLL in Case and Control Samples

Table (4.2): Description of BLL in both cases and controls

Mean	10.19 μg/dL
Median	9.95 μg/dL
Minimum	3.2 μg/dL
Maximum	65.1 μg/dL

Figure 4.1: Histogram of blood lead levels among case and control samples



4.3 Risk Factors of Lead Poisoning

4.3.1 BLL by Sociodemographic Variables:

Table (4.3): Distribution of study subjects by socio demographic variables

Variables		Case (≥ 10 μg/dl)		Control (≤ 9.9 μg/dl)		X^2	P-value
		Number	%	Number	%		
Father years of education	0	3	2.5	3	2.5	0.735	0.865
	1-8	39	32.5	35	29.2		
	9-12	56	46.7	55	45.8		
	>12	22	18.3	27	22.5		
Mother years of education	0	2	1.7	2	1.7	1.588	0.662
	1-8	30	25.0	22	18.3		
	9-12	72	60.0	78	65.0		
	>12	16	13.3	18	15.0		
Father job	Employee	39	33.3	45	37.5	1.929	0.749
	Lead job	12	10.3	15	12.5		
	Business	8	6.8	6	5.0		
	Unemployed	38	33.5	31	25.8		
	Worker	20	17.1	23	19.2		
Mother job	Employee	5	4.2	6	5.0	0.095	0.758
	House wife	115	95.8	114	95.0		

Table 4.3 presents the distribution of study subjects by father education, mother education, father job and mother job. The subject's father education was classified into four groups (0 years, 1-8 years 9-12 years and > 12 years). In case subjects, 3, 39, 56, 22 were the total number of case subject who their fathers were level learned for 0, 1-8, 9-12 and >12 years, respectively, in which 2.5%, 32.5%, 46.7% and 18.3% had BLL ≥ 10 μg/dl. In control subjects, 3, 35, 55, 27 were the total numbers of control subjects who their fathers were level learned for 0, 1-8, 9-12 and >12 years respectively, in which 2.5%, 29.2%, 45.8% and 22.5% had BLL ≤ 9.9 μg/dl, respectively. There is no statistical significant differences among father years of education for case and control (BLL) subjects (P= 0.865). The same trend was also found among mother years of education in terms of there are no statistical significant differences among them for case and control subjects (P=0.662).

As shown in the same table, there is no statistical significant differences among father job in case and control subjects (P= 0.749). Father employment was classified into five categories (employee, lead related job, business, unemployed and workers). The total number of case subjects whose fathers were employee, lead related job, business, unemployed and workers were 39, 12, 8, 38 and 20 respectively, while the total number of control subjects were 45, 15, 6, 31 and 23, respectively, as clear of father job, employees had the highest number of case and control subjects while worker of business field had the lowest number.

Regarding to mother job, it was classified into two categories (employee and house wife) and was found the majority of case subjects among mother job 115 from 120 were house wife, 5 of them were employee, while the majority of control subject's among mother job 114 (95%) were house wife, and 6 (5%)of them were employee. Statistical analysis showed no significant differences between mother job and BLL for case and control subjects (P = 0.758).

The educational level can be considered as a parameter for degree of medical orientation and health knowledge. Therefore, highly educated fathers and mothers had lower number of children than those of lower of educated ones. This outcome is in agreement with results obtained from other studies published by Safi (2004) and Bronschein (1986).

4.3.2 BLL by Housing Conditions Variables:

Table (4.4): Distribution of study subjects by housing conditions variables

Variables		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
House status	Basement	0	0.0	2	1.7	2.351	0.503
	Ground	52	43.3	47	39.2		
	1 floor above	24	20.0	24	20.0		
	2 flour or higher	44	36.7	47	39.2		
House old	< 1 year	0	0.0	1	0.8	4.399	0.494
	1-9 years	20	16.7	25	20.8		
	10-19 years	40	33.3	33	27.5		
	20-39 years	51	42.5	53	44.2		
	40-49 years	5	4.2	7	5.8		
	> 50 years	4	3.3	1	0.8		

Table 4.4 illustrates the distribution of study subjects by housing conditions. House statuses were divided into four categories; basement, ground, one floor above and two flour or higher in study subjects. The highest number of case subjects 52 (43.3%) were lived in ground house, 44 (36.7%) were lived in floor two or higher, 24 (20%) were lived in one floor above and no one were live in basement and as clear all of them with BLL ≥ 10 µg/dl. The control subjects of house status 2 (1.7%), 47 (39.2%), 24 (20%) and 47 (39.2%) were lived in basement, ground, one floor above and flour two or higher, respectively with BLL ≤ 9.9 µg/dl. The categories showed nearly the same numbers of case and control subjects, so there is no statistical significant differences between case and control (BLL) subjects (P= 0.503).

The above table revealed that, house old was divided into six groups < 1 year, 1-9 years, 10-19 years, 20-39 years, 40-49 years and >50 years in study subjects. It is obvious, that most of the populations are living in houses old of 20-39 years in both case 51 (42.5%) and control 53 (44.2%) subjects while the lowest number of case and control subjects 0, 1 (0.8%) were lived in house old less than one year, respectively. There are no statistical significant differences between case and control subjects (P= 0.494).

Regarding to the level of floor where the children live, the number of cases of ground floor is higher than other ones and control. This may be explained by the fact that atmospheric lead is in the form of particles and the concentration is much higher in the ground, first and second floor than the basement. Neonates or mothers living on first floor have the highest BLL in comparison to that of those living on higher floors (Nasralla, 1984). Lead can be found in food, ambient air, drinking water, gasoline, battery factories, smelters, flaking and chipping paint, dust and chips from improper removal of exterior / interior paint and lead-contaminated soil (Benin, 1999; Mushak & Crocetti, 1989).

Our study results illustrated that number of children increased with increasing years of living in the house. The building decay with time and lead paints begin to flake and become easily available to children. This can be matched with results of Rsocal et al. (1999), El-Araby et al. (1995), Hershko et al. (1989) Zenz (1988) and Abdullah 1984. This is in accordance with CDC findings that the prevalence of lead poisoning among children living in homes built prior to 1973 is five times higher than that among those living in homes built after (CDC, 1997). Also our results are in agreement with Pirkle 1998 who found that the likelihood of lead poisoning increases among children with multiple risk factors. The primary risk factor for lead poisoning is living in older housing (Pirkle 1998). Young children (6 months–6 years) are the group most exposed to lead because of their hand-to-mouth activity, especially those living in old houses with leaded paint or located near industrial facilities that do or did emit lead (Barbara Le Bot et al, 2011 and Lanphear et al, 2005).

4.3.3 BLL by Familial Exposure:

Table (4.5): Distribution of study subjects by familial exposure

Variables		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Smoking Cigarettes	Yes	65	54.2	55	45.8	1.667	0.197
	No	55	45.8	65	54.2		
Cigarettes by father	10 & less	41	77.4	39	81.3	0.232	0.630
	11 & more	12	22.6	9	18.7		
Smoking Nargila	Yes	23	19.2	14	11.7	2.588	0.108
	No	97	80.8	106	88.3		
Child Used Kohl	Yes	27	22.7	24	20.8	1.220	0.543
	No	92	77.3	95	79.2		
Child used kohl per week	1 & less	11	40.7	20	83.3	9.670	0.002
	2 & more	16	59.3	4	16.7		
Used kohl by mother	Yes	53	44.2	51	42.5	0.068	0.794
	No	67	55.8	69	57.5		
Kohl prepared by mother	Yes	19	35.8	17	32.7	2.236	0.327
	No	32	64.2	35	67.3		
Kohl used by mother	60m & less	9	17.6	12	25.0	0.800	0.371
	61m & more	42	82.4	36	75.0		
Pregnant mother used kohl	Yes	52	98.1	46	90.2	2.997	0.083
	No	1	1.9	5	9.8		
Mother used kohl long	pre <month	31	59.6	27	57.4	0.735	0.865
	1 – 3 month	11	21.2	12	25.5		
	4 – 6 month	4	7.7	2	4.3		
	7 – 9 month	6	11.5	6	12.8		

Table 4.5 presents the distribution of case and control subjects by familial exposure. Familial exposure includes cigarettes smoking and number of cigarettes in home by father and smoking nargila as well as used kohl by mother and her child. It was showed that 54.2% of cases were exposed to father's smoking compared to 45.8% of controls, while 45.8% of cases did not expose to their father smoking compared to 54.2% of controls. There is no statistically significant differences between smoking cigarettes and non among two groups (P= 0.197).

As indicated in the table, cigarettes numbers by father were divided into two groups, the first group was 10 and less, and the second group was 11 and more. Regarding to the exposure by smoking cigarettes numbers in home, 77.4% of cases was smoked 10 and less exposed to smoking compared to 81.3% of controls while 22.6% of cases was smoke 11 and more exposed to smoking compared to 18.7% of controls. It is clear that the difference between the two groups did not reach a statistical significant level (P= 0.630).

As shown in the same table, 19.2% of cases were exposed to father's smoking nargila compared to 11.7% of controls, while 80.8% of cases did not exposed to their father smoking nargila compared to 88.3% of controls. There is no statistically significant differences between two groups (P= 0.108).

Variable of using kohl by child showed that, 22.7% of cases were used kohl compared to 20.8% of controls, while 77.3% of cases did not used kohl compared to 79.2% of controls, and it is clear that there is no statistically significant differences between two groups (P= 0.543). As indicated in the category of using kohl by child per week, the difference of using kohl by child in long period of time showing that strongly statistically significant (P-value = 0.002), which means that the length period of using kohl by child affect the health of child and increase of BLL and considered to be a risk factor of lead poisoning among children according to the several publications by Safi, et al. (2006), Nir et al. (1992) and Trotter (1990).

As shown in the table, category of using kohl by mother show that, 44.2% of mothers cases were used kohl compared to 42.5% of mothers controls, while 55.8% of mothers cases did not used kohl compared to 57.5% of mothers controls, and it is clear that there is no statistically significant differences between two groups (P= 0.794).

As indicated that in the same table, length period of using kohl by mother were recoded into two groups, the first group was 60 months and less, and the second group was 61 months and more. Nine (17.6%) of mothers cases used kohl for 60 months and less compared to 25.0% of mothers controls while 82.4% of mothers cases was used kohl 61 months and more compared to 75.0% of mothers controls. Statistical analysis showed no significant difference between the two groups (P= 0.371).
As seen in Table 4.5 the category of using kohl by mother pregnant showed that 98.1% of mothers cases were used kohl compared to 90.2% of mothers controls, while 1.9% of mothers cases did not used kohl compared to 9.8% of mothers controls. There was no statistically significant difference between the two groups (P= 0.083).

The last part in the table illustrated that mother used kohl when she was pregnant in the child was classified into four groups, < month, 1-3 months, 4-6 months and 7-9 months. The majority of cases was 31 (59.6%) when mother used kohl in the first month compared to 27 (57.4) of controls. As clear that the difference between the two groups did not reach a statistical significant level (P= 0.865).

The present data revealed a non-significant increase in number of children whose parents smoke compared to those whose parents do not. Grandjean in 1993 found that BLL were related to smoking and drinking alcohol. Willers et al in 1988 reported a significant association between higher BLL in children and parental smoking. Sherlock et al. (1985) reported higher BLL in children whose parents smoked (statistically not significant) compared with children who reside with non smoking parents.

Regarding to the use of kohl, the study showed a non-significant increase in number of children to whom kohl was applied compared to those who did not while significant difference was found only among children when kohl used for one time per week and less or two times per week and more. Also, a non-significant difference in number of children was found in children of mothers used or not used kohl during pregnancy. These findings are in consistence with others (Nir et al., 1992 and Trotter 1990). Kohl could be of pathogenic action on infants. Shaltout et al. (1981) reported 20 cases of encephalopathy in Kuwaiti infants and the source of lead postulated as Kohl. In addition, some women in the Middle East are using a traditional homemade cosmetic called KOHL on their eyes and on the eyes of their young children (Parry & Eaton 1991). These women are unaware of the dangers of making and using homemade Kohl. Isolated cases of lead poisoning have been reported as a result of the use of dental powders such as Saoot and Cebagin, which may contain as high as 51% of lead (Nir et al., 1992).

4.3.4 BLL by Household Exposure:

Table (4.6): Distribution of study subjects by household exposure

Variables		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Water Drink	Tape water	23	19.2	20	16.7	1.589	0.662
	Bottled water	2	1.7	1	0.8		
	Filter water	95	79.2	98	81.7		
	Well water	0	0.0	1	0.8		
Water Cock	Tape water	58	48.3	52	43.3	1.524	0.677
	Bottled water	1	0.8	1	0.8		
	Filter water	61	50.8	66	55.0		
	Well water	0	0.0	1	0.8		
Water Store	Metallic tank	2	1.7	3	2.5	1.200	0.549
	Plastic tank	117	97.5	117	97.5		
	Other	1	0.8	0	0.0		
Plumbing age	< 10 years	28	23.3	34	28.3	1.003	0.606
	10-15 years	28	23.3	29	24.2		
	> 16 years	64	53.3	57	47.5		

Table 4.6 presents the distribution of study subjects by household exposure. Household exposure includes water drink, water cock, water store and plumbing age.
As indicated in the table, there were four categories for drinking water; tab water, bottled water, filters water and well water. There were 19.2% of cases drink tab water compared to 16.7% of controls, 1.7% of cases drink from bottled water compared to 0.8% of controls and 79.2% of cases drink filter water compared to 81.7% of controls and no one of cases drink well water compared to 0.8% of controls. There was no statistical significant relationship between drinking water and BLL among cases and controls (P= 0.662).

