KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF PUBLIC HEALTH IN THE COLLEGE OF ALLIED SCIENCE

EXPOSURE TO HEAVY METAL AND KIDNEY FUNCTION AMONG ADULTS POPULATION RESIDING NEAR AN OPEN DUMPSITE: A CROSS-SECTIONAL STUDY AT ABOKOBI, IN THE GA EAST MUNICIPAL ASSEMBLY

BY

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THIS DISSERTATION IS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF MASTER OF SCIENCE DEGREE IN ENVIRONMENT AND PUBLIC HEALTH

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DECLARATION

I, Kwadwo Opoku Boateng hereby declare that, except for references to other people's work which have been duly acknowledged, this proposal, submitted to KNUST, African Institute of Sanitation and Waste Management, my own original work and that this proposal has not been submitted to any institution by any student elsewhere.

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(HEAD OF DEPARTMENT) DATE

DEDICATION

I dedicate this work to God Almighty, supervisor and my family

ACKNOWLEDGEMENT

My first and foremost gratitude goes to the Almighty God for His abundant mercy, grace, wisdom and good health to the pursuit of this project work.

I also wish to express my appreciation to Dr. Reginald Quansah my supervisor for his guidance and all the necessary directives.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Waste in open dumps often becomes breeding grounds for lot things and other likely carriers of communicable diseases. Although open waste dumpsite are known in Ghana, there appears to be little research undertaken on them. The study sought to assess the prevalence of renal parameters and the levels of toxic metals in the environmental and biological media (urine and blood) in adults residing near Abokobi Dump site in the Ga East Municipality. Descriptive statistics was used to describe the frequency and percentages on the demographic characteristics of the participant. Multiple logistic regression analysis was used to assess the association between the outcome variable and exposure variables. Both Unadjusted Odds Ratio and Adjusted Odds Ratio with 95% confidence interval was used to show an association between the outcome variable and the independent variables. The determinant of symptoms of renal infection was smoke (40.64%). Except for Manganese and Silver, urine residual levels of Zinc, Cadmium and Lead were high. Similarly, the indicators of kidney function proportions in the blood samples of the participant were within detection level. There was no significant association between self-reported symptoms of renal infection and occupational exposure to heavy metals in urine samples. There was significant association between heavy metals and kidney function in blood samples. For example, the proportion of participant who had traces of BUN in blood was 0.08 times more likely to have Manganese in their urine (COR=0.08; 95%CI=0.01-1.06). There was no significant association between heavy metals in urine and occupational exposure to heavy metals. The study concluded that the prevalence of renal parameters, smoke, was high. Additionally, there was no significant association between symptoms of renal infection and exposure to heavy metals, but there was significant association between persistent urge to urinate, frequency of urination, lower abdominal pain, pain whiles urinating and indicators of kidney infection

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The term "open dump" is used to describe a land disposal area at which of solid waste are disposed of in a way that does not safeguard the environment, are prone to open burning, and are exposed to the diseases, harbor for disease causing pathogens and scrap pickers (International Solid Waste Association (ISWA, 2010). There are about three types of dumpsites which include

a. **Municipal Solid Waste Landfills –mainly house hold garbage**
b. **Industrial Waste Landfills- solid industrial waste (**plastic, glass, concrete, and construction debris.)
c. **Hazardous Waste Landfills- machine and electromagnetic gadgets**

Land filling is a process in which solid waste disposed of in line with environmental protection standards where the waste are spread, compacted and covered with a layer of soil periodically. (Rushbrook, 200, Joshi & Nachiappan, 2007)

Open dumpsite and landfills are a danger to H2O quality when precipitation percolates through waste, leaching out a range of substances such as metals, bacteria and other toxic materials or metal (Mg, Cd, Ld etc.). The leachate produced can eventually contaminate groundwater (Pedersen, 1997).

"Open dumpsite has been also attributed as the cause of Soil pollution. Waste transmit various metals which are imbibe in different ways by crops. Contingent On the susceptibility of the toxins, they ultimately end up either in the water retained in the soil and filtered into the groundwater. Contaminants including Cd, Cu, Ni, Pb and Zn can affect the chemistry and affect the nutrient-dependent bacteria and vegetation.

Several studies show evidence of health risks posed by open waste dumping ultimately affecting the plants' life cycles" (Syeda, Maria, Ali, et al).

Open burning of solid waste when employed can result in the emission of noxious substances such as smoke, fumes and dust into the atmosphere. The toxic fumes usually exacerbate the concentration of air pollutants such as nitrogen oxides, sulfur oxides, heavy metals (mercury, lead, chromium, cadmium, etc.), dioxins and particulate matter (Akpofure Rim-Rukeh, 2014).

The predominant way by which municipal solid waste is disposed in Ghana is through landfilling due to the fact that it cost next to nothing (*Environmetal Protection Agency, (2002*). Although the country is saddled waste, there just about few landfill sites in and around including Abokobi Dumpsite, Adoagyiri-Nsawam Dumpsite, Kpone landfills, Sarbah Landfill site, Oblogo landfill site

0n the other hand the crude methods and poor management practices of these landfills, it has resulted in environmental problems such as surface and ground water pollution, bad odor and prevalence of disease vectors. This has resulted in residence dumping indiscriminately (International Solid Waste Association (ISWA, 2010). In Ghana, dumpsites are typically left previously quarries and mining excavations sites and in a quest to reclaim these lands, they end up being filled with waste. As a result large proportion of the country's landfill sites are essentially dumpsites with little management and supervision in place. Despite efforts to encourage alternative waste disposal options. (*Agamuthu, P. (2013*).

In as much as the quantity of waste has astronomically doubled and the quality more varied, very little information exist on the kind of waste that end up in landfills in the country. Wrong strategy and bad working methods have given a wrong impression to the public that landfill can be managed with little or no impact on the environment, customers and workers. Consequently, no one wants landfills to be constructed on or near their properties.

Again very few educational and research institutions offer training in landfill studies, which has resulted in the lack of skilled personnel working in the area of landfill management. (Boadi, 2003)

This herculean challenge can be narrowed down to most Cities, Municipal and District Assemblies (MMDA'S) especially how to effectively dispose it. Abokobi is in no exception.

The populace of Ledzokuku-krowor, Madina-Nkwantanang, Ga-East and West and Adenta Municipalities all use Abokobi dumpsite of about 8,150.47 tons per month (Ga-East Municipal Environmental Health Officer, 2014). Waste pickers sift through the waste to retrieve materials considered to be of value economically. They therefore set a portion of the dump site on fire enabling them to easily obtain some materials like copper and other metallic materials.

The dangers of air pollution include high blood pressure and cardiovascular problems (Pope, et al. 2002) and Sanjay, (2008)

Associations Air quality and rising morbidity and mortality figures have been indicated (Schwartz, 2000).

The World Health Organization reports that about 2.4 million people die each year from causes openly attribute to air pollution (World Health Organisation 2000).

Epidemiological studies put forward that more than 500,000 Americans pass on each year from disease linked to breathing fine particle matter. (*American Chemical Society (2008*). In fact, air pollution is considered to trigger injury to livestock, forest areas and vegetation, and to aquatic ecosystems. Its effects on metals, constructions include cracking, decay and erosion (Turner, & Stern, 1994).

Although accessible disposal dumpsites are recognized in Ghana, there seems to be little study into them. Dumpsite may trigger issues for on-site carriers and harm to local inhabitants, and likely safety hazards may be intricate. If the waste of an open dumpsites are ignored, or undiscovered, the heavy metals it generate can become dangerous for our health. Assessing air, water and soil quality within the catchment area of open dumpsites will help to forestall the impacts on human health and by extension even animals that could contribute to renal problems in adults. Examine its implication local residents near the dumpsite, workforces and recyclable waste pickers on the other hand, (Sardinia 2005, Tenth International Waste Management and Landfill Symposium)

The assessment of the comparative safety and environmental hazards presented by dumpsites present in emerging nations could assist to prioritize, schedule and implement the rehabilitation of dumpsites. Identifying the danger factors of interest will enable the society to focus its attempts on minimizing both the risk impact of the landfill and the premium. The research therefore seeks to identify the relationship between cadmium, mercury lead and renal function among resident (adults) close to the dumpsite and recommend appropriate interventions to check the practice. Detecting risk factors associated with disease is essential in order to avert it from affecting residents.

1.2 Problem Statement

Municipal waste disposal is an increasing concern, as a result of inadequate collection and disposal effect on the environments of cities, contribute to the degradation of the urban environment and pose a health hazard to urban populations at large. Affected persons are those living adjacent the dumpsites due to the potential of the waste to pollute water, food sources, land, air and vegetation (WHO 2006 & 2005, UNHABITAT 2008). The tendency of these Metals affecting vital organs of the body such as kidney, liver and lungs is high.

The prevalence of kidney is consistently rising at a rate of 6% per annum globally. This is much higher than the rate at which the world is growing, which is predicted at 1.2% yearly (Bamgboye, 2006). West African nations accounts for 5% of the total.

In Ghana data on the prevalence of kidney dysfunction has been varied over the years. Bamgboye (2006) estimates the incidence of it in Ghana per million people at 1.6%. Addo et al., (2009). Heavy metals (Cadmium, Arsenic, Lead) in municipal solid waste which is a common feature (MSW) landfill enters the waste stream from diversity components of consumer products through different path ways by ingestion and inhalation. (Edwin and Howell, 1990; ATSDR, 1999).

The ingestion or inhalation of Cd may cause nausea, abdominal cramps, short breath, chocking fits, renal dysfunction and inhibition of iron absorption. Catarrhal and ulcerative gastroenteritis, congestion, pulmonary infarcts and subdural hemorrhages also may be detected at autopsy (Donahoe et al., 2015).

Mercury in small, but varying concentrations can is found practically in all geological media (UNEP, 2010).