The part of water cock in the above table illustrated that, there were 48.3% of cases used tab water for cocking compared to 43.3% of controls, 0.8% of cases used bottled water for cocking compared to 0.8% of controls, 50.8% of cases used filter water for cocking compared to 55.0% of controls and no one in cases used well water for cocking compared to 0.8% of controls. The data also showed that the difference between two groups did not reach a statistical significant level (P= 0.677).

Regarding to the third part in the table, (water store); there were 1.7% of cases store water in metallic tank compared to 2.5% of controls, 97.5% of cases store water in plastic tank compared to 97.5% of controls and 0.8% of cases stored water in other compared to no one of controls. It is seems that the percentage of this variable nearly the same so there is no difference between two groups and not reach statistical significant level (P=0.549).

As seen in the table plumbing age in houses was divided into three group, < 10 years, 10-15 years and >16 years. This variable showed that 23.3% of cases were plumbing in their houses less than 10 years compared to 28.3% of controls, 23.3% of cases were plumbing in their houses from 10-15 years compared to 24.2% of controls and 53.3% of cases were plumbing in their houses more than 16 years compared to 47.5% of controls. Statistical analysis showed that there was no significant difference between two groups (P=0.606).

Older homes that have plumbing with lead or lead solder may have higher amounts of lead in drinking water. Lead in drinking water of Gaza Strip is not the predominant source for poisoned children. In some circumstances, however, lead exposures from water are unusually high. Our study revealed that no significant differences among the groups of drinking, cocking and storing water and plumbing.

Several publications are in agreement of our results such as the ones which indicated that the most important route of lead exposure in children is unintentional ingestion of lead dust through teething and other hand-to-mouth activities. Other routes for lead exposure are the respiratory tract and through the skin (Word Health Organization, WHO, 1977). In many countries including the US, household paint and dust is the major route of exposure in children (Dart et al., 2004). Lead exposure nonetheless remains a public health concern both because exposure is still high in developing countries and because increasing evidence indicates effects at any levels below 10 µg/dl and even a possible steeper dose-response relationships at very low levels (Glorennec et al., 2010).

4.3.5 BLL by Household Location and Exposure Sources

Table (4.7): Distribution of study subjects by household location and exposure sources

Lead exposure sources near home		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Smelters	Yes	20	16.7	3	2.5	13.897	0.001
	No	100	83.3	117	97.5		
Battery manufacturing	Yes	16	13.3	11	9.2	1.043	0.307
	No	104	86.7	109	90.8		
Battery recycling	Yes	39	32.5	17	14.2	11.273	0.001
	No	81	67.5	103	85.8		
Radiator shop	Yes	14	11.7	4	3.3	6.006	0.014
	No	106	88.3	116	96.7		
Electronic shop	Yes	23	19.2	17	14.2	1.080	0.299
	No	97	80.8	103	85.8		
Petrol/ gas station	Yes	13	10.8	13	10.8	0.000	1.000
	No	107	89.2	107	89.2		
Other lead shops	Yes	40	33.3	24	20.0	5.455	0.020
	No	80	66.7	96	80.0		

Table 4.7 presents the distribution of study subjects by household location and exposure sources. Exposure sources included smelting, battery manufacturing and recycling, radiator repairing, electronics, gas and petrol station and other lead works.

As shown in the table 16.7% of cases were their homes near smelters compared to 2.5% of controls while 83.3% of cases were their homes not near smelters compared to 97.5% of controls. The data showed that there is strongly statistical significant difference between smelters and case and control subjects (P=0.001).

As indicated in the table, 13.3% of cases were their homes near battery manufacturing compared to 9.2% of controls while 86.7% of cases were their homes not near battery manufacturing compared to 90.8% of controls. There was no statistical significant difference between two groups (P=0.307).

As seen from the table, 32.5% of cases were their homes near battery recycling compared to 14.2% of controls while 67.5% of cases were their homes not near battery recycling compared to 85.8% of controls. There was a difference between two groups which lead to strongly statistical significant level (P=0.001) which means that this factor affect the chance of getting lead poisoning and considered to be one of the risk factors.

As illustrated in the table, 11.7% of cases were their homes near radiator repair compared to 3.3% of controls while 88.3% of cases were their homes not near radiator repair compared to 96.7% of controls. There was statistical significant difference between the two groups (P=0.014). Also this factor considered to be one of the risk factors of lead poisoning.

The above table showed that 19.2% of cases were their homes near electronic shops compared to 14.2% of controls while 80.8% of cases were their homes not near radiator repair compared to 85.8% of controls. There was no statistical significant difference between two groups (P=0.299).

As shown in the table, 10.8% of cases were their homes near gas-petrol station compared to 10.8% of controls while 89.2% of cases were their homes not near gas-petrol station compared to 89.2% of controls. The data also showed that the difference between two groups did not reach a statistical significant level (P= 1.000).

The last part in the table showed that 33.3% of cases were their homes near other lead shops compared to 20.0% of controls while 66.7% of cases were their homes not near other lead shops compared to 80.0% of controls. The data showed that the difference between the two groups reach a statistical significant level (P= 0.020), which means that any work related with lead affect the chance of getting lead poisoning and increase BLL specially in children.

The present results demonstrated strong statistical relationship between BLL of the children and the household location from exposure sources either smelter near home or not, battery recycling near home or not, radiator repair near home or not, and other lead source near home or not while the others are not. These findings are in agreement with Watts 2009, Safi et al., 2006, Safi 2004, Choudari 2002 and Ellenhorn et al., 1997. This means that smelters, battery recycling, radiator repair and other job related lead considered to be risk factors of lead poisoning according to several publications.

Thousands of children living near smelting plants in China have been found with unsafe levels of lead in their blood in the latest health scandal to hit the country (Watts, 2009). A gradual build-up of lead in the bloodstream can damage the nervous system and lead to anemia, muscle weakness, arrested development, and brain damage (Watts, 2009).

In the Middle East today, the major reported sources of lead exposure are currently used lead-based paints, gasoline and industrial sources including smelters, battery factories, and radiator repair shops and flour from the stone mills (Safi et al., 2006, Safi 2004, Rsocal et al., 1999, El-Araby et al 1995, Hershko et al., 1989, Abdullah 1984). The children of the lead-exposed workers are also at high risk for lead poisoning.

4.3.6 BLL by Household Distance and Exposure Sources:

Table (4.8): Distribution of study subjects by household distance and exposure sources

Household distance from exposure sources		**Case (≥ 10 μg/dl)**		**Control (≤ 9.9 μg/dl)**		**X^2**	**P-value**
		Number	**%**	**Number**	**%**		
Smelter distance	100 & less	18	90.0	1	33.3	5.831	0.016
	101 & more	2	10.0	2	66.7		
Battery manufacturing distance	100 & less	15	93.8	6	54.5	5.797	0.016
	101 & more	1	6.3	5	45.5		
Battery recycling distance	100 & less	32	82.1	9	52.9	5.116	0.024
	101 & more	7	17.9	8	47.1		
Radiator shop distance	100 & less	10	71.4	3	75.0	0.020	0.888
	101 & more	4	28.6	1	25.0		
Electronic shop distance	100 & less	18	78.3	14	82.4	0.102	0.749
	101 & more	5	21.7	3	17.6		
Petrol/ gas station distance	100 & less	6	46.2	1	7.7	4.887	0.027
	101 & more	7	53.8	12	92.3		
Other lead shop distance	100 & less	37	92.5	20	90.9	0.048	0.826
	101 & more	3	7.5	2	9.1		

Table 4.8 indicates distribution of study subjects by household distance and exposure sources. Exposure sources include smelting, battery manufacturing and recycling, radiator repairing, electronics, gas and petrol station and other lead shops.

As illustrated in the table, length distance of all variables were classified into two groups, the first group was 100 meters and less whereas the second group was 101 meters and more. From the total number 90.0% of cases were lived at ≤100m distance from smelters compared to 33.3% of controls while 10.0% of cases were lived at ≥101m distance from smelters compared to 66.7% of controls. Statistical analysis showed a significant difference between the two groups (P=0.016).

As shown in the table, from the total number 93.8% of cases were battery manufacturing distances 100m and less compared to 54.5% of controls while 6.3% of cases were battery manufacturing distance 101m and more compared to 45.5% of controls. Also, statistical analysis showed a significant difference between the two groups (P=0.016).

The variable of battery recycling distance in the in table 4.8 revealed that, from the total number 82.1% of cases were batteries recycling distance 100m and less compared to 52.9% of controls while 17.9% of cases were batteries recycling distance 101m and more compared to 47.1% of controls. Obviously, there is a significant difference between the batteries recycling distance and the two groups (P=0.024).

The above table indicated that, from the total number 71.4% of cases were radiator shops distance 100m and less compared to 75.0% of controls while 28.6% of cases were radiator distance 101m and more compared to 25.0% of controls. There was no statistical significant difference between radiator shops and the two groups (P=0.888).

The variable of electronic shops distance in the table showed that, from the total number 78.3% of cases were electronic shops distances 100m and less compared to 82.4 of controls while 21.7% of cases were electronic shops distance 101m and more compared to 17.6% of controls. Statistical analysis revealed no significant difference between the two groups (P=0.749).

The category of gas-petrol station distance in the same table, illustrated that, from the total number 46.2% of cases were gas-petrol station distances 100m and less compared to 7.7% of controls while 53.8% of cases were gas-petrol station distances 101m and more compared to 92.3% of controls. The difference between the two groups reach a statistical significant level (P= 0.027).

The last part in table 4.8, showed that other lead work distance, from the total number 92.5% of cases were other lead work distances 100m and less compared to 90.9% of controls while 7.5% of cases were other lead work distances 101m and more compared to 9.1% of controls. The difference between the two groups did not reach a statistical significant level (P= 0.826).

The study results revealed statistical significant differences between BLL of the children and the household distance from exposure sources either smelter distance 100 meter and less or 101 meter and more, battery manufacturing and recycling and gas station distance

100 meter and less or 101 meter and more, while the others are not. These findings are in agreement with Sanborn et al. (2002). Who reported that children living near facilities that process lead, such as smelters, have been found to have unusually high BLL. Thousands of children living near smelting plants in China have been found with unsafe levels of lead in their blood in the latest health scandal to hit the country (Watts, 2009).

In addition, our findings are in agreement with the following studies and reports. Ragan and Turner, (2009) reported that lead is a common environmental pollutant and causes of environmental contamination include industrial use of lead, such as is found in plants that process lead-acid batteries or produce lead wire or pipes, and metal recycling and foundries. Since lead has been used widely for centuries, the effects of exposure are worldwide (Payne, 2008). Environmental lead is ubiquitous, and everyone has some measurable BLL (Karri et al, 2008). Lead is one of the largest environmental medicine problems in terms of numbers of people exposed and the public health toll it takes (Pokras and Kneeland, 2008).

4.3.7 BLL by Occupational Exposure

Table (4.9): Distribution of study subjects by occupational exposure

Occupational exposure		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Smelting works	Yes	3	2.5	2	1.7	0.204	0.651
	No	117	97.5	118	98.3		
Plumbing works	Yes	2	1.7	3	2.5	0.204	0.651
	No	118	98.3	117	97.5		
Electric works	Yes	1	0.8	3	2.5	1.017	0.313
	No	119	99.2	117	97.5		
Painting works	Yes	5	4.2	0	0.0	5.106	0.024
	No	115	95.8	120	100		
Renovating works	Yes	5	4.2	4	3.3	0.115	0.734
	No	115	95.8	116	96.7		

Table 4.9 indicates the distribution of study subjects by occupational exposure. As shown in the table occupational exposure includes smelting, plumbing, electric, painting, and renovating works. Three (2.5%) of cases fathers were worked in smelting compared to 1.7% of controls while 97.5% of cases fathers did not work in smelting compared to 98.3% of controls. There was no statistical significant difference between the two groups (P=0.651).

As shown in the table 1.7% of cases fathers were worked in plumbing compared to 2.5% of controls while 98.3% of cases fathers did not work in plumbing compared to 97.5% of controls. There was no statistical significant difference between case and control subjects (P=0.651).

The above table 4.9 illustrated that 0.8% of cases fathers were worked in electric compared to 2.5% of controls while 99.2% of cases fathers did not work in electric compared to 97.5% of controls. The difference did not reach a statistical significant level (P=0.313).

The variable of painting works in the same table shwoed that 4.2% of cases fathers were worked in painting compared to no one of controls while 95.8% of cases fathers did not work in painting compared to 100% of controls. The difference between case and control subjects reached a statistical significant level (P=0.024). This result means that the painting works considered one of the risk factors of lead poisoning and also increase of BLL in young children and agreed with several publications (Dart et al., 2004, Golow, 1994).

The last variable in the table showed that 4.2% of cases fathers were worked in renovating compared to 3.3% of controls while 95.8% of cases fathers did not work in renovating compared to 96.7% of controls. There was no statistical significant difference between the two groups (P=0.734).

The present results pointed out that there was no statistical significant relationship between BLL of the children by occupational exposure except painting works (P=0.024). This agreed with Dart et al. (2004). Who reported that in many countries including the US, household paint and dust is the major route of exposure in children (Dart et al., 2004). Deteriorated lead paint was generally linked with elevated BLL (Golow, 1994). Lead is one of the largest environmental medicine problems in terms of numbers of people exposed and the public health toll it takes (Pokras and Kneeland, 2008).

In addition our findings are in agreement with Rubin who reported in 2002 that an important source of lead poisoning was father’s occupation while in disagreement with Goldman et al, 1987 and Morton et al 1982 who reported that soldering electric parts was classified as one of the high risk occupation.

4.3.8 BLL by Period of Occupational Exposure:

Table (4.10): Distribution of study subjects by period of occupational exposure

Period of occupation (month)		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Smelting	60 & less	2	66.7	1	50.0	0.139	0.709
	61 & more	1	33.3	1	50.0		
Plumbing	60 & less	1	50.0	1	33.3	0.139	0.709
	61 & more	1	50.0	2	66.7		
Electric	60 & less	0	0.0	1	33.3	0.444	0.505
	61 & more	1	100	2	66.7		
Painting	60 & less	3	60.0	0	0.0	-	-
	61 & more	2	40.0	0	0.0		
Renovating	60 & less	2	40.0	2	50.0	0.090	0.764
	61 & more	3	60.0	2	50.0		

Distribution of study subjects by period of occupational exposure is illustrated in Table 4.10. Periods of occupational exposure included 60 months and less, 61 months and more for smelting, making plumbing, electric, painting and renovating.

As indicated in the table, from the total number 66.7% of cases their fathers were worked in smelting for a period 60 and less months compared to 50.0% of controls while 33.3% of cases their fathers were worked in smelting for a period 61 months and more compared to 50.0% of controls. There was no significant difference between the two groups (P=0.709).

As shown in the table, from the total number 50.0% of cases their fathers were worked in plumbing for a period 60 months and less compared to 33.3% of controls while 50.0% of cases their fathers were worked in plumbing for a period 61 months and more compared to 66.7% of controls. There was no significant difference between the two groups (P=0.709).

The part of electric period in table 4.10 showed that, from the total number no one of cases fathers were worked in electric for a period 60 months and less compared to 33.3% of controls while 100% of cases fathers were worked in electric for a period 61 months and more compared to 66.7% of controls. The difference between case and control subjects did not reach a statistical significant level (P=0.505).
The above table indicated that, from the total number 60.0% of cases fathers were worked in painting for a period 60 months and less compared to no one of controls while 40.0% of

cases' fathers were worked in painting for a period 61 months and more compared to no one of controls.

The variable of renovating period in the table illustrated that, from the total number 40.0% of cases' fathers were worked in renovating for a period less than 60 months compared to 50% of controls while 60.0% of cases' fathers were worked in renovating for a period more than 61 months compared to 50.0% of controls. There was no significant difference between the two groups (P=0.764).

The study results revealed no statistical significant differences between BLL of the children and the period of occupational exposure which included 60 months and less, 61 months and more for smelting, making plumbing, electric, painting and renovating.

These findings are in disagreement with Sanborn et al. (2002) who reported that children living near facilities that process lead, such as smelters, have been found to have unusually high BLL. In addition, our findings are in disagreement with the studies published by Ragan and Turner in 2009. They reported that lead is a common environmental pollutant and causes of environmental contamination include industrial use of lead, such as is found in plants that process lead-acid batteries or produce lead wire or pipes, and metal recycling and foundries (Ragan and Turner, 2009). Environmental lead is ubiquitous, and everyone has some measurable BLL (Karri et al, 2008). Lead is one of the largest environmental medicine problems in terms of numbers of people exposed and the public health toll it takes (Pokras and Kneeland, 2008).

4.3.9 BLL by Work Clothes and Showering:

Table (4.11): Distribution of study subjects by work clothes and showering

Variables		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Work Clothes	Yes present	9	56.3	7	46.7	0.885	0.642
	Yes past	5	31.3	7	46.7		
	No	2	12.5	1	6.7		
Work Shoes	Yes present	9	56.3	7	46.7	0.885	0.642
	Yes past	5	31.3	7	46.7		
	No	2	12.5	1	6.7		
Wash Clothes	Yes present	10	62.5	7	46.7	0.831	0.660
	Yes past	5	31.3	7	46.7		
	No	1	6.3	1	6.7		
Shower at Site	Yes present	0	0.0	0	0.0	-	-
	Yes past	0	0.0	0	0.0		
	No	16	100	15	100		

Table 4.11 indicates the distribution of case and control subjects (BLL) by work clothes and showering. The table included four variables work clothes, work shoes, wash clothes and shower at work site. The data showed that 56.3% of cases who their fathers wear or bring their work clothes to home at present compared to 46.7% of controls, 31.3% of cases who their fathers wear or bring their work clothes to home in the past compared to 46.7% of controls and 12.5% of cases who their fathers did not wear or bring their work clothes to home compared to 6.7% of controls. The difference between the groups did not reach statistically significant (P=0.642).

As shown in the table 56.3% of cases who their fathers bring their work shoes to home at present compared to 46.7% of controls, 31.3% of cases who their fathers bring their work shoes to home in the past compared to 46.7% of controls and 12.5% of cases who their fathers did not bring their work shoes to home compared to 6.7% of controls. There was no statistical significant difference between the two groups (P=0.642).

The above table illustrated that 62.5% of cases who their fathers washed their work clothes in home at present compared to 46.7% of controls, 31.3% of cases who their fathers washed their work clothes in home in the past compared to 46.7% of controls and 6.3% of cases who their fathers did not washed their work clothes in home compared to 6.7% of controls. The difference between the two groups did reach statistical significant level (P=0.660).

BLL by work clothes and showering presented no statistical significant differences with the different protective occupational measures including wear or bring his work clothes and shoes home, wash his clothes at home and shower at worksite before coming home. These findings are in disagreement with Roscoe report who found in 1999 that household members worked in lead-contaminated environment or participate in certain hobbies can bring lead into home on their clothing or shoes. Although they are not significant, most of the percentage of the case subjects were more than 50%.

4.3.10 BLL by Tasks, Crafts and Hobbies at Home exposure:

Table (4.12): Distribution of study subjects by tasks, crafts and hobbies at home

Variables		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Remove Paint	Yes present	2	1.7	0	0.0	2.204	0.332
	Yes past	2	1.7	3	2.5		
	No	116	96.7	117	97.5		
Solder/Electric	Yes present	3	2.5	1	0.8	1.338	0.512
	Yes past	1	0.8	2	1.7		
	No	116	96.7	117	97.5		
Smelt Lead	Yes present	2	1.7	0	0.0	2.338	0.311
	Yes past	1	0.8	2	1.7		
	No	117	97.5	118	98.3		

Distribution of study subjects by activities, tasks, crafts and hobbies at home is presented in Table 4.12. The above table included three parts; remove paint, solder/electric and smelt lead. The first part results revealed 1.7% of cases who their fathers worked in remove paint at present compared to no one of controls, 1.7% of cases fathers worked in remove paint in the past compared to 2.5% of controls and 96.7% of cases fathers did not worked in remove paint compared to 97.5% of controls. The difference between the two groups did not reach statistically significant level (P=0.332).

The Solder/Electric variable illustrated that 2.5% of cases who their fathers worked in solder and electric at present compared to 0.8% of controls, 0.8% of cases fathers worked in solder and electric in the past compared to 1.7% of controls and 96.7% of cases fathers did not worked in solder and electric compared to 97.5% of controls. There was no statistically significant difference between the two groups (P=0.512).

The third part in the same table indicated that 1.7% of cases fathers worked in smelt lead at present compared to no one of controls, 0.8% of cases who their fathers worked in smelt lead in the past compared to 1.7% of controls and 97.5% of cases fathers did not worked in smelt lead compared to 98.3% of controls. The difference did not reach statistical significant level (P=0.311).

BLL by tasks, crafts and hobbies at home pointed out that there is no statistical significant differences with the different familial exposure including remove paint work, solder/electric work and smelt lead work. Case and control subjects of these families who do not do any of these works are the majority among others and have elevated BLL.

This means that those children are not exposed to lead within their families and may have other sources of exposure rather than familial one, since lead exposure is strongly related to elevate BLL. A statistical analysis suggests that closeness to source, occupational exposure of the father, not being breast-fed and attending a day care center were associated with increased risk. The presented data are not in consistent with Rubin, 2002 who reported that an important source of lead poisoning was father's occupation and disagreed with Goldman et al, 1987 and Morton et al, 1982 who reported that soldering electric parts was classified as one of the high risk occupation. Glorennec et al, 2010 illustrated that lead exposure nonetheless remains a public health concern both because exposure is still high in developing countries and because increasing evidence indicates effects at any levels below 10 μg/dL and even a possible steeper dose-response relationships at very low levels.

4.3.11 BLL by Child Feeding and Day Care:

Table (4.13): Distribution of study subjects by child feeding and day care

Variables		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Child kindergarten	Yes	28	23.3	22	18.3	0.909	0.340
	No	92	76.7	98	81.7		
Child out home/ weak	14 h & less	25	23.1	38	34.9	3.613	0.057
	15 h & more	83	76.9	71	65.1		
Child breastfed	Yes	117	97.5	113	94.2	1.670	0.196
	No	3	2.5	7	5.8		
Child drink milk	1 cup & less	61	76.3	56	76.7	0.005	0.946
	2 cups & more	19	23.7	17	23.3		
Child use tab water	Yes	46	38.3	36	30.0	1.852	0.174
	No	74	61.7	84	70.0		

Distribution of study subjects by child feeding and day care are presented in Table 4.13. It included five variables; child kindergarten, child out home, child breastfed, child drink milk and child use tab water.

As shown in the table, the variable of child kindergarten illustrated that 23.3% of cases were gone to kindergarten compared to 18.3% of controls while 76.7% of cases did not go to preschool compared to 81.7% of controls. There was no significant difference between the two groups (P=0.340).

As indicated in the table, child out home was classified into two categories; 14 hour and less per week and 15 hour and more per week. The data indicated that 23.1% of cases were spent 14h and less outside home compared to 34.9% of controls while 76.9% of cases were spent 15h and more outside home compared to 65.1% of controls. Obviously, the statistical analysis revealed a border line significant difference between case and control subjects (P=0.057).

This means that the length period of time which the children's spent outside home exposed them to the risk of lead poisoning, also increased the BLL among them and considered to be one of the risk factors.

The data in the same table showed that 97.5% of cases were breastfed compared to 94.2% of controls while 2.5% of cases did not breastfed compared to 5.8% of controls. There is no significant difference between the two groups (P=0.196).

Regarding to the child drink milk in the table, the variable was classified into two groups; 1 cup and less per day and 2 cups and more per day. The results revealed that 76.3% of cases were drink 1 cup and less per day compared to 76.7% of controls while 23.7% of cases were drink 2 cups and more per day compared to 23.3% of controls. The difference between case and control subjects did not reach statistical significant level (P=0.946).
The variable of child use tab water in the above table indicated that 38.3% of cases were their mothers used tab water to prepare food compared to 30.0% of controls while 61.7% of cases did not used tab water to prepare food compared to 70.0% of controls. There was no significant difference between the two groups (P=0.174).

The present results pointed out that there is no statistical significant relationship between BLL of the case and control subjects by child feeding and day care except child out home for 14 hours and less per week and 15 hours and more per week (P=0.057). In general, our children spent a considerable time outside the home playing in may be contaminated sandy soil with lead. Our findings are in agreement with Charney et al, 1980 who reported that a group of 50 children who had high BLL played in outside soil, mouthed objects and sucked their fingers more often than a matched group.

Water used to make baby formula could have a role in elevating BLL. Several babies have been poisoned when hot water, which was then boiled (resulting in concentrating the lead that it might be contain), was used to make baby formula (ASTDR, 1988). High lead levels may be presented in lead-soldered teapots. Lead can be found in food, ambient air, drinking water, gasoline, battery factories, smelters, flaking and chipping paint, dust and chips from improper removal of exterior / interior paint and lead-contaminated soil (Mushak & Crocetti, 1989; Schwartz & Level 1991, Lockitch, 1993 and Benin, 1999). Childhood lead poisoning associated with spices used in food preparation was reported by Woolf et al. (2005).

4.3.12 BLL by Child Habits and Lead Sources:

Table (4.14) : Distribution of study subjects by child habits and lead sources

Variables		Case (≥ 10 µg/dl)		Control (≤ 9.9 µg/dl)		X^2	P-value
		Number	%	Number	%		
Child suck fingers	Never	102	85.0	108	90.0	4.071	0.254
	Rarely	5	4.2	3	2.5		
	Sometimes	9	7.5	3	2.5		
	Frequently	4	3.3	6	5.0		
Child put toys	Never	105	87.5	108	90.0	0.528	0.913
	Rarely	4	3.3	4	3.3		
	Sometimes	8	6.7	6	5.0		
	Frequently	3	2.5	2	1.7		
Child eat paint chip	Never	113	94.2	116	96.7	1.039	0.595
	Rarely	1	0.8	1	0.8		
	Sometimes	6	5.0	3	2.5		
	Frequently	0	0.0	0	0.0		
Child eat soil	Never	110	91.7	115	95.8	2.111	0.550
	Rarely	1	0.8	1	0.8		
	Sometimes	6	5.0	3	2.5		
	Frequently	3	2.5	1	0.8		
Child play magazine	Never	106	88.3	110	91.7	2.803	0.423
	Rarely	2	1.7	0	0.0		
	Sometimes	10	8.3	7	5.8		
	Frequently	2	1.7	3	2.5		
Child bite nails	Never	108	90.0	112	93.0	3.844	0.279
	Rarely	2	1.7	3	2.5		
	Sometimes	6	5.0	1	0.8		
	Frequently	4	3.3	4	3.3		
Child play jewelry	Never	119	99.2	117	97.5	1.350	0.509
	Rarely	0	0.0	0	0.0		
	Sometimes	1	0.8	2	1.7		
	Frequently	0	0.0	1	0.8		

Distribution of study subjects by child index and lead sources are presented Table 4.14. Child and lead sources included seven variables; child suck fingers, child put toys, child eat paint chip, child eat soil, child play magazine, child bite nails and child play jewelry.