Research have further reported that heavy metals such as Cd, Lead (Pb), Nickel (Ni) and Copper (Cu) have a tendency to build up in vital organs such as the lungs and have a period of 30 to 100 years or more for it radioactivity to fall (ATSDR, 1999). For example, Cd can accumulate in the kidney and bind predominantly to metallothionein protein (Mehra & Juneja, 2004). Toxicity occurs when the body stores an excessive amount of heavy metals. These heavy metals can store in the body tissues as they have storage sites in the body over a period of time and cause serious health problems. Some of these heavy metals can be traced in foods, air, soil or in plants and became the toxic source for human. Some of them caused diseases in human (Agrawal, 2012).

Studies about kidney dysfunction near dumpsites have been conducted mainly outside Ghana and so therefore the need to measure the levels of trace metals and the linkage with the effect on human's especially kidney function in adult residents (adult).

1.3 Conceptual Framework

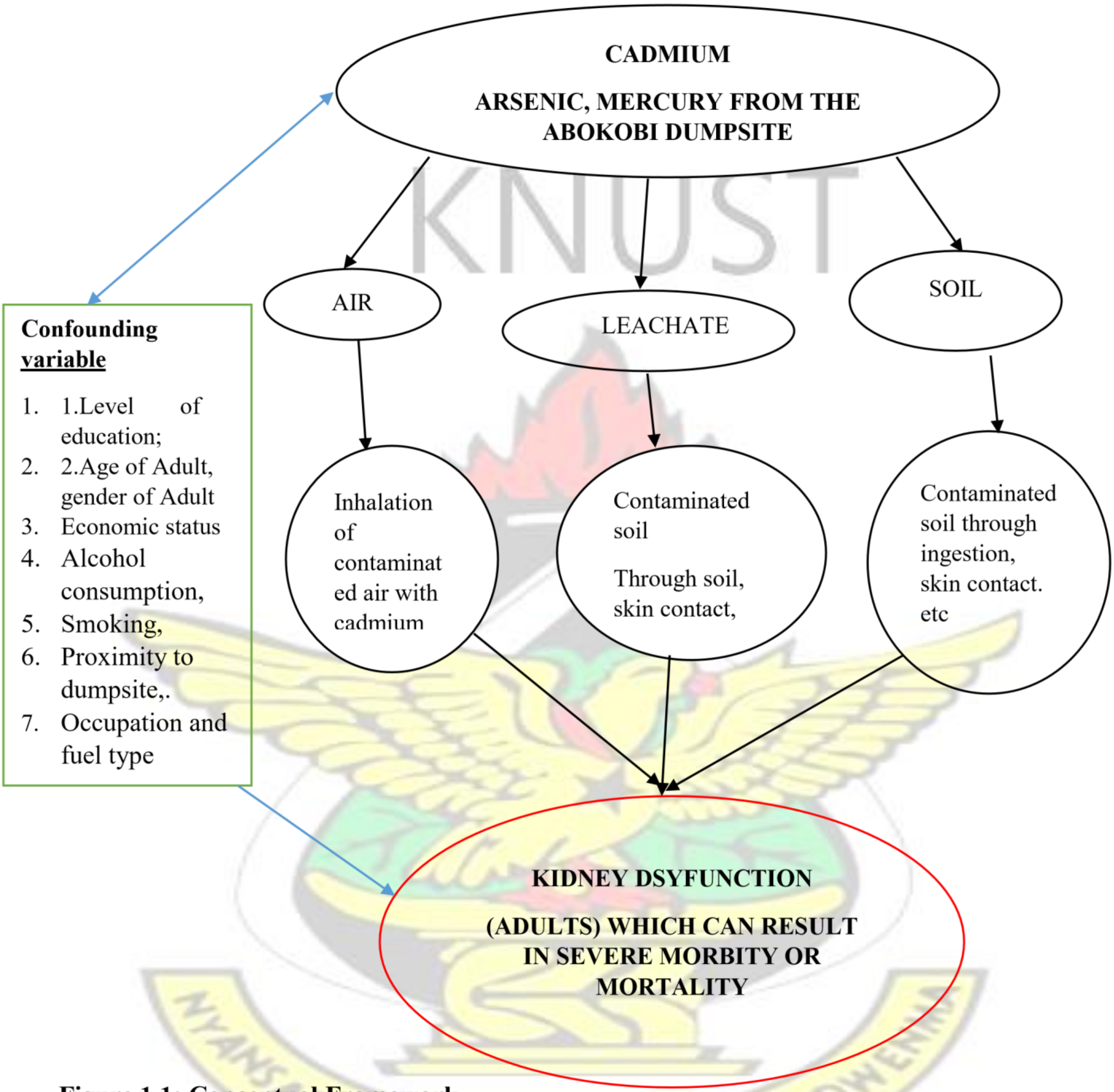

Figure 1.1: Conceptual Framework

Figure 1.1 shows the relationship between cadmium, arsenic and mercury with Kidney function in adults.

Heavy metals in municipal solid waste (MSW) landfill enters the waste stream from variety components of consumer products. The aggregate amount of Arsenic and Cadmium found in the solid waste enters the waste stream and can contribute for a major share of the Cadmium and Arsenic observed in atmospheric particulates. The most likely sources of Cd and As in the landfill are plastics, pigments, various industrial used and Nickel-Cadmium (NiCd) batteries (Edwin & Howell, 1990; ATSDR, 1999). The ingestion or inhalation of Cd may cause nausea, abdominal cramps, short breath, chocking fits, renal dysfunction and inhibition of iron absorption. Mercury in small, but varying concentrations can also be found virtually in all geological media (UNEP, 2010). Elemental and some forms of oxidized mercury always found in the atmosphere due to their volatility.

1.4 Justification of the Study

Continues exposure to environmental pollutant contributes to one-fourth of ailments that has bedeviled our generation as reported by World Health Organization (WHO) (Prüss-Üstün & Corvalán, 2006; Kimani, 2007).

It cannot be over emphasized about the fact that waste is hazardous to health. The immediate surroundings of a Dumpsite is generally embedded with toxic heavy metals and it is a fertile ground for farming by inhabitants. Person who consume fruits or vegetable from such sources rick their lives since the produce accumulate the heavy metals imbibed by the plant (USEPA, 2002; UNDP, 2006; Rotich et al., 2006).

Water bodies are not spared. The heavy metals that sip to the water table affect water quality and serves as breeding grounds for pest and disease victors (Etekpo, 1999; Eddy et al., 2006).

Human and animal health is affected by hazardous waste and even consequence death through pollution. Exposure to various chemical reactions in communities residing close disposal dumpsites has resulted in a number of negative health conditions. (Zupancic, 1997; Palmer et al., 2005; Alimba et al., 2006).

Abokobi dumpsite was an old stone quarry at Abokobi in the Ga East District, which has become an environmental hazard and a threat to the health to residents and its environs. Flies hovering around the community in addition to the constant smoke and stench that emanates from the dumpsite are some of the nuisances. Insects such as flies have simply made it impossible to communicate freely in the area. The presence of the site has become a big worry to officials of the Pantang Hospital and the Nurses Training College whose offices are located few metres away from it.

Residents will always have to use the road in front of the dumpsite for their day-to-day activities and obviously be exposed to the hazards of the dumpsite through either inhalation or ingestion by poor hygienic practices. The contaminated soil with heavy metals like cadmium, mercury and arsenic may find its way into their body through contact, inhalation and ingestion. Statistics from the Pantang hospital in 2015 indicates that, urinary tract infections, gastrointestinal infection and organ disorders are among the top ten (10) diseases reported among patients from the community and its environs.

The research therefore seeks to ascertain the relationship between cadmium, mercury lead and renal function among resident (adults) close to the dumpsite and recommend appropriate interventions to check the practice. Ascertaining risk factors associated with disease is essential in order to prevent it from affecting even patients.

1.4 Objectives of the Study

1.4.1 General Objective

To determine the prevalence of self-reported renal symptoms

1.4.2 Specific objective

1. To determine the parameters of kidney function as measured in serum creatinine, Blood Urea Nitrogen (BUN) and Estimated Glomerular Filtration Rate (eGFR)
2. To determine Urine levels of heavy metals (Mercury, Asenic, Lead and Cadmium)
3. To determine the association between Heavy Metals in Urine and Kidney Function as well as self-reported renal symptoms.

1.5 Significance of Study

Heavy metals in municipal solid waste (MSW) landfill enters the waste stream from variety components of consumer products. The aggregate quantity of Arsenic and Cadmium discovered in municipal solid waste, reaches the waste stream in the burning and may account for a significant proportion of Cadmium and Arsenic discovered in atmospheric particulate matter. . The findings of the study therefore will help policy makers both Governmental and Non-Governmental to deduce mitigation strategies to permanently stop the dumping of waste at the site in order to reduce or prevent the environmental and health impacts.

1.6 Structure of Report

The study comprises five main chapters, and below is a summary of the chapters:

The synopsis of the study is given as: chapter one gives the introductory of the study, related literature is reviewed in chapter two Chapter three details out the method, concept and parameters used for the study. The data collection method and instrument are explained here. Analysis, interpretation and illustrations with appropriate tables and figures are discussed in chapter four. Chapter five and six concludes the study with a summary of the findings, conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Scope of the Review

The study comprises review of theoretical and empirical literature germane to the association Abokobi dumpsite. The literature review will include a brief history of waste dumping site in Ghana including Abokobi dumpsite (Section 2.2), Types of waste (Section 2.3), dumpsites and environment (Section 2.4), dumpsites and health (Section 2.5), and dumpsite and renal function (Section 2.6).

2.2 History of Waste Dumping Site in Ghana Including Abokobi Dumpsite

Yankson and Gough, (1999) indicated that urbanization is one of the variables for many economic and social activities. Person who live in the low income suburb in most African countries without any consideration in line with planning with rapid population growth. This is the driven by a single called Urbanization (Yankson & Gough, 1999).