As indicated in the table, there were four categories for each variable; never, rarely, sometimes and frequently. The results showed that 85.0% of cases were never sucked their fingers compared to 90.0% of controls, 4.2% of cases were rarely sucked their fingers compared to 2.5 of controls, 7.5% of cases were sometimes sucked their fingers compared to 2.5% of controls and 3.3% of cases were frequently sucked their fingers compared to

5.0% of controls. The difference between the two groups did not reach a statistical significant level (P= 0.254).

Child put toys in table 4.14 indicated that 87.5% of cases were never put toys in their mouths compared to 90% of controls, 3.3% of cases were rarely put toys in their mouths compared to 3.3% of controls, 6.7% of cases were sometimes put toys in their mouths compared to 5.0% of controls and 2.5% of cases were frequently put toys in their mouths compared to 1.7% of controls. There was no significant difference between the two groups (P=0.913).

Regarding to the variable of child eat paint chip in the table, 94.2% of cases were never eat paint chip compared to 96.7% of controls, 0.8% of cases were rarely eat paint chip compared to 0.8% of controls, 5.0% of cases were sometimes eat paint chip compared to 2.5% of controls and no one of cases and controls were frequently eat paint chip. The difference between case and control subjects did reach statistical significant level (P=0.595).

As shown in the above table, the results revealed that 91.7% of cases were never eat soil compared to 95.8% of controls, 0.8% of cases were rarely eat soil compared to 0.8% of controls, 5.0% of cases were sometimes eat soil compared to 2.5% of controls and 2.5% of cases were frequently eat soil compared to 0.8% of controls. There was no statistical significant difference between the two groups (P=0.550).

As seen in table 4.14 the data in child play magazine variable indicated that 88.3% of cases were never play in magazines compared to 91.7% of controls, 1.7% of cases were rarely play in magazines compared to no one of controls, 8.3% of cases were sometimes play in magazines compared to 5.8% of controls and 1.7% of cases were frequently play in magazines compared to 2.5% of controls. The difference between the two groups did reach statistical significant level (P=0.423).

The variable of child bite nails showed that 90% of cases were never bite their nails compared to 93% of controls, 1.7% of cases were rarely bite their nails compared to 2.5% of controls, 5.0% of cases were sometimes bite their nails compared to 0.8% of controls and 3.3% of cases were frequently bite their nails compared to 3.3% of controls. There was no significant difference between case and control subjects (P=0.279).

The last variable in the same table illustrated that 99.2% of cases were never play in jewelry compared to 97.5% of controls, no one of cases and controls were rarely play in jewelry, 0.8% of cases were sometimes play in jewelry compared to 1.7% of controls and no one of cases were frequently play in jewelry compared to 0.8% of controls. The difference between the two groups did not reach a statistical significant level (P=0.509).

The present results showed no statistical significant differences between the BLL of the study subjects concerning the child habits which include sucking fingers, putting toys in mouth, eating paint chips and soil, playing with magazine and jewelry and biting nails. These habits could be of potential risk to children. In general our children spent a considerable time outside the home playing in contaminated sandy soil with lead. Our findings are in agreement with Charney et al, 1980 who reported that a group of 50 children who had high BLL played in outside soil, mouthed objects and sucked their fingers more often than a matched group. Children are more vulnerable to lead exposure because of the frequency of pica and hand-to-mouth activities and because children have a greater rate of intestinal absorption and retention of lead (Yeoh 2008, Safi et al 2006, CDC 2005, Rubin et al 2002, Nriagu et al 1996, EPA 1991 and CDC 1991).

While pica has long been a known risk factor for elevated BLL, children ingest dust and soil contaminated with lead from paint that flaked or chalked as it aged or which has been disturbed during home maintenance or renovation. This lead contaminated house dust is now recognized as major contributor to the total body burden of lead in children (Barbara et al, 2011, Safi et al, 2006, Freeman, 1997, Bornchein et al, 1986 Dugan, 1983). Young children (6 months–6 years) are the group most exposed to lead because of their hand-to-mouth activity, especially those living in old houses with leaded paint or located near industrial facilities that do or did emit lead (Barbara et al., 2011). In the present study, the child habit of playing with newspaper or magazine pointed out that there is no statistical relationship between BLL of case and control subjects. Our study results are in disagreement with Zenz (1988) who reported that although lead as such or in alloys is used in printing newspaper and magazine where colored magazine illustrations had extremely high concentrations of lead.

4.3.13 BLL by Child's Health:

Table (4.15) : Distribution of study subjects by child's health

Variables		Case (≥ 10 μg/dl)		Control (≤ 9.9 μg/dl)		X^2	P-value
		Number	%	Number	%		
Child general health	Good	120	100	114	95.0	6.154	0.013
	Not good	0	0.0	6	5.0		
Child has a disease	Yes	24	20	27	22.5	0.224	0.636
	No	96	80.0	93	77.5		
Child need medical care	Yes	1	0.8	8	6.7	5.657	0.017
	No	119	99.2	112	93.3		
Child anemia	Yes	1	0.8	7	5.8	4.655	0.031
	No	119	99.2	113	94.2		
Child blood problem	Yes	1	0.8	4	3.3	1.838	0.175
	No	119	99.2	116	96.7		
Child frequent coughs	Yes	13	10.8	10	8.3	0.433	0.511
	No	107	89.2	110	91.7		
Child wheezing	Yes	3	2.5	8	6.7	2.382	0.123
	No	117	97.5	112	93.3		
Child colds	Yes	7	5.8	6	5.0	0.081	0.776
	No	113	94.2	114	95.0		
Child difficult breathing	Yes	6	5.0	4	3.3	0.417	0.518
	No	114	95.0	116	96.7		

Distribution of study subjects by child's health are indicated in Table 4.15. Child health included ten variables; child general health, child has a disease, child need medical care, child anemia, child blood problem, child coughs, child wheezing, child cold and child breathing.

As illustrated in the table, child general health showed that there were 100% of cases in good health compared to 95% of controls but none of cases was with not good health compared to 5.0% of controls. The difference between the two groups reach a statistical significant level (P=0.013).

The results of child have a disease in the table showed that 20% of cases had a disease compared to 22.5% of controls while 80% of cases did not have a disease compared to 77.5% of controls. There was no statistical significant difference between case and control subjects (P=0.636).

Child need medical care variable revealed statistical significant difference between case and control subjects (P=0.017). The data in the same variable showed that there were 0.8% of cases need medical care's compared to 6.7% of controls while 99.2% of cases did not need medical care compared to 93.3% of controls.

As shown in the table child anemia indicated that 0.8% of cases had anemia compared to 5.8% of controls while 99.2% of cases did not have anemia compared to 94.2% of controls. The difference between the two groups reach a statistical significant level (P=0.031).

Regarding to child blood problem variable there were 0.8% of cases had blood problem compared to 3.3% of controls while 99.2% of cases did not have blood problem compared to 96.7% of controls. There was no significant difference between case and control subjects (P=0.175).

Child coughs variable in the table revealed that there were 10.8% of cases had coughs compared to 8.3% of controls on other hand 89.2% did not have coughs compared to 91.7% of controls. There was no statistical significant difference between the two groups (P=0.511).

As indicated in the above table child wheezing showed that 2.5% of cases had a wheezing compared to 6.7% of controls while 97.5% of cases did not have a wheezing compared to 93.3% of controls. The difference between the case and control subjects did not reach statistical significant level (P=0.123).

Regarding to child colds in the same table there were 5.8% of cases had a cold compared to 5% of controls whereas 94.2% of cases did not have a cold compared to 95% of controls. There was no statistical significant difference between the two groups (P=0.776).

The last variable in the table, child difficult breathing indicated that there were 5% of cases had difficulty in breathing compared to 3.3% of controls while 95% of cases did not have difficulty in breathing compared to 96.7% of controls. The difference between the case and control subjects did not reach statistical significant level (P=0.518).

The study results revealed statistical significant differences between BLL of the study children and the child' health for child general health good, child needs frequent medical care and child have anemia while the other variables are not statistically significant. These findings are in agreement with Ringold et al 2005 who reported that lead is damaging the red blood cells. These manifestations can be serious and can lead to coma and death in acute poisoning. Minor lead poisoning may cause in children, milder effects such as sleep and behavioral problems, fatigue, shortened memory and anemia (Campbell and Osterhoudt

2000). Since the first reports on the lead poisoning, there has been much research bringing to light the relationship of lead absorption into the body and its deleterious effects, not only on the gastrointestinal tract but also on the central nervous system and kidneys (Bellinger 2008, Rengold et al 2005, Shen et al 2001; and Lanphear et al 2000).

These findings are also in agreement with the following authors who reported that lead poisoning may have serious and even fatal consequences at any age, but young children are especially vulnerable. This environmental toxicant may deleteriously affect the nervous, hematopoietic, endocrine, renal, and reproductive systems (CDC 2008, Bellinger 2008, Rengold et al 2005, ATSDR, 1993). Hemolysis, abdominal pain, damage to kidneys, nausea, vomiting, diarrhea, and constipation are other acute symptoms (Brunton, 2007). Fatigue, problems with sleep, headaches, stupor, slurred speech, and anemia are also found in chronic lead poisoning. Children with chronic poisoning may refuse to play or may have hyperkinetic or aggressive behavior disorders (Pearce, 2007).

Thousands of children living near smelting plants in China have been found with unsafe levels of lead in their blood in the latest health scandal to hit the country. A gradual build-up of lead in the bloodstream can damage the nervous system and lead to anemia, muscle weakness, arrested development, and brain damage (Watts, 2009).

Chapter 5
Conclusions and Recommendations

5.1 Conclusions

The overall aim of the study was to identify the common risk factors associated with lead poisoning among children aged 2-6 years in Gaza Governorates. The study also aimed to protect human health and the environment from the adverse effects of lead. The study design was a quantitative analytical retrospective case control study. Cases (120) were selected from children with BLL 10 μg/dl or higher while controls (120) were selected from children with BLL less than10 μg/dl living in the same community. Data were statistically analyzed using SPSS and the relationship between the variables was tested by using Chi Square and P values were calculated.

Socio-demographic variables illustrated that 152 (63.3 %) were males and 88 (36.7 %) were females. The age of study subjects was classified into two groups. The first one (51.7 %) was 24-48 months, while the second one (48.3 %) was 49-72 months. The majority of study subjects were in Gaza Governorate (50.0 %), while the smallest one was in Rafah Governorate (6.7 %).

Statistical analysis of capillary BLL of the study samples indicated that the minimum and maximum was 3.2 μg /dl and 65.1 μg /dl respectively with mean level of 10.19 μg /dl and median level 9.95 μg /dl.

BLL by socio demographic variables pointed out that there is no statistical significant relationship between subject's father education, mother education, father and mother job, marital status, house status and house old and BLL of case and control subjects.

BLL by familial exposure included smoking cigarettes and number of cigarettes in home by father and smoking nargila as well as using kohl by mother and her child revealed no statistical significant relationship except using kohl by child in long period of time (P= 0.002).

The study results indicated that there is no statistical significant relationship between the BLL of the study subjects and household exposure variables including water drink, water cock, water store and plumbing age.

The study results demonstrated strong statistical relationship between BLL of the children and the household location from exposure sources either smelter near home, battery recycling near home, radiator repair near home, and other lead source near home.
The study results revealed statistical significant relationship between BLL of the study subjects and the household distance from exposure sources either smelter distance 100 meter and less or 101 meter and more, battery manufacturing and recycling and gas station distance 100 meter and less or 101 meter and more.
The present results pointed out no statistical significant relationship between BLL of the children and all occupational exposure variables except painting works (P=0.024).

The study results revealed no statistical significant differences between BLL of the children and the period of occupational exposure variables which included 60 months and less, 61 months and more for smelting, making plumbing, and electric, painting, renovating, and other jobs with lead exposure.
BLL by work clothes and showering presented no statistical significant differences with the different protective occupational measures including wear or bring his work clothes and shoes home, wash his clothes at home and shower at worksite before coming home.
BLL by tasks, crafts and hobbies at home results showed no statistical significant relationship between the BLL of children and the different familial exposure including remove paint work, solder/electric work and smelt lead work.

BLL by child feeding and day care included five variables; child kindergarten, child out home, child breastfed, child drink milk and child use tab water. As indicated by the results, only child out home which was classified into two categories; 14 hour and less per week and 15 hour and more per week demonstrated a statistical significant relationship between case and control subjects (P=0.057).

The study results showed no statistical significant relationship between BLL of the study subjects and the child habits which included sucking fingers, putting toys in mouth, eating paint chips and soil, playing with magazine and jewelry and biting nails.

The study results revealed statistical significant relationship between BLL of the study subjects and the child' health for child general health good, (P=0.013), child needs frequent medical care (P=0.017) and child have anemia (P=0.031).

5.2 Recommendations

Lead poisoning is one of the most common and preventable pediatric health problems of environmental origin nowadays. Based on our study findings, the following recommendations are proposed to the Ministry of Health and health professionals and other related agencies:

1. Provide anticipatory guidance to parents of all infants and toddlers about preventing lead poisoning in their children and inquire about lead hazards in housing and child care settings and be aware of any special risk groups that are prevalent locally.

2. Childhood Lead Poisoning Prevention policies should be initiated and implemented.

3. Identify all children with excess lead exposure, and prevent further exposure to them as well as minimize the further entry of lead into the environment. Children with high BLL more than 25µg/dl should be treated and followed-up.