Furthermore, Solomon, (2011) also states that Ghana has an increasing amount of towns facing the challenge of providing its population with appropriate water supply, sanitation and solid waste facilities in perspective of the rapid urbanization room. This increase in population has created a huge governance task for local authorities to provide efficient public services, including solid waste facilities.

The will and might of managing waste are also increasing continually. Schubeler (1996) also noted that municipal solid waste management (MSWM) is a foremost duty of governments normally taking up between 20 to 30% of municipal budget in developing countries. Despite this huge budget, many countries collect less than generated.

The reality of this problem cannot be lost on Ghana, particularly in its major cities for instance Abokobi in Ga East Municipality, which are wallowing in waste. Heaps of wastes are found at many places with landfill sites continuously running out of space for new waste generated while other options are fast depleting. This poses serious consequences for the public service including pressure on budget of government, growing demand for space consumed by waste as in landfill sites and the environmental, health and other social problems accompanying with improper waste management. There is thus the urgent need for efficient and alternative ways of generating and managing waste

The country is currently overwhelmed with so much waste that government and private agencies have not been able to handle the complications of waste adequately, particularly, in the major cities in the country (Selby, 2010).

However, there have been sequences of efforts by successive governments to help curb the problem of waste over the years, the situation has deteriorated. Solid waste bedevils Accra particularly among residents living within highly populated areas and low-income communities. As at 2013, Accra was generating about 2,500 tonnes of solid waste daily (Arku, 2013). Solid waste management constitutes a serious problem in Ghana. Most municipalities do not collect the total quantity of waste generated and of the waste collected, just a percentage receives proper disposal. The insufficient collection and impropriate disposal of solid waste represent a source of pollution that poses risk to human health and the environment since the health status and productivity levels of the population are greatly influenced by the state of the environmental sanitation condition in which they live.

Tema Municipal Assembly (2010) suggests that the problem of waste management in Ghana is a combination of factors prominent among which are poor spatial planning, inadequate and inappropriate equipment, inadequate expertise and underdeveloped private sector. The focus on waste management has been the centralized bureaucratic and conventional collection, transporting and dumping of waste in light of the inadequate resources and the overwhelming rate of waste generation to the neglect of other alternative means like pre-cycling, recovery of waste for reuse and recycling which could further lead to income generation particularly by households.

Nevertheless, waste generation and management in the Ga East Municipality is a matter of great worry to the Assembly. The growing inflow of people into the municipality because of urbanization has led to an alarming rate of waste generation.

The assembly estimates about 385 tonnes of solid waste generated per month (Ga East Municipal Assembly, 2014). However, only about 261 tonnes (67%) are collected. The 33% that is left builds up presenting various forms of health and environmental hazards.

The solid waste management situation at Abokobi, reflects the above cited challenges alongside the health and environment problems. The Municipal Planning Coordinating Unit (MPCU) of the Ga East Municipal Assembly based at Abokobi estimated the population of the municipality, using the 2010 population and housing census data, to be about 450,200 as at 2013 with 51% males and 49% females, and growing at an inter-censual rate of about 4.2% mainly because of migration inflows. The estimated population density of 1,214 persons per square kilometre (sq. km) is much higher than the national density of 79.3 persons per sq. km and the regional density of 895.5 persons per sq. km (Ga East Municipality Annual Report for 2013). With such huge numbers of people in the municipality, there is great likelihood that has led the increased waste generation and disposal requiring informed research to solve the problems pertaining to waste management and the developmental problems associated with it.

2.3 The Types of Heavy Metal

Heavy metal	Source of exposure to the environment	Minimium Level of hazard	Chronic exposure toxicity effects
Lead	Industrial and vehicular emissions, paints and burning of plastics, papers etc	Blood lead levels below 10mg per decilitre of blood	Impairment of neurological development, Suppression of the haematological system (anaemia), Kidney failure, immunosuppression etc.
Mercury	Electromagnetic and polymer waste, pesticides, pharmacological(production etc) and dental(syringe etc) waste	Less than 10 micrograms per deciliter of blood; oral RfD 4mg/kg/da	Digestive and lung irritation, renal failure, neurotoxic
Cadmium	Electromagnetic and polymer waste, batteries-diet and water	Under 1 microgram per decilitre of blood	Local irritation of the lungs and gastrointestinal tract, kidney damage and defects of skeletal system
Arsenic	Herbicides and pesticides, equipment, waste combustion containing the hazardous elements, contaminated water	Oral exposure of 0.0003mg/kg/day	Liver peripheral nerve infection-neuropathy, hepatitis, neck and lung disease, upper respiratory system infectionpharyngitis, laryngitis, rhinitis, anaemia, heart (circulatory) disease

(*Agency for Toxic Products and Disease Registry (ATSDR). Toxicological profile for lead. US Department of Health and Human Services; Public Health Services), (Young R. Toxicity summary for Mercury, Cadmium. 1992) and (Opresko DM. Toxicity summary for Arsenic. 1992.)*

2.4 Dumpsites and Environment

Mercury (Hg)

"Mercury is a widespread toxin that generates a wide range that affect human wellness and its impacts" (Ratcliffe et al., 1996; Sweet & Zelikoff, 2001; Campbell et al., 2003; Guzzi & Porta, 2008). Metallic mercury, mercuric sulfide (cinnabar salt), mercuric oxide and methylmercury are the most common types of mercury discovered in the setting (ATSDR, 1999b; Guzzi & La Porta, 2008).

Mercury is found generally in Very small levels and very sensitive in the environment. Total mercury levels are generally less than 10 ng /g in crustaceans such as granites, feldspars and clays" (Davis et al., 1997) and between 40 and 200 ng / g in soils and sediments that are not immediately affected by human induced activities.

Methylmercury can accumulate in freshwater, saltwater fish and aquatic animals at concentrations often greater than any of those detected in the surrounding water" (ATSDR, 1999b; Campbell et al., 2003; Guzzi & La Porta, 2008; Wiwanitkit, 2009). Metallic and acidic mercury is emitted from excavating ores carrying mercury, from coal-fired power plants, from household and medical waste can be carried long distances. In air, the mercury vapor can be changed into other forms of mercury, and can be further transported to water or soil in rain or snow.

Inorganic mercury may impact water or soil from the weathering of mercurycontaining materials, from mills or water treatment plants that release mercurycontaminated water, and from the burning of residential mercury-containing waste" (ATSDR, 1999b; Balshaw et al., 2007). Mercury may join and grow in the food chain. The mercury form that builds up in the food supply chain is methylmercury (Sweet &

Zelikoff, 2001; Balshaw et al., 2007; Wiwanitkit, 2009).
Clinical signs of mercury poisoning comprise persistent brain and kidney damage, character alterations, tremor, sight alterations, deafness and deterioration of function.

(ATSDR, 1999b).

Cadmium

Contrasting numerous other metals, cadmium has been used by man, only relatively in recent times. *Strohmeier and Hermann in 1817* discovered independently along with others same compound. It is an element found naturally under the belly of the earth and got rank 7 of ATSDR's "Top 20 list" (ATSDR, 1999). Because Cadmium is found in pesticides, sludge, and fertilizers, which are consistently used in agriculture, its percentage in the upper soil has been snowballing. Cadmium (Cd) is the end-product of the development of zinc is one of the most toxic elements to which people can be present in our surroundings. Once consumed, Cd is readily stored in the human body, accumulating over a lifetime. Cd is primarily toxic to the kidney, in specific to the proximal tubular body, the main place of the disease. Accumulation, man. Cd may also trigger bone demineralization, either through immediate bone harm or partly due to renal dysfunction. In the Indians (Bernard, 2008). Environmental exposure to cadmium has been shown to trigger harm to alveolar epithelial cells in the lung, impair their ability to adapt and consequence in permanent functional changes (Bernard, 2008). Cell surface heparin phosphate proteoglycans (HSPGs) modulate cell reactions to pain through their relationship with tiny effector molecules (Bernard, 2008). These reactions are often particular. Chen et al (2014) also observed that cadmium induces cytotoxicity in human respiratory cells through up-regulation of eukaryotic translation initiation factor (EIF5AI) cell lines in the laboratory. Zhang et al (2012) sought to outline the role of 6-O-sulfate is played in cellular reactions to cadmium toxicity in two epithelial cell types of epithelial disease (H292 and A549) and in usual human main alveolar type II (hAT2) neurons. They observed that Heparin Sulfate-1 acclimatized these cancer cells and enhanced cadmium-induced injuries, indicating that 6-O-sulfate communities on HSPGs may play important roles in preventing towards certain types of cancer (Zhang et al., 2012).

Solid waste which include e-waste recycling from dumpsite lead to the release of various toxic chemicals including mixtures of heavy metals such as Pb, Ni, Cr, Cd, and Mn.

These toxic chemicals occur through dismantling and open burning processes, contaminating the food chain, water sources and ambient air. The workers are exposed to these contaminants through ingestion of contaminated food and water, inhalation and dermal contact in the course of their work. Unprotected and uncontrolled exposure can cause many health effects including poor pregnancy outcomes, infertility, blood dyscrasies, poor neurodevelopmental outcomes and adverse respiratory function leading to reduced lung function, and increasing the risk of occupationally induced or aggravated asthma, COPD etc.

When, where and how an animal consumes cadmium, it can play a part in the conduct of its impact. Animals that carry cadmium in their organs ('flesh strain') may be consumed by others, and so on, so that cadmium accumulates and biomagnifies in the food chain. (*EPA 2000*). Fish can build up cadmium from the water and by eating foods contaminated with cadmium (contaminated food chain). It is important to note that bioaccumulation as well as bio magnification occur when build up it cannot be easily broken down. Cadmium exhibits this persistence (ATSDR Medical Fact-Sheet, 2008).

Cadmium and Human Health

Cadmium has nearly no beneficial use by the human body. Cadmium is introduced into animal tissue and may boost its danger. Cadmium causes cancer, birth defects, and gene mutations. Maximum concentration of cadmium is identified in the kidneys and liver. Urinary elimination of cadmium is low; however, it is the main process by which the brain extracts cadmium. Accumulation of cadmium contributing to massive excretion.

Cadmium bioaccumulation occur at tropic level (Ferard et al., 1983; Pinto et al., 2003). It also accumulates in significant levels in many tissues of fish (Sindayigaya et al., 1994;

Kumar et al., 2008). De Smet et al., (2001) reported that cadmium accumulates in tissues of carp *Cyprinus carpio*in accordingly: kidney> Liver> Gills. Some insects can also elevated high levels of cadmium without showing any adverse effects (Jamil et al., 1992). Kidney is the main object arrangement for cadmium. The liver can hold a considerable quantity of the accumulated cadmium. Cadmium moves to these organs directly resulting uptake through the gills and intestine, but there may also be redistribution of cadmium from other organs (Olsson et al., 1987).

Toxicity of cadmium

Cadmium harmfulness can be demonstrated by a diversity of forms and impact such as renal dysfunction, hypertension, lung, hepatic injury mage and after inhalation exposure, reproductive toxicity, teratogenic effects and bone abnormalities (Friberg et al., 1974; Nriagu, 1989). In humans, the key organs for cadmium deposited are kidney, liver, lung and pancreas (Cherry, 1981). The kidney is a serious organ; in long-term, low level exposures can prove to be lethal, because of a 30-year biological half-life in this organ (Friberg et al. 1974). Symptoms of cadmium toxicity to the kidney include tubular proteinuria, decreased capacity for concentrating urine, glucosuria, calcuria and microglobulinuria (Kazantzis, 1979).

Arsenic

According to (Tchounwou et al., Author manuscript; available in PMC 2014 August 26), Arsenic is a present anywhere. This is identified at low levels in virtually all environmental matrices. Arsenic is found in all small concentrations in atmosphere, in aquatic environments, in soils and sediments and in organism (World Health Organization 1981).

As, arsenide's, sulfides, oxides, arsenates (Smedley & Kinniburgh 2002). Where its mobility, absorption and speciation depends on various abiotic factors in the environment (Cullen & Reamer 1989; Lahermo et al. 1996; Huang et al. 2011). In natural conditions the speciation of Arsenic is controlled by chemical properties of the environment such as change in pH and oxidation/reduction conditions along with absorption, desorption and ion exchange reactions (Ferguson ,Gavis, & Sadiq 1997). Microbial activity, dissolution and precipitation also affects the chemical speciation of As (Lahermo et al., 1996). The redox equilibrium between different As forms is highly pH-dependent and speciation of As is affected strongly by redox-potential (Violante et al. 2008). As is a problematic element due to its relatively high mobility over a wide range of redox-conditions and its toxicity to humans, animals and plants can cause acute death or chronic adverse effects (Turpeinen et al. 1999). The major inorganic forms of arsenic include the trivalent arsenite and the pentavalent arsenate. Environmental pollution by arsenic occurs because of natural phenomena or processes (such as weathering, biological and volcanic outbreaks, soil erosion) and evolutionary activities. Study shows that in Ghana as well as Finland a typical anthrogenic sources has being mining activities, paint oil refinery industries, and landfills (Hakala & Hallkainen, 2004).

It is estimated that millions of individuals around the globe are chronically exposed to arsenic, notably in countries such as Ghana, Bangladesh, India, Chile, Uruguay, Mexico and Taiwan, where groundwater is polluted with high levels of arsenic. Exposure to arsenic happens to some level via the oral path (ingestion), inhalation, subcutaneous / cutaneous interaction, and parenteral pathway. Arsenic levels in air round about 1 to 3 ng/m^3 in far-off locations (away from human releases), and from 20 to 100 ng/m^3 in cities. Its water concentration is usually less than 10µg/L, although higher levels can occur near natural mineral deposits or mining sites like Obuasi, Tarkwa, and Konogo and amongst others in Ghana.

Health and Environmental Effects of Arsenic

As is considered one of the most toxic metals for humans, animals and plants. The toxicity of Arsenic is dependent on chemical forms, speciation, oxidation state and its complexes with organic ligands and inorganic substances (Cullen & Reimer 1989; Pongratz, 1998; Huang et al. 2011). The volatile arsines, arsine, monomethylarsine (MMAA), dimethylarsine (DMA) and trimethylarsine (TMA) are the most toxic As compounds to mammals (Petrick et al. 2000). They are anyhow readily oxidized to less toxic As products and in general, inorganic forms arsenite (III) and arsenate (V) are known to be the most toxic predominant As species (Poser, 2006; Zavala et al., 2008; Huang et al. 2011). Organic forms like monomethylarsonic acid (MMAA) and dimethylarsinic acid (DMAA) are less toxic and organ Asarsenonobetaine (AsB) and arsenocholine (AsC) are considered to be non-toxic (Cullen & Reimer, 1989; Pongratz, 1998). Among inorganic forms, arsenite is 25-60 times more toxic than arsenate (Violante et al., 2008). Inorganic As have capability to alter metabolic pathways (Peralta-Videa et al., 2009). Because different species exhibit wide-ranging levels of toxicity to various organism, the toxicity of As should be examined by analyzing As should be examined by analyzing As speciation instead of total concentration.

Humans may be exposed to as through breathing; water or food and the main pathways are respiratory organs or digestive tracts (Turpeinen et al., 1999). Exposure may rarely occur through skin contact with water and soil polluted by As. The absorption and subsequent metabolism of As and the effects in man greatly depends on the chemical form, the dose, the length of exposure and the absorption path (Hakala & Hallkainen, 2004). Soluble inorganic forms of As are rapidly absorbed through the lungs and intestine (Cullen & Reimer 1989). In the human body inorganic As is partly methylated into less toxic organoass, mainly dimethylarsine, and is extracted in urine.

Methylation is believed to be part of the detoxification mechanism in living organisms (Peralta et al., 2009). As is excreted from the body in three main stages and about 50% of total As is excreted in urine and feces in two days. Some of the less soluble forms of As, like lead arsenate and As sulfide, are absorbed slowly from the lungs and may stay several years in respiratory organs. Arsenite accumulates in keratin rich tissues: skin, nails and hair. In bones, the phosphate of apatite is readily substituted by arsenate (Hakala & Hallkainen, 2004)

As can cause acute death or chronic adverse effects: A lethal dose of As oxide is generally regarded as 70-120mg, but acute poisonings are rather rare. Ingestion of large doses of soluble inorganic As leads to gastrointestinal symptoms, disturbances of cardiovascular and nervous system functions. Long-term exposure for large doses of Arsenic also raises the risk of different kinds of cancer and As-associated skin lesions. Lesser chronic exposure can cause nausea, the lack of appetite and weakness of limbs (Hakala & Hallkainen, 2004). The World Health Organization (WHO) has set a value of 2µgAskg^{-1}body weight as a tolerable daily intake (Peralta-Videa et al., 2009). For instance, the daily dietary intake of As in Finland is about 10-20µg (Hakala & Hallkainen, 2004).

2.5 Dumpsites and Health

2.5.1 Dumpsite and renal function

One of the fundamental rights of each human being without discrimination is age, race, religion, and political belief, economic or social condition (WHO 1998). WHO (1979, 1984) and Grant (1980) have stressed that the health status of citizenry in any country is very crucial is health because it is an indicator for measuring living standard as well as for determining the future prospects of a country.

Water contamination is one key outcome of improperly handling of waste. Waste proximate to waterways deepens the technical difficulty of providing clean water and other related risk. Municipal floods happen when drainage systems and other storm drains overflow because of waterway blockages (Peter, 2002; Gwatkin, 1980)

There are myriad records of the close association between the waste dump and human health which increasing the burden of diseases. It is reported that health statistics shows that more than 60% of all morbidity and mortality incidences in the waste dump communities are water and sanitation-related" (MOH 2008). The Waste dump is said to contain toxic groundwater contaminants, including bacteria, dissolved salts, heavy *metals*, petroleum hydrocarbons, volatile organic compounds, and pesticides nitrate.

The aim of this study is to study is to explore the degree to which the Abokobi community is prone to environmental health risk from the waste dump and how it negatively impact on their health and well-being especially household living within 200meters from the dump. This study attempts to improve to the existing literature on the socio- cultural components of adults and renal function.

CHAPTER THREE

METHODS

3.1 Study Design

The study was a population-based cross-sectional study involving 200 adult living in household residing 200meters of the Abokobi dumpsite. A questionnaire was administered to all 200 participants and containers given to provide urine and blood samples for laboratory analysis for heavy metal and kidney function respectively.

3.2 Study Area

The Ga East Municipal Assembly, established in 2004, is located in the northern part of the Greater Accra Region. The Ga East Municipal Assembly is one of the ten

Districts in the Greater Accra region and spans an area of about 166 square km (ghanadistricts.com). It is made up of 65 settlements. Abokobi is on the boundary west by the Ga-West Municipal Assembly, on the east by the Adentan Municipal Assembly, the south by Accra Metropolitan Assembly (AMA) and the north by the Akwapim South District Assembly. The 2010 National Population and Housing Census reported that the District's population at 259,668 with a growth rate of about 2.3%. The development of the population is primarily due to the impact of migration inflows.

"The population structure is approximately 51 percent male and 49 percent woman. There are 66, 286 households in the municipal. The population constitutes 82% of the district total population with the remaining 18% residing in the rural portion towards the Akwapim Hills. These communities include Ablor Adjei, Evangelical Presbyterian area (EP), Paraku Estates and Pantang. The district can therefore be described as predominantly urban with the population concentrated largely along the urban areas of the district predominantly along the border with AMA to the south" (GEMA, 2013).