4. Removal of all nearby battery recycling and manufacturing plants/smelters, auto radiator repair workshops and gas stations located in the middle of a highly populated urban area and dwelling zones. Unleaded gasoline should be used to reduce lead from automobile exhaust emissions.

5. Realize that case-finding per se will not decrease the risk of lead poisoning. It must be coupled with public health programs including environmental investigation, transitional lead-safe housing and public health activities and with facilities for medical management and treatment.

6. Require coverage of lead testing for at-risk children by all third-party and the MOH should be commitment to the Healthy People goal of eliminating lead poisoning.

7. Measure children’s blood lead concentrations to allow national estimates of exposure and should periodically resurvey housing to measure reduction of lead exposure hazards.

8. Avoid using traditional and folk remedies as stone kohl for both child and mother. Children should be kept away from remediation activities and the houses should be tested for lead content.

9. Parents are recommended to keep an eye on children while playing outside home to prevent lead exposure and wash their hands frequently before eating or handling food.

10. Decision-makers should introduce public awareness and educational programs to child sponsors and all levels of the interested personal about risk factors associated with lead poisoning and sources of lead exposure and its impact on human health.

11. Further research is needed for BLL analysis for all Palestinian children aged 2-6 years mainly those at risk for lead exposure by considering the option of using the BLL measurements in hot spot areas only.

12. Further research is needed for obtaining information on the degree of lead exposure and lead poisoning among children experience worst case scenario, and to ascertain other potential sources of exposure.

References

Alan RA. and Margaret S. (2010): Lead and children. Clinical management for family physicians. *Canadian Family Physician,* 56:531-535.

Abdullah M.A. (1984): Lead poisoning among children in Saudi Arabia. *Journal Tropical Medical Hygiene,* 87(2): 67-70.

ATSDR, Department of Health and Human Services, Public Health Service (1997): *Toxicological Profile for lead publication*. U.S.

Bannoura S. (2009): Unemployment rate in Gaza. *International Middle East Media Center (IMEMC).*

Baghurst P & Tang S. (1992): Environmental exposure to lead and children’s intelligence at the age of seven years: the port pirie cohort study. *New England Journal of Medicine,* 327:1279-84.

Barbara B., Claire A., Emmanuel B., and Philippe G. (2011): Sequential digestion for measuring leachable and total lead in the same sample of dust or paint chips by ICP-MS. *Journal of Environmental Science and Health Part A,* 46: 1–7

Barbosa F. Jr., Tanus-Santos Je., Gerlach Rf., & Parsons Pj. (2005): A critical review of biomarkers used for monitoring human exposure to lead: advantages, limitations, and future needs. *Environmental health perspectives,* 113 (12): 1669–1674.

Bellinger, DC (2008): Very low lead exposures and children's neurodevelopment. *Current Opinion Pediatrics,* 2:172-177.

Bellinger, DC. (2004): *Lead. Pediatrics,* 113 (4): 1016–1022.

Bellinger, DC (2005): Teratogen update: lead and pregnancy. *Birth defects research. Clinical and molecular teratology,* 73 (6): 409–420.

Benin Al., Sargent JD., & Dalton Mand Roda S. (1999): High concentrations of heavy metals in neighborhoods near ore smelters in Northern Mexico. *Environmental Health Perspective,* 107:279-284.

Bernard S. M., (2003): Should the CDC childhood lead poisoning intervention level be lowered?. *American Journal of Public Health.* 93(8):1253-1260.

Bornschein RL, Succop PA. and Krafft KM. (1986): Exterior surface dust lead, interior house dust lead and childhood lead exposure in an urban environment in Hemphill D, ed. Trace substance in environmental health. Columbia, (MO): University of Missouri, 322-332.

Brunton L.L., Goodman L.S., Blumenthal D., Buxton I., & Parker K.L. (2007): *Principles of toxicology*. Goodman and Gilman's Manual of Pharmacology and Therapeutics. McGraw-Hill Professional. pp. 1131.

Brodkin, E. Copes, R. Mattman, A. Kennedy, J. Kling & R. Yassi, A. (2007): Lead and mercury exposures: interpretation and action. *Canadian Medical Association journal,* 176 (1): 59–63

Brody DJ, Pirkle JL. and Kramer RA. (1994): Blood lead levels in the US population; Phase 1 of the Third Health and Nutrition Examination Survey (1991 to 1998). *Journal of American Medical Association,* 272:277-283.

Brown M. J., & Meehan P. J. (2004): Health effects of blood lead levels lower than 10 µg/dL in children. *American Journal of Public Health.* 94(1):8-9.

Campbell C. & Osterhoudt, KC. (2000): Prevention of childhood lead poisoning. *Pediatric,* 12 (5): 428-437.

CDC (2008): Interpreting and managing blood lead levels <10 µg/dL in children and reducing childhood exposures to lead. *Morbidity and mortality weekly report* Recommendation Report 56 (8):1-16.

CDC (2006): *Death of a child after ingestion of a metallic charm-Minnesota. Morbidity and mortality weekly report,* 55 (12): 340-1.

CDC (1991): *Preventing lead poisoning in young children: a statement by the Centers for Disease Control.* Atlanta: CDC reports.

CDC (2005): Preventing lead poisoning in young children: a statement by the Centers for Disease Control. Atlanta: CDC reports.

CDC (2000*): Recommendations for Blood Lead Screening of Young Children Enrolled in Medicaid: Targeting a Group at High Risk,* MMWR, 49 (RR14), 1-13.

CDC (1997): *Screening young children for lead poisoning: guidance for -state and local public health officials.* Atlanta, GA.

Cecil, M. Brubaker, J. Adler, M. Dietrich, N. Altaye, M. Egelhoff, C. Wessel, S. & Elangovan, I. (2008): Decreased brain volume in adults with childhood lead exposure. *PLoS medicine* **5** (5): e112.

Choudhari R, Sathwara NG, Shivgotra VK, Patel S, Rathod RA, Shaikh S, Shaikh MI, Dodia S, Parikh DJ, & Saiyed HN. (2010): Study of lead exposure to children residing near a lead-zinc mine. *Indian Journal of Occupation Environmental Medicine,* 14(2):58-62.

Choudari Y, Noonan G, Rosenblum L, Safi JM, El-Haj S., Abu Hashish M., Jaghabir M, Richter E & Fischbein A. (2002): *Childhood lead poisoning prevention project: A case study for the West Bank, Gaza, Israel and Jordan. World Summit on Sustainable Development in Johannesburg, South Africa.* USAID-MERC.

Cleveland, LM. Minter, ML. Cobb, KA. Scott, AA. and German, VF. (2008): Lead hazards for pregnant women and children. *American Journal of Nursing,* 108 (10): 40-49.

Cox RD, Kyle PB, Brackin B, Snazelle T, & Surkin J. (2010): Blood lead levels in Mississippi children. *Journal of Mississipi State Medical Association*,51(8):206-210.

Dart R.C., Hurlbut K.M., & Boyer-Hassen L.V. (2004): Lead. in Dart, RC. *Medical Toxicology, 3rd edition*. Lippincott Williams & Wilkins. pp. 1426

EL-Araby I, Hafez B, Mostafa Y, EL-Delgawi W, Badr EL-Din O & Loka M. (1995): Environmental lead pollution and children at Alexandria, Part 1:Demographic characteristics & environmental conditions, *Alexandria J of Pediatrics*, 9(1):113-18.

Ekong, E. Jaar, B. & Weaver, V. (2006): Lead-related nephrotoxicity: a review of the epidemiologic evidence". *Kidney international* 70 (12): 2074-2084.

EPA. (1986): Air Quality Criteria for lead, Environmental Criteria and Assessment Office, US. EPA, Cincinnati, Ohio. Report No. EPA 600/8-83/028.

Epstein SG. Taylor AB. Brown MJ. (1998): Coordinating care from clinic to community. Boston, MA: New England SERVE, Rhode Island Department of Health.

Eubig PA, Aguiar A, Schantz SL. (2010): Lead and PCBs as risk factors for attention deficit/hyperactivity disorder. Environ Health Perspect. ;118(12):1654-67.

Garbo G., Frigerio M., Ivaldi PA, Caroni G., Ferrari G., Giachino GM. (1998): Lead Poisoning in the newborn and infants: an epidemiological study in an area of Northern Italy. *Pediatr Med Chir*. 20 (5):309-13.

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

Glorennec P. Peyr C. Poupon J. OulhoteY. and Le Bot B. (2010): "Identifying Sources of Lead Exposure for Children, with Lead Concentrations and Isotope Ratios". *Journal of Occupational and Environmental Hygiene*, 7: 253–260

Gollow AA, Kwaansa-Ansah, EE. (1994): Comparison of lead and zinc levels in hair of pupils from four town in Kumasi municipal are of Ghana. *Bull Environ. Contam. Toxicology.* 53: 325-331.

Grant L.D. (2009): Lead and compounds. in Lippmann, M.. *Environmental Toxicants: Human Exposures and Their Health Effects, 3rd edition*. Wiley-Interscience. pp. 785

Guidotti, T. Ragain, L. (2007): Protecting children from toxic exposure: three strategies. *Pediatric clinics of North America* 54 (2): 227–235.

Hu H., Shih R., Rothenberg S., Schwartz S. (2007): The epidemiology of lead toxicity in adults: measuring dose and consideration of other methodologic issues. *Environmental health perspectives* 115 (3): 455–462.

Hunt, W. Watson, R. Oaks, J. Parish, C. Burnham, K. Tucker, R. Belthoff, J. Hart, G. (2009): "Lead bullet fragments in venison from rifle-killed deer: potential for human dietary exposure". *PloS one* 4 (4): e5330.

IRIN, (2009): Humanitarian news and analyses. Gaza's sewage system in crisis.

Karri Sk., Saper Rb., Kales Sn. (2008): Lead encephalopathy due to traditional medicines. *Current Drug Safety* **3** (1): 54–59.

Kasten-Jolly J, Heo Y, Lawrence DA. (2011): "Central nervous system cytokine gene expression: modulation by lead. " *J Biochem Mol Toxicol.*;25(1):41-54.

Kemper A. R., Cohn, L. M., Fant, K. E., Dombkowski, K. J., Hudson, S.R. (2005): "Fellow-up Testing among Children with Elevated Screening Lead Levels." *JAMA*, 293 (18):2232-2237.

Khan DA, Ansari WM, Khan FA. (2011): Synergistic effects of iron deficiency and lead exposure on blood lead levels in children. *World J Pediatr.* (in Press)

Kosnett J., Wedeen P., Rothenberg J., Hipkins L., Materna L., Schwartz S., Hu H., Woolf A. (2007), "Recommendations for medical management of adult lead exposure." *Environmental Health Perspectives* 115 (3): 463–471.

Kosnett., M.J. (2007): Heavy metal intoxication and chelators. in Katzung, B.G. *Basic and Clinical Pharmacology*. McGraw-Hill Professional. pp. 948

Kosnett, M.J.. Lead. in Olson, K.R.. *Poisoning and Drug Overdose, 5th edition*. McGraw-Hill Professional. pp.241. 2006.

Lanphear B. P. (2005): Childhood Lead Poisoning Too Little, Too Late. *J. of the American Med. Association (JAMA)*, 293(18):2274-76.

Lanphear B.P, Deitrich K, Auinger P, and Cox C, (2000): Cognitive deficits associated with blood lead concentrations <10 micrograms per deciliter in US children and adolescents. *Public Health Rep*, 115(6): 521-529.

Lanphear, B. Hornung, R. Khoury, J. Yolton, K. Baghurst, P. Bellinger, Dc. Canfield, Rl. Dietrich, Kn. Bornschein, R. Greene, T. Rothenberg, Sj. Needleman, Hl. Schnaas, L. Wasserman, G. Graziano, J. and Roberts, R (2005): "Low-level environmental lead exposure and children's intellectual function: an international pooled analysis" . *Environmental health perspectives* 113 (7): 894–9.

Llop S, Aguinagalde X, Vioque J, Ibarluzea J, Guxens M, Casas M, Murcia M, Ruiz M, Amurrio A, Rebagliato M, Marina LS, Fernandez-Somoano A, Tardon A, Ballester F. (2011): Prenatal exposure to lead in Spain: Cord blood levels and associated factors. *Sci Total Environ.* (in press)

Maas, R. Patch, S. Morgan, D. Pandolfo, T (2005): Reducing lead exposure from drinking water: recent history and current status . *Public health reports* 120 (3): 316–21.

Marshall W.J., Bangert S.K. (2008): Therapeutic drug monitoring and chemical aspects of toxicology. *Clinical Chemistry, 6th edition*. Elsevier Health Sciences. p. 366.

Markowitz ME (2003): Managing Childhood Lead Poisoning. *Salud Publica Mex*. 45 (Suppl2):S225-31.

Meyer, PA; Mcgeehin, MA; Falk, H (2003): A global approach to childhood lead poisoning prevention. *International journal of hygiene and environmental health* 206 (4-5): 363–9.

Meyer PA., Brown MA., Falk H. (2008): Global approach to reducing lead exposure and poisoning. *Mutation research* **659** (1-2): 166–175.

MEnA (2000): Palestinian Environmental Strategy (PES). Al-Bireh, Palestine.

MOH (2003): Health Status in Palestine, Annual Report. *Palestinian Health Information Center*, Palestine.

MOH (2004): Health Status in Palestine, Annual Report. *Palestinian Health Information Center,* Palestine.

MOH (2005): Health Status in Palestine, Annual Report. *Palestinian Health Information Center,* Palestine.

MOH, (2006): Health Status in Palestine, Annual Report. *Palestinian Health Information Center*, Palestine.