The communities have problem of land litigation, encroachment on the few open spaces, rapid waste generation, open defecation, indiscriminate refuse disposal, and construction of illegal structures are some of the development challenges the Assembly has. Malaria continues to be the major cause of Out-Patients Department (OPD) attendance in the Ga East Municipal accounting for approximately 40.8% of morbidity. Frequent outbreaks of cholera in the district are also of great concern and poor environmental sanitation is a known and major contributory factor (GEMA, 2013). Below is the map of the Ga East Municipality and key institution relation to the dumpsite.

Figure 3.1: Map of Ga Municipal Assembly

Figure 3.2: Abokobi Dumpsite and the Community Living in the Area

3.3 Study Population

The source population for the study include all adult residing in household within 200meters of the Abokobi open dumpsite. The study population will involve two hundred (200) adult.

3.3.1 Inclusion and Exclusion criteria

The subjects recruited for the study included (i) adult residents (ii) The household should be staying in the area for more than a year. (iii) the individual should be willing to follow the study protocol and complete the study. Inclusion criteria function removed the influence selection bias etc. however individuals who had not lived there for more than one(i.e < 1year) and not permanent residents of the study area were excluded.

3.4 Study Variables

3.4.1 Main determinants

The main determinants of interest include

(i) urine levels of mercury, cadmium, and arsenic, and lead detected in urine

(ii) occupational exposure defined as exposure to dust or fume or smoke

3.4.2 Outcomes of interest

The main outcome of the study is kidney function. This is determined by using urine test for creatinine, blood urea nitrogen and estimated glomerular filtration rate. Renal infection indicators of kidney defined as persistent urge to urinate, urination frequency, lower abdominal pain, pain when avoiding urinating, foul smelling urine and blood in urine

3.4.3. Confounding variables

The following variables were considered as potential confounders, level of education, age and gender, alcohol consumption, smoking, proximity to dumpsite, occupation and fuel type.

3.5 Sampling Procedure

Participation was voluntary. This was done by inviting all the community members to a durbar where they were briefed about the purpose of the study. The research team addressed questions in participating in the study. The population of 200 adults residing within 200meters around the dumpsite were recruited for the study.

3.6 Data collection procedure

The fieldwork was implemented in three (3) phases: (i) stakeholder meeting, (ii) selection and enrollment of study participants, (iii) data collection.

3.6.1. Stakeholder meetings

Three meetings were held with stakeholders in and around the dumpsite to seek their view on the conditions in and around the dumpsite and also seek their consent to enter the community without any apprehension. Some identifiable stakeholders were (a) The Chief and Elders (b) Waste Landfill Company Ltd. Adenta, (c) The Head Pastor of Faith Anointing Ministry (d) The Assembly Member of the electoral areas (Agbogba, Ablorh Adjei, Pantang and Abokobi) (e) The unit committee members (f) The Head Pastor of the Presbyterian Church and (g) and the rest of the students from KNUST working at the same project site. The research team was headed by Dr. Reginald Quansah (School of Public Health, University of Ghana, Legon) and Dr. Udofia

(University of Ghana Medical School). Other members of the team include; a Laboratory Technicians, Crenstil Kofi Bempah, Jacob Asomaning and Prof. Mary Boadu from Ghana Atomic Energy Commission (GAEC) and Dr. Bannerman a pediatrician from Korle-Bu Teaching Hospital. The Assemblyman of Ablorh Adjei; Hon. Jacob Ablorh was nominated by the elders of the communities to lead the project team to the community. The subsequent meetings were held at the Abokobi District Assembly.

Figure 3.3: Stakeholder engagement at the dumpsite with one of the waste management company

3.6.2. Selection and enrolment of study participants

The study participants were made up of 200 adults. Adult who were selected were asked to express their willingness to participate in the study. Adult with severe illnesses (e.g. dysentery, typhoid fever etc.) were not allowed to take part in the study.

Contacts were made with the nearest health facility (Pantang Hospital) for early diagnosis and treatment.

Figure 3.4: Selection and enrolment of study participants

3.7. Data Collection

The data collection tools for the study include modified symptoms of kidney questionnaire and urine/blood sampling kit for urine sampling.

3.7.1 Codes generation

The 200 participants were given an identifiable code starting from 001 to 200. For blood samples the code reads B001A-B200A and U001A-U200A for Urine sample respectively. (B-meaning Blood, U-meaning Urine, A-meaning Adult)

3.7.2. Vitals

The vitals of the participants were taken. This include; temperature, height and weight for Body Mass Index (BMI). Participants who were detected of any ailment were referred to a team of Nurses for early diagnosis and treatment.

3.7.3. Questionnaire

A modified questionnaire was used in this study to elicit information on person, characteristics, environmental risk exposures and dietary habits of the respondents.

The questionnaire consists of three parts; Part A the socio-demographic background, Part B symptom or renal function, Part C the associated health problems.

The questionnaires were administered by members of the trained nurses of the team. Participants who cannot read or write were assisted by the research team.

3.8. Sample Collection

Blood sample Collection

Following explanation of the test procedure, 2.5ml of whole blood was collected from the median cubital and cephalic veins into three separate haematology tubes (Sarstedt, S-monovette, Germany), two free and one containing Z-gel, an additive carrier and a clot activator (for serum separation) using a butterfly needle and a tourniquet. The blood samples with the additive was centrifuged and the supernatant, the serum collected for subsequent refrigeration at 4-8°C for analysis at the Ghana Atomic Energy Commission.

Figure 3. 5: Blood Sample Collection

3.8.1 Urine sample analysis for heavy metals

Adult of ages 18-60 years were provided with clean water and soap for hand washing before handing out to them sterile meta-free plastic containers for urine collection.

“They were advised to empty out the first portion of the urine stream before collecting 75 mls midstream urine into the plastic urine container. 10mls of the urine was drawn into four sterile sample tubes” (Sarstedt, S-monovette, Germany) Contained in cool boxes filled ice packs (4-8 °C) and transported to the Ghana Atomic Energy Commission for storage at -20°C. Later, biological sample analysis was done for estimation of heavy metal concentration.

Urine samples were pretreated with nitric acid and triton. Samples were analyzed using high resolution continuum source atomic absorption spectrophometry (HRCS-AAS Contr AA 700 Analytik Jena) at the Ghana Atomic Energy Commission for heavy metals.

Figure 3.5: Urine sample analysis for heavy metals

3.8.2. Laboratory Analysis for Renal infection parameters

Calibrated analytical balances and pipettes was used in measuring all samples as well as standard reference materials. All materials and instruments were washed with 1M nitric acid and demineralized water prior to analysis. Urine Sample Collection.

3.8.3. Urea analysis for BUN (Blood Urea Nitrogen)

Glassware and water were devoid of Ammonia and Ammonia salt. This was followed by calibration using serum calibrator to avoid systemic error machine (MINDRAY BS200). Clean disposable pipette were used. Heparin was used as anticoagulant instead of Ammonia salt of fluoride. The reagent used Ureasa-GLDH. Kinatic liquid which has detection range of 0.743mgLdL and linearity limit of 400mg/Dl but it is diluted if the concentrations is high (1:2of the sample).

3.8.4. Creatinine

The sample were stabilized within 24hrs at 2-8 degrees Celsius The blood serum were heparinized. In the case of urine the sample was diluted 1/5 with distilled water. The result was multiplied by 50 dilution factor. Creatinine stability can stay for 7days at 28 degrees celcius and the spectrophotometer measuring at 492nm. The name of the reagent is Labkit. The reaction of creatinine with sodium picrate as described by *Jaffe.*

Creatinine reacts with Alkaline picrate forming a red complex. Time interval was allowed to avoid interference. The intensity of the colour formed was proportional to the creatinine concentration in the sample.

3.9 Data Analysis

The data was crossed checked to identify missing values and other lapses for appropriate treatment. It was examined for validity. The data was double checked to reduce errors and improve results before entry into Epi- Info 7 (Centre for Disease Control, CDC, USA).

For normally distributed data, means and standard deviations were computed as summary measures, linear regression and odds ratio.

3.9.1 Informed consent

Informed consent was sought and obtained and/or assent participants. An oral script introducing the study was read to participants who can read and write and by a translator for those who cannot read nor write. Written consent form was read by the participant and/or by a translator and any questions raised by the subjects were answered. Interested participants were interviewed.

3.9.2 Protection of subjects' privacy

Parents of children do not have to answer any survey questions that they feel was an invasion of their privacy. Also, participants do not have to participate in any particular aspects of the study that they find invasive.

3.9.3 Provision to prematurely end a particular subject's participation in the study

Participants can opt to be interviewed in a location of their choice to increase privacy. In the case of an adverse event or situation of distress, a subject's participation in the study was concluded. There was a little likelihood that such an event or distress may occur, so no specific criteria or parameters can be identified.

3.9.4 Record storage and protection

All research records, data and specimens were protected and retained for at 3-5years against inappropriate use or disclosure, or malicious or accidental loss or destruction in order to protect the confidentiality of subject data. Hard copy data was under locked and soft copy data were protected with a password on a secured laptop. There was a routine electronic back up and Digital data encryption. Security software (firewall, anti-virus, anti-intrusion) has been installed and updated regularly on all servers, workstations, laptops and other devices used in the project. Safe disposal / destruction of data or devices, as appropriate (e.g. shredding of paper documents, destroying disks or thumb drives, secure erasing of electronic media).

3.9.5 The data and/or any specimens will be destroyed at the conclusion of this study

Specimens of urine were destroyed as well as the identifiers on their storage containers after laboratory analysis. The interviews will be destroyed by deleting them from their storage device (digital format) after 10 years retention. Study survey forms (hard copy) were destroyed at the conclusion of the study. The data/specimens were retained until the completion of the research program. The data collected was linked to subjects' identities in anticipation of the need to be able to return metals analysis results to those participants who desire it, and if significant new knowledge is obtained that must be relayed.

3.9.6 Retention of Data and/or Specimens Detail

Retention was for future research by the investigator and/or the creation of a bank or repository. In the case of return to the community or future research on this area, a longitudinal study can be done to show how conditions have changed over time. Also, in order to deliver individual participants' results on a subsequent return visit, these data must be retained.

3.9.7 Compensation of Subjects or Other Incentives for their time/participation

Subjects received cash and token gift for their participation in the study. A payment of 10 Ghana new cedis (approximately US$3) was given to study participants who complete all proposed data collection elements. Compensation was given at the time of data/specimen collection.

3.10 Ethical Consideration

Ethical clearance was sought from the Kwame Nkrumah University of Science and Technology Ethical Review Board. Permission was also sought from the leaders of the community. Oral or written consent was obtained from every participant. Before the individual respondents give their consent, the participant information leaflet and the consent form, which enclosed the benefits, risks and the processes for research was read out and explained to each participant before appending his or her signatures or thumbprints. They had the liberty to ask questions, and to seek clarifications or withdraw unconditionally.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic characteristics

Participant' characteristics is presented in Table 4.1. The mean age was 35±11.67 years with a higher proportion in the 29years of age bracket (34.5%). Most of the participant were females (85.0%); had primary education (39.0%) were employed (77.5%), used charcoal as their primary fuel for their daily energy need (51.0%); had previously smoked cigarette (91.0%), do not drink alcoholic beverage (58.0%) and lived within 150m from the Abokobi dumpsite (39.0%).

Table 4.1: Characteristics of study population of adults at Abokobi (n=200)

Variable	Frequency	Percentage
Age	Mean (std dev)	35±11.67
≤29	69	34.5
30-39	48	24.0
40-49	57	28.5
≥49	26	13.0
Gender		
Female	170	85.0
Male	30	15.0
Educational level		
No formal education	39	19.5
Primary	78	39.0
Secondary/technical	56	28.0
Tertiary	27	13.5
Employment status		
Employed	155	77.5
Unemployed	45	22.5
Fuel type		
High polluted fuel (Charcoal)	102	51.0
Low polluted fuel (LPG)	67	33.5
Medium pollute fuel (Wood)	31	15.5
Cigarette smoking status		
Past smoker	182	91.0
Current smoker	10	9.0
Alcohol intake		
No	116	58.0
Yes	84	42.0
Proximity to dumpsite		
100m	57	28.5
150m	78	39.0
200m	65	32.5

4.2 Self-reported occupational exposure indicators

Occupational indicators was defined as exposure to smoke, fumes or dust. In all, 40.64% were exposed to smoke (40.64%); 33.89% followed by dust (33.89%) and fumes (25.47%).

4.3 Self-reported symptoms of renal infection

The proportions of respondents reporting renal infection as shown in Table 4.2. In all, persistent urge to urinate (70%) and the frequency to urinate (69%), lower abdominal pain (55.5%), pain when voiding (56.5%), foul smelling urine (48.5%), blood in urine was common among respondents.

Respondents who had persistent urge to urinate were exposed to dust (76.3) or smoke (77.3) or fumes (76.3%). Though most of the participant urinated frequently, the frequency at which participant urinate was common among those exposed to smoke from the dumpsite (77.3%) compared to those exposed to fumes (61.9%).

Inasmuch as lower abdominal pain was experienced, it was least among residents who were exposed to smoke (27, 61.4%) than those exposed to dust (34, 57.6%). Experiencing pain during urination was experienced most by those exposed to fumes from the dumpsite compared to those exposed to smoke and dust (55, 56.7% vs 35, 59.3% vs 23, 52.3%) respectively.

Though foul smelling urine was never experienced by those exposed to fumes from the dumpsite (58.8%), it was occasionally experienced among participant exposed to dust (55.9%). Blood in urine was frequently experience by only 27.3% of residents exposed to excessive smoke but never experienced by those exposed to fumes from the dumpsite (87.6%).

Table 4.2: Prevalence of symptoms of renal infection and occupational exposure to heavy metals at Abokobi dumpsite (n=200)

Symptoms of renal infection	All adults	Dust	Smoke	Fumes
Persistent urge to urinate No	60 (30%)	14 (23.7%)	10 (22.7%)	36 (37.1%)
Yes	140 (70%)	45 (76.3%)	34 (77.3%)	61 (62.9%)
Urination frequency				
No	62 (31.0%)	15 (25.4%)	10 (22.7%)	37 (38.1%)
Yes	138 (69.0%)	44 (74.6%)	34 (77.3%)	60 (61.9%)
Lower abdominal or groin				
No	89 (44.5%)	25 (42.4%)	17 (38.6%)	47 (48.5%)
Yes	111 (55.5%)	34 (57.6%)	27 (61.4%)	50 (51.5%)
Pain when voiding (urinating)				
No	87 (43.5%)	24 (40.7%)	21 (47.7%)	42 (43.3%)
Yes	113 (56.5%)	35 (59.3%)	23 (52.3%)	32 (56.7%)
Foul smelling urine				
No	103 (51.5%)	26 (44.1%)	20 (45.5%)	34 (58.8%)
Yes	97 (48.5%)	33 (55.9%)	24 (54.5%)	40 (41.2%)
Blood in urine				
No	163 (81.5%)	46 (78.0%)	32 (72.7%)	85 (87.6%)

Yes	37 (18.5%)	13 (22.0%)	12 (27.3%)	12 (12.4%)
N (%), Column total				

4.4 Mean Kidney function parameters

The indicators of kidney function parameters is shown in Figure 4.1. Kidney function was defined as Blood Urea Nitrogen (BUN), estimated Glomerular Filtration Rate (eGFR) and Creatinine. The mean concentration of BUN (26.69 µmol/L; 6.52), eGFR (66.92 µmol/L; 17.45) and Creatinine (65.34 µmol/L; 5.35) were detected in the blood samples. The mean residual of Creatinine was highest; followed by eGFR and BUF respectively.

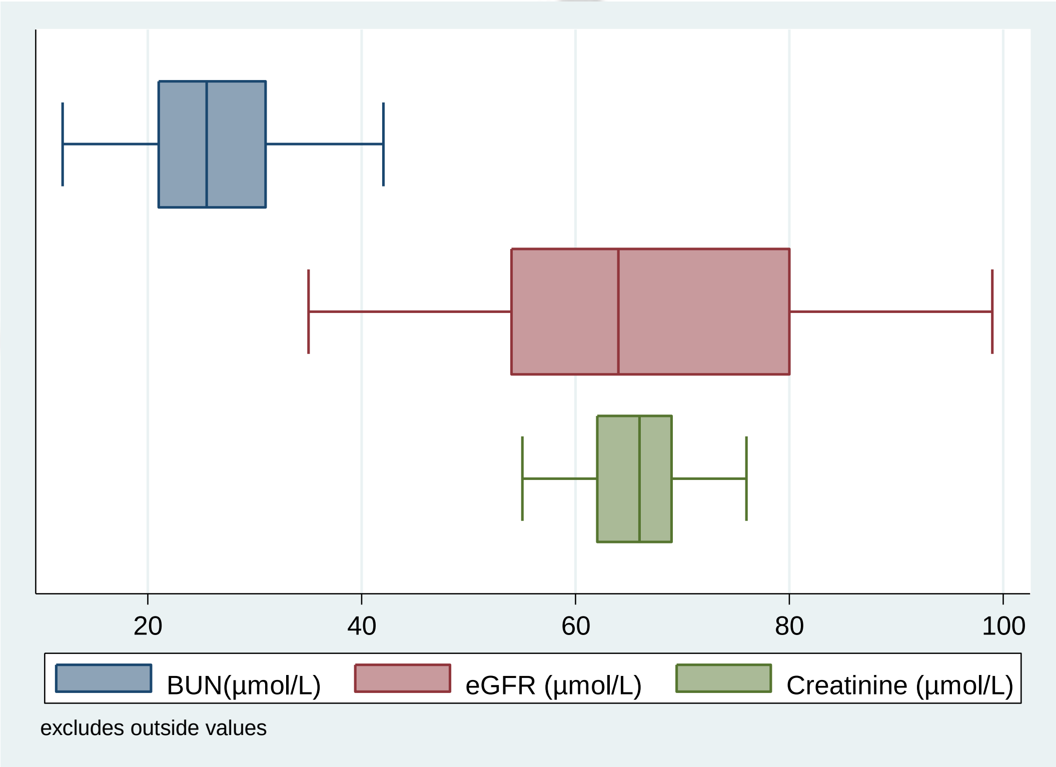

Figure 4.1: Indicators of kidney function parameters
BUN, Blood Urea Nitrogen, eGFR, estimated Glomerular Filtration Rate

4.5 Mean concentration of heavy metals in urine

Six (6) heavy metals were detected in the hexane extract of urine samples of the study participants (Table 4.3). The mean residue and standard deviation of Cadmium (2.42 µg/L; 0.78) was higher in participant. This was followed by the mean residue and standard deviation of Mercury (1.69 µg/L; 0.49).

The least mean and standard deviation concentration of urine residue was recoded in Manganese (0.81 µg/L; 0.47) followed by Zinc (1.11 µg/L; 0.20) and Arsenic (1.33 µg/L; 0.39).