Murata K., Iwata T., Dakeishi M., Karita K. (2009): Lead toxicity: does the critical level of lead resulting in adverse effects differ between adults and children?. *Journal of Occupational Health* 51 (1): 1–12.

Mycyk M., Hryhorczuk D., Amitai Y. (2005): Lead. in Erickson, TB; Ahrens, WR; Aks, S; Ling, L. *Pediatric Toxicology: Diagnosis and Management of the Poisoned Child*. McGraw-Hill Professional. pp. 463

Mushak P, and Crocetti AF (1989): Determination of numbers of lead-exposed American children as a function of lead source: integrated summary of a re\port to the US congress on childhood lead poisoning. *Environmental research*, 50(2): 210-229.

Navas-Acien, A. Guallar, E. Silbergeld, K. Rothenberg, J. (2007): Lead exposure and cardiovascular disease-a systematic review. *Environmental health perspectives* 115 (3): 472-482.

Needleman, H. (2004). Lead poisoning. *Annual review of medicine* 55: 209–222.

Needleman H. L. Landrigan P. J. (2004): What Level of Lead in Blood is Toxic for A child? *Am J Public Health*. 94(1): 8-8.

Nir A., Tamir A., Zelnik N., Iancu T.C. (1992): Is eye cosmetic a source of lead poisoning? *Isr J Med Sci,* 28(7): 417-21.

Park, K. O'Neill, S. Vokonas, S. Sparrow, D. Wright, O. Coull, B. Nie, H. Hu, H. *et al*. (2008): Air pollution and heart rate variability: effect modification by chronic lead exposure. *Epidemiology (Cambridge, Mass.)* 19 (1): 111–120.

Patrick, L (2006). Lead toxicity, a review of the literature. Exposure, evaluation, and treatment" . *Alternative medicine review* 11 (1): 2–22.

Payne M. (2008): Lead in drinking water. *Canadian Medical Association Journal* 179 (3): 253–254.

PCBS (2006): Palestine in Figures. Ramallah, Palestine.

PCBS (2007): The average of rainfall according to month and center. Ramallah – Palestine.

PCBS, (2008): Selected Indicators by Region, Palestine in Figures 2007. Ramallah – Palestine.

PCBS, (2009): Population, Housing, and Establishment Census-2007.

PCHR (2006): (Sourani R. Wishah J. Alami I. Shaqqura H): Poverty in the Gaza Strip Report.

Pearson H.A., Schonfeld D.J. (2003): Lead. in Rudolph, C.D. *Rudolph's Pediatrics, 21st edition*. McGraw-Hill Professional. pp.369

Pearce J. M. (2007): Burton's line in lead poisoning. *European Neurology* 57 (2): 118–119.

Pokras M., Kneeland M. (2008): Lead poisoning: using transdisciplinary approaches to solve an ancient problem". *EcoHealth* 5 (3): 379–385.

Ragan P., Turner T. (2009): Working to prevent lead poisoning in children: getting the lead out. O*fficial Journal of the American Academy of Physician Assistants* 22 (7): 40–45.

Ringold S., Lymn C., Glass R. M., (2005): Lead Poisoning. *JAMA*, 2293:2304.

Rossi E. (2008): Low level environmental lead exposure - a continuing challenge. *The Clinical biochemistry. Australian Association of Clinical Biochemists* 29 (2): 63–70.

Romieu I. (2003): Use of Blood Lead Data to Evaluate and Prevent Childhood Lead Poisoning in Latin America. *Salud Publica Mex*. 2:S244-51.

Roscoe RJ, Gittleman J, Deddens JA, et al. (1999): Blood lead levels among children of lead-exposed workers: a meta-analysis. *American J Industrial Med.*, 36:475-481.

Rubin CH, Esteban E., Reissman D.B., Daley W.R., Noonan G.P., Karpati A., et al. (2002): Lead poisoning among young children in Russia: concurrent evaluation of childhood lead exposure in Ekaterinburg, Krasnouralsk, and Volgograd. *Environ Health Perspective,* 110(6): 559-62.

Safi J. (1998): The State of the Environment in Gaza Strip. *Alexandria Science Exchange*. 19 (1): 137- 150.

Safi J, Alf Fischbein, Sameer El-Haj, R Sansour, M. Abu Hashish, H. Suleiman, M Jaghabir, ED Richter and Y Choudari (2006): Childhood Lead Exposure in the Palestinian Authority and Jordan, Results from the Middle Eastern Regional Cooperation Project 1996-2000". *Environmental Health Perspectives,* Vol. 114 (6): 917-922.

Safi J.M. (2004): Childhood Lead Poisoning in Gaza Strip. Presented in Dubai International Conference on Atmospheric Pollution, 21-24 Feb., Dubai, United Arab Emirates.

Shaltout A, Yaisha SA, and Femando N. (1981): "Lead encephalopathy in infants in Kuwait." A study of 20 infants with particular reference to clinical presentation and source of lead poisoning. *Ann Trop Pediatr.* 1:209-215.

Sanborn Md., Abelsohn A., Campbell M., Weir E. (2002): "Identifying and managing adverse environmental health effects: Lead exposure". *Canadian Medical Association Journal* 166 (10): 1287–1292.

Sherlock J, Barltrop D, Evans W. (1985): Blood Lead Concentrations & lead intake in children of different ethnic origin. *Human Toxicology*; 4:413-519.

Sanders, T. Liu, Y. Buchner, V. Tchounwou, Pb (2009): "Neurotoxic effects and biomarkers of lead exposure: A review". *Reviews on environmental health* 24 (1): 15–45.

Sanna E, De Micco A, Vallascas E. (2011): "Evaluation of Association between Biomarkers of Lead Exposure in Sardinian Children (Italy). " Biol Trace Elem Res. (in press).

Shen X. Wu S, and Yan C, (2001): "Impacts of low-level lead exposure on development of children: recent studies in China", *Clin Chim Acta,* 313 (1-2): 217-20.

Srinivasa Reddy Y, Pullakhandam R, Radha Krishna KV, Uday Kumar P, Dinesh Kumar B. (2011): "Lead and essential trace element levels in school children: A cross-sectional study." *Ann Hum Biol.*;38(3):372-377.

Sol English, (2009): Environmental destruction in Gaza. www.english.sol.org.tr/news/international/environmental-destruction-gaza. Accessed 10/ 2010.

Statistical Package for Social Sciences (SPSS 1997). Inc. Chicago, Illinois, USA.

Trotter RT. (1990): The cultural parameter of lead poisoning A medical anthropologist's view of intervention in environmental lead exposure. *Environ. Health Perspectives,* 89: 79-84.

Wang Q**,** Ye LX**,** Zhao HH**,** Chen JW**,** Zhou YK**.** (2011): Benchmark dose approach for low-level lead induced haematogenesis inhibition and associations of childhood intelligences with ALAD activity and ALA levels. *Sci Total Environ.***;**409(10):1806-1810.

Watts, J (2009): Lead poisoning cases spark riots in China. *Lancet* 374 (9693): 868.

Woolf, A. Goldman, R. Bellinger, D. (2007): Update on the clinical management of childhood lead poisoning. *Pediatric clinics of North America* 54 (2): 271–294.

Woolf A. D, Woolf N. T. (2005): Childhood Lead Poisoning in 2 Families Association with Spices Used in Food Preparation. PEDIATRICS, 116(2): pp. e314-e318.

World Health Assembly (2005): The Relationship between the Israeli Ministry of Health and Palestinian Health Authority. 58th WHA, 17 May 2005.WHO,Geneva.

WHO. Environmental Health Criteria 111. (1977): "Lead" World Health Organization, Geneva; 30-123.

Willers S, Schutz A, Attewel R, Skerfving S. (1988): Relation between lead & cadmium in blood & the involuntary smoking of children. Scand *J. Work Environment Health,*14: 385-89.

Yeoh B, Woolfenden S, Wheeler D, Alperstein G, Lanphear B. (2008): Household interventions for prevention of domestic lead exposure in children. *Cochrane Database Syst Rev.* 16 (2): CD006047.

Zhang L, J Dai. Y (2002): Effects of Low-level lead exposure on neurobehaviour development in 1-3 year-old Children and the intervention guideline. *Wei Sheng Yan Jiu.* (1): 4-6.

Annexes

Annex (1) Arabic questionnaire

بسم الله الرحمن الرحيم

عوامل الخطر المرتبطة بالتسمم بالرصاص بين الأطفال فى الفئة العمرية 2- 6 سنوات في محافظات غزة

الجزء (1): معلومات خاصة : (س1 - س8) التاريخ

الحالة: Control Case

1- اسم العائلة____________ اسم الطفل _____________ اسم الأب ________________

العنوان: البلدة _____________ الشارع _________________

2- تاريخ ولادة الطفل (اليوم /الشهر/السنة): □□/ □□/ □□

3- رقم الهاتف ____________

4. العمر (بالأشهر) □□

5 الجنس ذكر (1) أنثى (2)

6.المحافظة (1) الشمال (2) غزة (3) الوسطى (4) خانيونس (5) رفح

7. الشخص الذى تمت المقابلة معه:

(1) أم (2) أب (3) أخ أو أخت (4) أحد الأقارب ، صلة القرابة _______ (5) غير ذلك . حدد

8. عمر الأب □□ 8.1. عمر الأم □□ 8.2. عمر الشخص الذى تمت معه المقابلة □□ .

الجزء (2): المقيمون فى الأسرة (س 9- س13)

9. الحالة الاجتماعية للوالدين. فى حالة عدم وجود الوالدين . ولى الأمر □ الوصى □

(1) متزوجان (2) مطلقان (3) أعزبان (4) أرملان .

10. الأم: سنوات التعليم:

(1) غير متعلمة (2) 1-8 سنوات (ابتدائى)

(3) 9-12 سنة (ثانوى) (4) أكثر من 12 سنة (كلية متوسطة أو جامعة)

11. الأب: سنوات التعليم:

(1) غير متعلم (2) 1-8 سنوات (ابتدائى)

(3) 9-12 سنة (ثانوى) (4) أكثر من 12 سنة (كلية متوسطة أو جامعة)

12. ما هى مهنة الأب الحالية؟

13. ما هى مهنة الأم الحالية؟

الجزء (3) معلومات عن المقيمين فى الأسرة (س 14- س16)

14. هل شقتك/ بيتك مستأجر أو ملك ؟ (1) ملك (2) مستأجر

15. إذا كنت تسكن شقة فى أى طابق يوجد مسكنك؟

(1) الطابق تحت الأرضى (2) الطابق الأرضى (3) الطابق الأول (4) الطابق الثانى فما فوق

16. كم عمر بيتك أو شقتك ؟

□ أقل من سنة □ 1-9 سنوات □ 10-19 سنة □ 20-39 سنة

□ 40-49 سنة □ اكثر من 50 سنة □ لا أعرف

الجزء 4.: وضع السكن (س 17 – 18.7)

17. موقع البيت / الشقة (1) ليس على طريق رئيسى (2) مجاور لطريق رئيسى

18. هل يقع سكنك قرب أحد الأماكن التالية:

18.1. مصهر للمعادن. (0) لا (1) نعم (9) لا أعرف. يبعد عن السكن □□□ أمتار .

18.2. مصنع بطاريات كهربائية (0) لا (1) نعم (9) لا أعرف. يبعد عن السكن □□□ أمتار.

18.3. ورشة إعادة تصنيع بطاريات (0) لا (1) نعم (9) لا أعرف. يبعد عن السكن □□□ أمتار.

18.4 مشغل تصليح رادياتور (0) لا (1) نعم (9) لا أعرف. يبعد عن السكن □□□ أمتار.

18.5. ورشة لحام أو إلكترونيات (0) لا (1) نعم (9) لا أعرف. يبعد عن السكن □□□ أمتار.

18.6 محطة غاز او وقود (0) لا (1) نعم (9) لا أعرف. يبعد عن السكن □□□ أمتار.

18.7. ورشات أخرى حدد ___ (0) لا (1) نعم (9) لا أعرف. يبعد عن السكن □□□ أمتار.

الجزء 4.1 المياه (س 19 – 21)

19 مصدر مياه الشرب فى سكنك

□ 19.1 . شبكة مياه المدينة. □ 19.2 . الينابيع/ ماء يباع فى عبوات تجارية.

□ 19.3 . مياه مفلترة □ 19.4 . مياه ابار/ أمطار □ 26.4. لا أعرف.

20. مصدر مياه الطبخ فى سكنك:

□ 20.1 . شبكة مياه المدينة □ 20.2 . الينابيع/ ماء يباع فى عبوات تجارية

□ 20.3 . مياه مفلترة □ 20.4 . مياه ابار/ أمطار □ 27.4. لا أعرف.

21. هل تقوم بتخزين الماء فى :

(1) خزان معدنى (2) خزان بلاستيك (3) حوض (4) زير فخار (5) أوعية أخرى

جزء 4.2 - شبكة تمديدات المواسير والتدفئة والسطوح المطلية (س 29 – 31)

22. تم تمديد شبكة المواسير فى البيت / شقتك:

(1) أقل من 10 سنوات (2) 10-15 سنة (3) أكثر من 16 سنة (9) لا أعرف.

23. شبكة تمديدات المواسير فى سكنك مصنوعة من مادة :

PVC 30.1 : (0) لا (1) نعم (9) لا أعرف

30.2 المعدن : (0) لا (1) نعم (9) لا أعرف

24. هل تمت فى السنة الماضية تصليحات أو إعادة تصميم فى البيت واستخدم فيها اللحام أو أعمال سمكرة أو حت للجدران بورق الزجاج أو قشط للسطوح المطلية بالدهان ؟

(0) لا (1) نعم (9) لا أعرف

جزء 5: تعرض أفراد الأسرة:

جزء 5.1 التدخين (س 25 – 27) :

25. هل يدخن أحد أفراد الأسرة، أو هل كان فى السابق يدخن

25.1. السجائر (0) لا (1) نعم (9) لا أعرف

25.2. النارجيلة (0) لا (1) نعم (9) لا أعرف

26. عدد الأفراد المقيمين الذين يدخنون (أى من الأنواع المذكورة أعلاه) حالياً فى البيت .