Table 4.3: Concentration of heavy metals in urine samples

Heavy metals	Occupational exposure to heavy metals							
	LOD	**Mean**	**SD**	**Median**	**LQ**	**UQ**	**Min**	**Max**
Mn	0.01	0.81	0.47	0.99	0.99	1.03	0.01	1.29
Pb	0.01	1.64	0.62	2.00	1.03	2.01	1.01	2.91
Zn	0.01	1.11	0.20	1.08	1.02	1.17	0.81	1.44
Cd	0.01	2.42	0.78	2.00	2.00	2.10	2.00	3.91
Hg	0.01	1.69	0.49	2.00	1.09	2.12	1.03	2.14
As	0.01	1.33	0.39	1.10	1.06	1.90	1.01	1.96

LOD-Level of detection SD-Standard deviation LQ-Lower quartile UQ-Upper quartile, Min-Minimum Max-Maximum

4.6 Correlation analysis of heavy metals

The correlation between metals in the urine residuals of participants is presented in Table 4.4. There was positive significant correlation between Pb and Mn (r=0.625); Pb and Zn (r=0.783); Pb and "As" (r=0.310). However, there was negative significant correlation between Cd and Pb (r=-0.459); Cd and Hg (r=-0.688) and Cd and "As" (R=-0.153). There was no significant association between Hg and Zn (r=-0.095)

Table 4.4: Correlation between metals in urine residuals

Variables	Mn	Pb	Zn	Cd	Hg	As
(1) Mn	1.000					
(2) Pb	0.625***	1.000				
(3) Zn	0.121**	-0.444***	1.000			
(4) Cd	0.220***	-0.459***	0.783***	1.000		
(5) Hg	-0.510***	-0.688***	-0.095	0.341***	1.000	
(6) As	0.310***	0.153***	0.582***	0.652***	-0.171***	1.000

***p>0.05 **p>0.01

4.7 Association between self-reported symptoms of renal infection and occupational exposure.

The association between self-reported symptoms of renal infection and occupational exposure is shown in Table 4.5. Occupational indicators was defined as exposure to smoke, fumes or dust. There was no significant association between self-reported symptoms of renal infection and occupational exposure to heavy metals in urine samples. However, there was significant association between blood in urine and indicators of occupational exposure to heavy metals in urine. That is, the proportion of participant to see blood in their urine after being exposed to fumes is about 0.32 times more compared to those who do not see blood in their urine (Adjusted Odds Ratio [AOR]= 0.32 (95%Confidence interval (CI) 0.14-0.88).

Table 4.5: Association between self-reported renal symptoms and occupational exposure

Renal symptoms	Occupational exposure					
	Dust		Smoke		Fumes	
	Crude OR (95% CI)	**Adjusted** OR (95% CI)**	**Crude CI)**	**Adjusted** OR (95% OR (95% CI)**	**Crude OR (95% CI)**	**Adjusted** OR (95% CI)**
Persistent urge to urinate						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.47 (0.04-6.06)	0.85 (0.27 -2.69)	0.90 (0.09-8.76)	0.73 (0.29-1.86)	0.38 (0.06-2.45)	0.52 (0.24-1.11)
Urination frequency						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	2.74 (0.20- 7.37)	1.08(0.33-3.58)	0.84 (0.09-8.02)	0.68(0.26-1.76)	1.85 (0.29-11.87)	0.57 (0.26-1.23)
Lower abdominal pain						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.45 (0.07-2.68)	0.57 (0.19-1.71)	0.80 (0.20-3.18)	0.93 (0.37-2.31)	0.96 (0.31-3.00)	0.67 (0.32-1.40)
Pain when urinating						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.92 (0.51-7.25)	1.14 (0.39-3.36)	1.33 (0.44-4.04)	1.43 (0.59- 3.51)	1.72 (0.68-4.35)	1.18 (0.58-2.43)
Foul smelling urine						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.47 (0.08-0.46)	0.65 (0.22-1.91)	2.00 (0.54-7.45)	1.27 (0.52-3.12)	0.69 (0.23-2.08)	0.58 (0.28-1.19)
Blood in urine						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	2.41 (0.45-12.98)	1.16 (0.35-3.86)	0.46 (0.13-1.61)	0.54 (0.18-1.62)	0.47 (0.16-1.41)	0.32(0.14-0.88)

**alcohol consumption, smoking, proximity to dumpsite, age of participant, gender, educational level, occupation and fuel type

4.8 Association between heavy metals in urine and kidney function

The association between heavy metals and kidney function in blood samples is presented in Table 4.6. There was no significant association between BUN and Manganese (β=0.08; 95%CI=0.01, 1.06); or Lead (β=2.69; 95%CI=0.19, 7.76) or Zinc (β=0.37; 95%CI=0.03, 5.22) or Cd (β=3.96; 95%CI=0.75, 5.88) or Hg (β=2.81; 95%CI=0.83, 9.50) or As (β=0.36; 95%CI=0.11-1.21).

Table 4.6: Association between heavy metals in urine and kidney function

	Heavy metals in urine					
	Mn	**Pb**	**Zn**	**Cd**	**Hg**	**As**
Kidney function	**Coef (95%CI)**	**Coef (95%CI)**	**Coef (95%CI)**	**Coef (95%CI)**	**Coef (95%CI)**	**Coef (95%CI)**
δδBUN	0.08 (0.01-1.06)	2.69 (0.19-7.76)	0.37 (0.03-5.22)	3.96 (0.75-5.88)	2.81 (0.83-9.50)	0.36 (0.11-1.21)
***φφ* eGFR**	2.92 (4.07-6.15)	0.32 (0.02-4.46)	3.11 (0.22-4.23)	2.58 (0.34-9.77)	1.35 (0.38-4.82)	0.74 (0.21-2.65)
Creatinine	0.06 (0.01-0.62)	0.57 (0.14-2.43)	1.74 (0.41-7.37)	2.06 (0.29-4.45)	2.22 (0.52-9.38)	0.45 (0.11-1.91)

δδ Blood Urea Nitrogen; φφ Glomerular Filtration Rate

4.9 Association between self-reported occupation exposure and kidney function

The association between occupation exposure and kidney function is presented in Table 4.7. Occupational indicators was defined as exposure to smoke, fumes or dust. There was no significant association between BUN and dust (β=1.10; 95%CI=2.63, 4.85); or smoke (β=3.00; 95%CI=4.98, 10.99) or fumes (β=0.76; 95%CI=2.27, 3.79). Additionally, there was no significant association between eGFR and dust (β=3.05; 95%CI=3.12, 7.02); or smoke (β=5.70; 95%CI=7.19, 15.78) or fumes (β=1.46; 95%CI=6.69, 9.61). Also, there was no significant association between Creatinine and dust (β=2.09; 95%CI=0.95, 5.14); or smoke (β=3.66; 95%CI=2.85, 10.16) or fumes (β=0.28; 95%CI=2.18, 2.75).

Table 4.7: Association between self-reported kidney function parameters and occupational exposure

	Occupational exposure		
	Dust	**Smoke**	**Fumes**
Kidney function	**Coef (95%CI)**	**Coef (95%CI)**	**Coef (95%CI)**
BUN	1.10 (2.63, 4.85)	3.00 (4.98, 10.99)	0.76 (2.27, 3.79)
eGFR	3.05 (3.12, 7.02)	5.70 (7.19, 15.78)	1.46 (6.69, 9.61)
Creatinine	2.09 (0.95, 5.14)	3.66 (2.85, 10.16)	0.28 (2.18, 2.75)

Coef, coefficient

4.10 Association between self-reported symptoms of renal infection and heavy metals in urine

The association between self-reported symptoms of renal infection and heavy metals in urine is shown in Table 4.8. There was no significant association between selfreported symptoms of renal infection and heavy metals in urine samples. However, there was significant association between blood in urine and Lead. Thus, the proportion of participant to see blood in their urine is about 0.33 times more in those with lead in their urine compared without lead in their urine (AOR= 0.33 (95%CI, 0.09-1.16).

Table 4.8: Association between renal symptoms and heavy metals in urine sample

Renal symptoms	Heavy metals in urine											
	Mn		**Pb**		**Zn**		**Cd**		**Hg**		**As**	
	COR	**AOR**	**COR**	**AOR**	**COR**	**AOR**	**COR**	**AOR**	**COR**	**AOR**	**COR**	**AOR**
Persistent urge to urinate												
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.99 (0.31-3.12)	0.37 (0.03-5.22)	1.19 (0.39-3.71)	2.69 (0.19-7.76)	0.45 (0.14-1.46	2.81 (0.83-9.50)	0.08 (0.01-1.06)	0.84 (0.27-2.60)	0.36 (0.11-1.21)	2.21 (0.69-7.14)	3.96 (0.75-5.88)	1.03 (0.31-3.42)
Urination frequency												
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.18 (0.37-3.79)	0.74 (0.21-2.65)	3.11 (0.22-4.23	0.61 (0.19-1.92)	0.32 (0.02-4.46)	0.17 (0.04-0.70)	2.92 (4.07-6.15)	2.58 (0.34-9.77)	5.95 (1.42-7.94)	1.64 (0.52-5.18)	1.35 (0.38-4.82)	0.19 (0.04-0.79)
Lower abdominal pain No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.51 (0.48-4.75)	2.06 (0.29-4.45)	0.45 (0.11-1.91)	0.06 (0.01-0.62)	1.74 (0.41-7.37)	0.57 (0.14-2.43)	2.09 (0.47-9.34)	0.66 (0.21-2.09)	0.48 (0.11-2.13)	1.07 (0.27-4.26)	2.54 (0.78-8.28)	2.22 (0.52-9.38)

Pain when urinating												
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.80	0.50	0.87	0.60	0.58	0.64	1.61	0.78	1.73	1.75	1.10	0.90
	(0.12-5.21)	(0.12-2.02)	(0.19-4.03)	(0.17-2.07)	(0.17-2.00)	(0.26-1.55)	(0.22-4.59)	(0.20-3.01)	(0.42-7.07)	(0.58-5.31)	(0.36-3.36)	(.36-2.25)
Foul smelling												
urine No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	5.53	2.81	5.01	6.75	3.01	2.50	1.29	0.59	0.92	0.60	1.28	1.12
	(0.54-7.11)	(0.39-4.45)	(1.82-7.49)	(1.20-8.02)	(0.42-7.59)	(0.50-4.55)	(0.14-2.81)	(0.11-3.12)	(0.18-3.03)	(0.16-2.24)	(0.36-4.56)	(0.43-2.94)
Blood in urine												
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.10	0.48	0.28	0.33	1.87	1.52	0.24	0.75	1.04	1.39	0.47	0.40
	(0.08-5.44)	(0.09-2.68)	(0.03-2.34)	(0.09-1.16)	(0.34-4.32)	(0.53-4.31)	(0.01-4.27)	(0.18-3.11)	(0.11-9.75)	(0.39-5.01)	(0.09-2.43)	(0.11-1.48)

COR, Crude Odds Ratio (95%CI) *AOR, Adjusted Odds Ratio (95%CI)*

CHAPTER FIVE

DISCUSSION

5.1 Main findings

In this cross sectional study, the proportion of occupational exposure to heavy metals was smoke and was highest among residents of Abokobi as a result of their work. This could be attributable to the inhalation of fine particulate matter. It could also be attributed to the persistence of obnoxious air in rooms of residents. Also, persistent urge to urinate was common among adults who were exposed to smoke from the dumpsite. This could be attributable to the ingestion of heavy metals, particularly Cadmium from contaminated soils. The accumulation of heavy metals in vital organs could be a reason for frequency at which residents who are exposed to smoke from the burning on the dumpsite urinate.