27. ما عدد السجائر الذى يدخن حالياً فى البيت ؟

1. من قبل الأب 2. من قبل الأم 3. من قبل الآخرين. المجموع

جزء 5.2 الكحل (س 28 – 36) :

28. هل صادف أن استخدمت الأم الكحل لتجميل عينيها؟ (0) لا (1) نعم (9) لا أعرف

29. هل صادف أن استخدمت الأم الكحل لتجميل عينى الطفل قيد الفحص؟

(0) لا (1) نعم (9) لا أعرف

29.1. مدة الاستخدام بالأشهر

30. هل تحضر الأم هذا الكحل بنفسها؟ (0) لا (1) نعم (9) لا أعرف

31. إذا كانت الإجابة نعم فما المادة التى استخدمت فى تصنيعها ؟

(1) زيت الزيتون (2) صيغة معدنية/ حجرية (3) مادة أخرى ، حدد_______

32. إذا الأم تشترى الكحل ما نوعه (1) مادة حجرية (9) لا أعرف

33. ما طول الفترة التى استخدمت فيها الأم الكحل لتجميل عينيها بالأشهر؟

(ضع رقماً فى كل خانة 12 ,11 ,10 ,9.........3 ,2 ,1)

34. هل استخدمت الأم الكحل لعينيها أثناء حملها بالطفل قيد الفحص؟

(0) لا (1) نعم (9) لا أعرف

35. ما مدة استخدام الكحل أثناء فترة الحمل؟

(1) أقل من شهر (2) 1-3 أشهر (3) 4-6 أشهر (4) 7-9 أشهر (9) لا أعرف

36. كم مرة فى الأسبوع خلال فترة الحمل استخدمت الأم هذا الكحل؟ ________.

الجزء 5.3 التعرض أثناء العمل (س 37 - س 46):

هل عمل أحد يقيم فى السكن الحالى فى أى من الوظائف أو الحرف التالية خلال السنوات الستة الماضية؟

ملاحظة : إذا كان الجواب نعم فى الماضى أو فى الحاضر ضع إشارة على المربعين (1) (2)

37. تعدين أو صهر الرصاص:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

38. **صنع البطاريات الرصاصية:**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

39. **إعادة تصنيع البطاريات الرصاصية:**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

40. **تصنيع رادياتورات السيارات:**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

41. **ورشات تصليح "بودى" هياكل السيارات:**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

42. **أعمال كهربائية:**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

43. **أعمال الطراشة والدهان**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

44. **تجديد المبانى وصيانتها :**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

45. **العمل فى محطات الوقود :**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

46. **أعمال أخرى يتم التعرض فيها للرصاص:**

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

إذا كانت الإجابة نعم فكم عدد الأشخاص .... منذ متى .... ولمدة كم شهر ....

الجزء 5.4. ملابس العمل والاستحمام (س 47 – 50) :

* إذا كانت الإجابة على أى من الأسئلة السابقة"نعم" هل كان يقوم أحد العمال على الأقل.

47. باصطحاب ملابس العمل إلى البيت:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

48. بالذهاب بحذاء العمل إلى البيت:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

49. بغسل ملابسه فى البيت:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

50. بالاستحمام فى موقع العمل قبل الذهاب إلى البيت:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

الجزء 5.5. الأنشطة والحرف والهوايات فى البيت (س 51 – 54) :

هل قام أحد المقيمين فى السكن الحالى بمزاولة أى من الأنشطة والهوايات والحرف التالية فى المنزل خلال السنوات الست الماضية ؟

51. إزالة الطلاء عن المواد الخشبية أو الأثاث أو السيارات أو الدراجات أو القوارب ؟

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

52. لحام قطع كهربائية:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

53. صهر الرصاص لصنع ثقالات شباك صيد الأسماك:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

54. معالجة وتصليح أو صهر بطاريات السيارات:

(0) لا (1) نعم فى الحاضر (2) نعم فى الماضى (9) لا أعرف

الجزء 6 : معلومات عن الطفل قيد الفحص والرعاية اليومية (س 55 – 58) :

55. هل يقيم الطفل (ة) فى البيت خلال النهار؟

(0) لا (1) نعم (9) لا أعرف

56. هل يذهب الطفل (ة) إلى روضة أطفال بشكل منتظم ؟

(0) لا (1) نعم (9) لا أعرف

57.هل يذهب الطفل (ة) إلى بيت أحد أقربائه بشكل منتظم ؟

(0) لا (1) نعم (9) لا أعرف

58. إذا كان الطفل يلزم المنزل ، كم عدد الساعات التى يقضيها خارج المنزل أسبوعياً ؟

الجزء 6.1- معلومات عن الطفل قيد الفحص والتغذية (س 59 – 64)

59. هل رضع طفلك رضاعة طبيعية (من حليب أمه) ؟

(0) لا (1) نعم (9) لا أعرف .

60. كم كوباً من الحليب يتناول طفلك يومياً ؟ (ضع الرقم المناسب فى المربع 10 ,9 … ,2 ,1) .

61. هل تقدمين لطفلك مشروبات خفيفة ؟

(0) لا (1) نعم (9) لا أعرف .

62. هل يتناول طفلك جميع وجباته الغذائية فى البيت ؟ (0) لا (1) نعم (9) لا أعرف .

* إذا كان الجواب "لا " فكم عدد الوجبات اليومية التى يتناولها خارج المنزل.

(أكتب الرقم داخل المربع 0 ، 1 ، 2 ، 3)

63. هل صادف أن قدمت لطفلك بديلاً من الحليب ؟ (0) لا (1) نعم (9) لا أعرف .

64. هل تستخدمين ماء الحنفية لتحضير غذاء طفلك ؟ (0) لا (1) نعم (9) لا أعرف .

الجزء 6.2- معلومات عن الطفل قيد الفحص ومصادر الرصاص التغذية (س 65 – 71)

هل يقوم طفلك / أو قام بــ :-

65. مص أصابعه أثناء النهار ؟

(0) لم يفعل ذلك أبداً (1) نادراً (2) أحياناً (3) غالباً (4) لا أعرف .

66. وضع دمى (العاب) أو أجسام مطلية فى فمه ؟

(0) لم يفعل ذلك أبداً (1) نادراً (2) أحياناً (3) غالباً (4) لا أعرف .

67.أكل رقاقات أو شظايا طلائية منسلخة عن الجدران أو السقوف أو التقط طعاماً من سطوح مطلية ؟

(0) لم يفعل ذلك أبداً (1) نادراً (2) أحياناً (3) غالباً (4) لا أعرف .

68. أكل التراب؟

(0) لم يفعل ذلك أبداً (1) نادراً (2) أحياناً (3) غالباً (4) لا أعرف .

69. أكل أو اللعب بالجرائد أو المجلات ؟

(0) لم يفعل ذلك أبداً (1) نادراً (2) أحياناً (3) غالباً (4) لا أعرف .

70. يقرض أظافره ؟

(0) لم يفعل ذلك أبداً (1) نادراً (2) أحياناً (3) غالباً (4) لا أعرف .

71. اللعب بالمجوهرات أو طلقات الرصاص أو الخرز أو ثقالات شباك صيد الأسماك أو أية إلكترونيات؟ (0) لم يفعل ذلك أبداً (1) نادراً (2) أحياناً (3) غالباً (4) لا أعرف .

الجزء 7 الوضع الصحى العام للطفل (س 72 - س 130) :

72. الوضع الصحى العام لطفلك ؟ (1) جيد (2) ليست جيد .

73. خلال الأشهر الستة الماضية ، هل أخبرك الطبيب أن طفلك مريض ؟

(0) لا (1) نعم (9) لا أعرف . " إذا كانت الإجابة " نعم " حدد نوع المرض ------ .

74. هل تناول طفلك أى نوع من الأدوية فى الأسابيع القليلة الماضية ؟

(0) لا (1) نعم (9) لا أعرف .

إذا كان الجواب " نعم " حدد نوع الأدوية ---------------------- .

75. هل يحتاج طفلك رعاية طبية متكررة؟

(0) لا (1) نعم (9) لا أعرف .

إذا كان الجواب "نعم" ما المشاكل التى بحاجة للمتابعة؟ ....

76. هل يعانى طفلك من انخفاض نسبة الحديد أو فقر الدم؟ (0) لا (1) نعم (9) لا أعرف .

77. هل يتناول طفلك أغذية تمده بالحديد؟ (0) لا (1) نعم (9) لا أعرف .

78. هل يعانى طفلك من مشاكل فى الدم؟ (0) لا (1) نعم (9) لا أعرف .

هل يعانى طفلك قيد الفحص من أى من:

79. نوبات سعال متكررة (قحة) (0) لا (1) نعم (9) لا أعرف .

80. تنفس مصحوب بصفير وسحرجة (0) لا (1) نعم (9) لا أعرف .

81. رشوحات وسيلان فى الأنف (0) لا (1) نعم (9) لا أعرف .

82. صعوبات فى التنفس (0) لا (1) نعم (9) لا أعرف .

83. هل يعانى الطفل قيد الفحص من مشاكل تخص نموه وسلوكه وقدرته على التعلم؟

إذا كانت الإجابة "نعم" حدد ______________________

لا يسعنى إلا أن أتقدم لكم بجزيل الشكر والامتنان على الوقت والتعاون.

Annex (2) English questionnaire

بسم الله الرحمن الرحيم

An interview questionnaire

Risk Factors Associated with Lead Poisoning among Children Aged 2-6 Years in Gaza Governorates

Subject 1) Case 2) Control

Part I: Cover information (Q1-Q7)

1. Date (m\d\y): __ /__ / __

Family name:__________ Child's name:__________ Father's name:__________

Address: Town__________ Street__________ Telephone: __________

2. Governorate 1 North 2. Gaza 3. Middle Zone 4. Khan Younis 5. Rafah

3. Child's Date of birth (d, m, y): |_| |_| / |_| |_| / |_||_|

4. Child Age (Months) _________ 5. Sex |1| Male |2| Female

|_| **Interviewee:**

6. (1) Mother (2) Father (3) Sister or brother (4) Relative: Specify:____

7.|_| |_| age of father |_| |_| age of mother |_| |_| age of interviewee

Part 2: Household Residents (Q8-Q14)

|_| **8.** Marital status of the parents

(1) Married (2) Divorced/separated (3) Single (4) Widowed

|_| **9.** Mother: years of education:

(1) None (2) 1-8 years (3) 9-12 years (4) >12 years or college/university

|_| **10.** Primary caretaker's relation to child:

(1) Mother (2) Father (3) Brother

(4) Sister (5) Relative

|_| **11.** Father: years of education:

(1) None (2) 1-8 years (3) 9-12 years (4) >12 years or college/university

|_| **12.** What is the current job of the **father?** ______________________________

|_| **13.** What is the current job of **mother?** ______________________________

|_| **14.** Number of people currently living in the household?

Part 3: Household information (Q16-Q19)

|_| **16.** Do you rent or own your house\ apartment? (1) Own (0) Rent

|_| **17.** If you are living in apartment, on which floor level is your dwelling unit?

(1) Basement (2) Ground floor

(3) One Floor above ground (4) on the second floor or higher

|_| **18.** How old is your house/apartment?

(1) <1 year (2) 1-9 years (3) 10-19 years (4) 20-39 years

(5) 40-49 years (6) >50 years (7) Don't Know

|_||_|**19.** When did you move to this house/apartment?
(1)<1 year ago (2) 1-6 years ago (3) >7 years ago

Part 4: Household location and exposure sources (Q20-Q21.7)

|_| **20.** Location of your house/apartment is:
(1) Not on major road (2) On, above or next to a major roadway
|_| |_||_| If not on major road, approximate distance from major road in **meters.**

|_| **21.** Is your house/apartment near of the following?
|_| **21.1** Smelter (0) No (1) Yes (9) don't know
Distance from house |_| |_||_| meters
|_| **21.2** Battery manufacturing (0) No (1) Yes (9) don't know
Distance from house |_| |_||_| meters
|_| **21.3** Battery recycling (0) No (1) Yes (9) don't know
Distance from house |_| |_||_| meters
|_| **21.4** Radiator repair (0) No (1) Yes (9) don't know
Distance from house |_| |_||_| meters
|_| **21.5** Electronic/ soldering (0) No (1) Yes (9) don't know
Distance from house |_| |_||_| meters
|_| **21.6** Gas or petrol station (0) No (1) Yes (9) don't know
Distance from house |_| |_||_| meters
|_| **21.7** Others (specify) (0) No (1) Yes (9) don't know
Distance from house |_| |_||_| meters

Part 4.1 Water (Q22-Q24)

22. The Water you drink in your house frequently comes from
1 City-tap water |_| **2** Spring/commercial bottled water
3 Well-tap water/ collected rain water **9** Don't know

23. Your household cooking water most frequently comes from:
1 City-tap water **2** Spring/ commercial bottled water
3 Well-tap water/ collected rain water **4** Don't know

24. Do you generally store water in?
(1) Metallic tank (2) Plastic tank (3) Other, Specify

Part 5: Familial exposure
5.1 Smoking: (Q25-Q27)

25. Does any family member ever, now or in the past, **smoke**
25.1 Cigarettes (0) No (1) yes (9) don't know
25.2 Nargila (0) No (1) yes (9) don't know
26. Number of residents who currently **smoke** any of the above in the house?

27. What is the **number of cigarettes** currently smoked per day in the house?
27.1 |_| |_| **by father** **27.2** |_| |_| **by others (total)_______**

Part 5.2 Kohl: (Q28-Q36)

|_| **28.** Did the mother ever use any kind of **Kohl** on her own eyes?
(0) No (1) yes (9) don't know

28.1 For **how long?** (In months) |_||_||_|
(0) No (1) yes (9) don't know

|_| **29.** Did the mother ever use any kind of **Kohl** on index **child's of eyes**?
(0) No (1) yes (9) don't know

29.1 For **how long?** (In months) |_||_||_|

|_| **30.** Did or does the mother prepare the khol by herself?
(0) No (1) yes (9) don't know

|_| **31.** If Yes with: (1) olive oil (2) mineral/ stone form (3) other,

|_| **32.** If she buys her khol, what kind is it? (1) stone (mineral) based (9) Don't know

|_| **33.** How many **years** has the **mother** been using **kohl** on her **own eyes**?

|_| **34.** Did the mother **use** this **kohl** on her own eyes while she was pregnant with the **index** child? (0) No (1) yes (9) don't know

35. For how long did **mothe**r use kohl during **pregnancy**?
(1) Less than a month (2) 1-3 months (3) 4-6 months
(4) 7-9 months (9) don't know

36. How many **days per week** during **pregnancy** did the mother use this **kohl**? ____

Part 5.3 Occupational exposure (Q37-Q46)

Has one or more person living in the household worked in any of the following jobs or trades during the past six years? (Note: If yes, presently and yes, past both true, then mark in both (1) and (2)

37.	**Smelting** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
38.	**Making lead batteries** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
39.	**Recycling lead batteries** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
40.	**Auto radiator repair work** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
41.	**Plumbing or pipefitting** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
42.	**Electric work** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
43.	**House painting, spray painting** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
44.	**Renovating homes** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______
45.	**Gasoline Station work** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months ______

46.	**Other jobs with lead exposure (**Specify if possible: ________________ **)** (0) No (1) Yes, presently (1) Yes, past (9) don't know If yes, how many persons ____from when _____and for how many months _______

Part 5.4 Work Clothes and Showering: (Q47-Q50)
If answer to any one or more of above is yes, does one or more workers

47.	**Wear or bring his work clothes home?** (0) No (1) Yes, presently (1) Yes, past (9) don't know
48.	**Wear or bring his work shoes home?** (0) No (1) Yes, presently (1) Yes, past (9) don't know
49.	**Wash his clothes at home** (0) No (1) Yes, presently (1) Yes, past (9) don't know
50.	**Shower at worksite before coming home** (0) No (1) Yes, presently (1) Yes, past (9) don't know

Part 5.5 Tasks, Crafts or Hobbies at Home: Exposure (Q51- Q53)
Did any person living in the current residence work at any of the following tasks, hobbies or crafts at home (during the last 6 years):

51. Remove paint or varnish while in the dwelling from woodwork, furniture or cars, bicycles, boats in the yard?
(0) No (1) Yes, presently (1) Yes, past (9) don't know

52. Solder electric parts
(0) No (1) Yes, presently (1) Yes, past (9) don't know

53. Melt Lead to make fishing sinkers
(0) No (1) Yes, presently (1) Yes, past (9) don't know

Part 6: Information about index child and day care (Q54- Q58):

54. Does the child stay at home during the day?
(0) No (1) yes (9) don't know

55. Does the child regularly attend kindergarten?
(0) No (1) yes (9) don't know
Where (address) and Name _________________________

56. Does the child regularly attend a licensed day-care center?
(0) No (1) yes (9) don't know

57. Does the child regularly visit a relative's house?
(0) No (1) yes (9) don't know
Where (address) and Name _________________________

58. If the child stays at the house, how many hours (s) he is outdoors/week?

Part 6.1 Information about index child and feeding (Q59-Q64)

59. Was your child breastfed?
(0) No (1) yes (9) don't know
60. How many cups of milk does your child drink per day? (0, 1, 2, 3, … etc.)
61. Do you give your child soft drink?
(0) No (1) yes (9) don't know
62 Does your child eat all his/her meals at home?
(0) No (1) yes (9) don't know
63. Have you ever given your child a milk substitute?
(0) No (1) yes (9) don't know
64. Do you use tap water to prepare your child's formula?
(0) No (1) yes (9) don't know

Part 6.2 Information about child index and lead sources (Q65-Q71)
Did/does your child ever:

65. **Suck his/her fingers** during the daytime?
(0) Never (1) Rarely (2) Sometimes (3) Frequently (9) don't know
66. Put toys or paint **objects in his/her mouth**?
(0) Never (1) Rarely (2) Sometimes (3) Frequently (9) don't know
67. Eat paint chips or pick on painted surfaces?
(0) Never (1) Rarely (2) Sometimes (3) Frequently (9) don't know
68. Eat soil or dirt?
(0) Never (1) Rarely (2) Sometimes (3) Frequently (9) don't know
69. Eat or play with **newspapers** or **magazines**?
(0) Never (1) Rarely (2) Sometimes (3) Frequently (9) don't know
70. Bite his/her nails?
(0) Never (1) Rarely (2) Sometimes (3) Frequently (9) don't know
71. Play with jewelry, bullets, fishing sinkers or electronics items?
(0) Never (1) Rarely (2) Sometimes (3) Frequently (9) don't know

Part 7 Child's health (Q72-Q86)

72. Your child **general health:** (1) Good (2) Not good
73. In the past six months, has your doctor told you that **your child has a disease**?
(0) No (1) yes (9) don't know
If yes, specify which illnesses ____
74. Has your child been **receiving any medicine** in the past few weeks?
(0) No (1) yes (9) don't know
If yes, specify which medication ____

75. Has the index child ever been found to have **elevated blood lead level**?
(0) No (1) yes (9) don't know
76. **If Yes,** When? **.** What was the level?
77. Was the child treated (0) No (1) yes (9) Don't know
When? ______________ Where? _____________ Which medication? ____________
78. Does your child **need frequent medical care**?
If yes, for what problem(s)? ……………………………………………………………

79**.** Does your child have **iron insufficiency or anemia**?
(0) No (1) yes (9) Don't know
80**.** Does the index child receive any **iron supplements**?
(0) No (1) yes (9) Don't know
81**.** Does the index child have any **blood problems**?
(0) No (1) yes (9) Don't know
Does the index child suffer from:
82**.** Frequent coughs? (0) No (1) yes (9) Don't know
83**.** Wheezing? (0) No (1) yes (9) Don't know
84**.** Colds/ running nose? (0) No (1) yes (9) Don't know
85**.** Breathing problems? (0) No (1) yes (9) Don't know
86**.** Does the index child have any development, behavior, learning problems**?**
If Yes, Specify

Thank you very much for your time and kind cooperation.

Annex (3) Approval of Helsinki

Palestinian National Authority
Ministry of Health
Helsinki Committee

السلطة الوطنية الفلسطينية
وزارة الصحة
لجنة هلسنكي

التاريخ: 07/03/2011

Name: **Mohammed Safi**

الاسم: محمد صافي

I would like to inform you that the committee has discussed your application about:

" Risk factors associated with lead poisoning among children aged 2-6 years in Gaza Governorates; case control study".

نفيدكم علماً بأن اللجنة قد ناقشت مقترح دراستكم حول:-

In its meeting on March 2011
and decided the Following:-
To approve the above mention research study.

و ذلك في جلستها المنعقدة لشهر 3 2011
و قد قررت ما يلي:-
الموافقة على البحث المذكور عاليه.

Signature
توقيع

Member	Member	Chairperson
عضو	عضو	

Conditions:-

- Valid for 2 years from the date of approval to start.
- It is necessary to notify the committee in any change in the admitted study protocol.
- The committee appreciate receiving one copy of your final research when it is completed.

13

Arabic abstract

ملخص الرسالة

عوامل الخطر المرتبطة بالتسمم بالرصاص بين الأطفال فى الفئة العمرية 2- 6 سنوات في محافظات غزة

يعتبر تسمم الأطفال بالرصاص من المشاكل العالمية، حيث أن معدل انتشار هذا النوع من التسمم يتحدد بشكل كبير جدا بحسب العمر والمصادر البيئية. يعتبر الأطفال من أكثر الفئات العمرية عرضة لخطر التسمم بالرصاص وذلك لعدة أسباب منها حركة الأطفال النشطة بامتصاص أصابعهم، كما أن الأطفال يتميزون بمعدلات إمتصاص معوية عالية للرصاص والاحتفاظ به. يصاحب التسمم بالرصاص آثار ضارة جدا ليس فقط على الجهاز الهضمي وإنما على الجهاز العصبي المركزى والكلى كما إن التسمم بالرصاص يمتاز بالقدرة على تحطيم وتكسير كرات الدم الحمراء. إن هذه الأخطار السالفة الذكر يمكن أن تكون خطيرة بما يكفي ليصاحبها إصابة الأطفال بالإغماء والوفاة عند التسمم الحاد. لهذا تم دراسة عوامل الخطر المرتبطة بتسمم الرصاص بين الأطفال من الفئة العمرية 2-6 سنوات في محافظات غزة ولقد تم تصميم دراسة الحالة والضابطة للتعرف على عوامل الخطر الشائعة وحماية صحة الانسان والبيئة من تأثير الرصاص الضار، وقد انتهجت هذه الدراسة المنهج الكمي-الوصفي-الاستعادي لتفي بتحقيق أهداف الدراسة. كان حجم عينة الدراسة 240 طفلا، 120 طفلا مصابا بالتسمم بالرصاص من مجموعة أطفال كان مستوى الرصاص بالدم لديهم ≥10 ميكروجرام/ديسيليتر واشتملت الدراسة أيضا على 120 طفلا غير مصابا بالتسمم بالرصاص من مجموعة أطفال كان مستوى الرصاص بالدم لديهم ≤9.9 ميكروجرام/ديسيليتر. إن هذه المعلومات المستخدمة فى الدراسة تم الحصول عليها من قاعدة البيانات المخزنة فى معهد أبحاث وحماية البيئة، غزة.

أظهرت النتائج أن المتغيرات الاجتماعية-الديموغرافية وجد بها 152 (63.3%) ذكور و88 (36.7%) إناث من عينة الدراسة. كما تم تقسيم الفئات العمرية لعينة الدراسة إلى فئتين عمريتين، الأولى كانت تمثل (51.7%) من العينة حيث كانت أعمارهم 24-48 شهرا ، أما الفئة العمرية الثانية فكانت تمثل (48.3%) من عينة الدراسة حيث كانت أعمارهم 49-72 شهرا. كانت أغلبية عينة الدراسة من محافظة غزة (50%) بينما كانت محافظة رفح (6.7%) هي الأقل تمثيلا من مجمل محافظات قطاع غزة. تم تحليل البيانات بإستخدام المجموعة الإحصائية للعلوم الأجتماعية ، حيث أوضح التحليل الإحصائي لمستويات الرصاص في الدم أن 3.2ميكروجرام/ديسيليتر هو الحد الأدنى وأن 65.1ميكروجرام/ديسيليتر هو الحد الأقصى بمتوسط حسابي مقداره 10.19 ميكروجرام/ديسيليتر ووسيط 9.95مقداره ميكروجرام/ديسيليتر.

أظهرت نتائج الدراسة علاقات ذات دلالة إحصائية معنوية بين مستويات الرصاص في الدم والعديد من متغيرات عوامل الخطر المستقلة مثل التعرض العائلي للرصاص والتى تشمل أستخدام الكحل للأطفال لفترات زمنية طويلة ، موقع المنزل من مصادر التلوث بالرصاص والتى تشمل عمليات الصهر وعمليات إعادة تدوير البطاريات وصيانة وتصليح المبردات ومصادر اخرى للتلوث بالرصاص، بعد المنزل عن مصادر التلوث بالرصاص والتى تشمل الصهر وتصنيع البطاريات واعادة تدويرها ومحطات الوقود، التعرض للرصاص أثناء العمل والتى تشمل الدهان ، تغذية وصحة الأطفال والتى تشمل الاطفال خارج المنزل، صحة الطفل والتى تشمل الصحة العامة للأطفال وحاجة الأطفال المستمرة للرعاية وفقر الدم لدى الأطفال. كما أظهرت الدراسة كذلك بأنه لا يوجد علاقة ذات دلالة احصائية معنوية بين مستوى الرصاص في الدم لدى الأطفال والعوامل الاجتماعية-الديموغرافية، التعرض المنزلي، فترة التعرض خلال العمل، الملابس المستخدمة في العمل والأستحمام، الاعمال اليدوية وعادات الاطفال في المنازل.

أوصت الدراسة بضرورة وضع وتطبيق سياسات وقائية لحماية الأطفال من التسمم بالرصاص وكذلك إزالة جميع أماكن صهر الرصاص وتصنيع وإعادة تدوير البطاريات القريبة من الاماكن المزدحمة بالسكان. كذلك أوصت الدراسة بأن الأطفال الذين لديهم مستوى الرصاص بالدم يزيد عن 25ميكروجرام/ديسيليتر لا بد معالجتهم ومتابعتهم . وأخيرا يجب على صانعي القرار إصدار وإنشاء برامج تربوية وتوعوية لأولياء الأمور ولجميع الأشخاص المهتمين بعوامل الخطر المرتبطة بالتسمم الرصاص ومصادر التلوث به وأثره على صحة الانسان.