Except for Manganese and Silver, urine residual levels of Zinc, Cadmium and Lead were high. But urine residual levels of the heavy metals were not related to determinants of occupational exposure to heavy metals. Similarly, the indicators of kidney function proportions in the blood samples of the participant were within detection level. Though water sources around the dumpsite get contaminated with heavy metals as a result of leaching, the residual levels recorded could be as a result of persistence from pesticides (burning of mosquito coils, mosquito insecticide spray) use.

There was no significant association between self-reported symptoms of renal infection and occupational exposure to heavy metals in urine samples. But, the proportion of participant to see blood in their urine after being exposed to fumes is about 0.32 times more compared to those who do not see blood in their urine (AOR=

0.32 (95%CI 0.14-0.88). This could be attributed to the continuous inhalation of poisonous materials among residents living close to the dumpsite where burning of such materials are incessant.

There was significant association between heavy metals and kidney function in blood samples. For example, the proportion of participant who had traces of BUN in blood was 0.08 times more likely to have Manganese in their urine (COR=0.08; 95%CI=0.01-1.06) while the traces of eGFR in blood was 2.92 folds greater to have traces of Manganese in urine (COR=2.92; 95%CI= 4.07-6.15) and the traces of Creatinine are 0.06 times to have Manganese in their blood (COR=0.06; 95%CI=0.01-
0.62). This could be attributable to residents' nonchalant attitude towards their wellbeing. Thus, not paying attention to what they put in their mouths, whether they wash the fruits before eating them considering that they live in a polluted environment.

There was no significant association between heavy metals in urine and occupational exposure to heavy metals. This could be attributable to residents' work places further away from the polluted environment.

5.2 Methodological Validity

The residents in Abokobi who live close to the dumpsite, from which samples was selected from for this study, had a high participation rate therefore, minimizing selection bias. Trained nurses were involved in the collection of samples. The population for this study comprised adults, who were voluntary recruited. Data on heavy metals exposure was collected objectively and subjectively and findings on the heavy metals body burden and prevalence of exposure experience were the same.
Thus, the effect of information bias in this study is minimal. The study population was quite homogeneous with regard to culture and by socio-economic status, reducing the potential

effect of unmeasured confounding. Again, to the researcher, this is the first study in Ghana to look at this association.

Irrespective of the strength of this study, the study had some limitations. The study used voluntary participation to select study participants; it was possible that some residents (adults) and vital information may have been missed.

Self-reporting of outcomes of the study is another limitation that is whether the participants understood the questions.

Different people from the research team administrating the questionnaire cannot guarantee the consistency of the outcome but it was not proven in the study.

However, the effect of this on the study estimates need to be verified. Irrespective of the fact traces of Manganese and Lead are metabolized easily in humans, it was measured and traces was detected. To still detect Manganese and Lead residues in the urine samples suggested that exposure to heavy metals was common in the study population and that a single measurement as applied in this present study reflects average exposure over a longer period. Again, the cross-sectional design restricted the ability to discern any temporality. The present findings may be complicated by domestic use of water to bath, wash utensils, foodstuffs and ingested, which was not the focus of this study. Future studies that follow residents that live close to dumpsites prospectively and collect data on occupational and non-occupational exposures will help to clarify this possibility.

5.3 Comparison of present findings with previous studies

The prevalence of determinants of symptoms of renal infection was smoke and was high among residents of Abokobi. The prevalence of renal infection was in agreement with Peter, (2002) who found that unregulated leachants from refuse near waterways increase burden of renal diseases. Similarly, available data from the ministry of health indicates that more than 60% of all morbidity and mortality cases in the waste dump communities are water and sanitation-related (MOH 2008). Another major danger from the waste dump is the regular unpleasant odours which can pose problems by causing eye irritation or respiratory ailments.

There was no statistical significant association between indicators of occupational exposure to heavy metals and toxic heavy metals. Studies have further found that heavy metals such as Cadmium, Lead, Nickel and Copper have a tendency to accumulate in vital organs such as the lungs and have a half-life of 30 to hundred years or more (ATSDR, 1999). The findings are also consistent with recent studies which found that ingestion or inhalation of heavy metals may cause nausea, abdominal cramps, short breath, chocking fits, renal dysfunction and inhibition of iron absorption (Donahoe et al., 2015).

There was significant association between heavy metals and kidney function in blood samples. The finding was confirmed by results that soil around dump site is usually rich in toxic heavy metals as a result of the dumped waste and used by the people living around the dump for planting vegetables and fruits. These plants bioaccumulates heavy metals from the soil and when they are eaten by human beings and animals, the heavy metal accumulate in the body with serious health effects (USEPA, 2002; UNDP, 2006; Rotich et al., 2006). On the contrary, Oh et al. (2014) reported that blood cadmium levels was associated with decline in the lung function. Excessive exposures to airborne Cd may impair lung function and increase the risk of lung cancer (Bernard, 2008). This is in disagreement with this study which found no association between self-reported symptoms of renal infection and occupational exposure to heavy metals in urine samples

This study was conducted among adult residents in a predominately dumping site community where precautionary and safety measures are problematic. To the best of my knowledge, this study is the first to have investigated the association between heavy metals exposure and renal infection among adult residents living close to a commercial dumpsite.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The prevalence of determinants of renal infection found in this study was smoke. Similarly, persistent urge to urinate and frequency of urination were renal infection symptoms common among adults exposed to smoke. The study did not find any significant association between symptoms of renal infection and exposure to heavy metals, except for Manganese and Lead were high but not related to symptoms of renal infection. However, there was significant association between persistent urge to urinate, frequency of urination, lower abdominal pain, pain whiles urinating and indicators of kidney infection.

6.2 Recommendations

It is recommended that awareness be created in health facilities for adults on attendance on the safety practices (such as burning waste far from the house and burn in contrast to the direction of the wind) to protect residents from being exposed to contaminated smoke particles.

In addition, educate and train families on the ‘right’ ways of disposing of their waste that is not harmful to their health and the environment.

It is recommended that person who live close to open dumpsite do regular check-up or screening.

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6.2.1 Recommendation for further studies

Longitudinal studies are encouraged to ascertain the findings of this study. Further research is encouraged to find out the association between renal symptoms and water leachate and quality.

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APPENDIX A: PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

Title of Research:

Association of toxic metals exposure and kidney function among adults residing near an open dumpsite: a cross-sectional study at Abokobi

Name(s) and affiliation(s) of researcher(s):
This study is being conducted by Mr Kwadwo Opoku Boateng of the KNUST African Institute of Sanitation and Waste Management (K-AISWAM), Accra.

Background (Please explain simply and briefly what the study is about):
The term “open dump” is used to describe a land disposal site where the indiscriminate deposit of solid waste takes place with very limited measures to control the operation and to protect the surrounding environment (international solid waste association 2010).

In addition, it is typical that no planning (such as location sensitivity) or engineering measures have been implemented prior to the delivery of waste. An open dump has nothing to do with a sanitary landfill. Sanitary landfill is an acceptable waste management method, with controlled emissions and limited health and environmental impacts, while open dumps are exactly the opposite. In between an open dump and a sanitary landfill there is a grey area usually named as “controlled dump” with varying levels of engineering and environmental controls. These vary from region to region and/or from nation to nation.

Land filling is an important component of waste management for safe disposal of the fractions of municipal solid waste (MSW) that cannot recycled, composted, combusted or processed. About three-quarters of the countries and territories around the world use ‘open dumping’ method of disposal of MSW (Rushbrook, 2001)

It is a primitive stage of landfill development at which solid wastes are disposed of in a manner that does not protect the environment, susceptible to open burning, and exposed to disease vectors and scavengers. Lack of adequate waste treatment and disposal infrastructure, large volumes of waste involved in metropolitan cities, proximity of disposal sites to the water bodies and ever-burgeoning residential areas even in the proximity of waste disposal sites has given rise to significant environmental deterioration and health impairment in most of the cities (Joshi and Nachiappan, 2007)

Soil pollution is another environmental problem caused by dumpsites. Waste carries different metals, which are then transferred to plants by different ways. Depending on the tendency of the contaminants, they end up either in water held in the soil or leached to the underground water. Contaminants like Cd, Cu, Ni, Pb and Zn can alter the soil chemistry and have an impact on the organisms and plants depending on the soil for nutrition. Many studies show evidence of serious hazards caused by open waste dumping ultimately affecting the plants’ life cycles (Syeda Maria Ali et al).

Waste in open dumps often becomes a breeding grounds for a lot things and other likely carriers of communicable diseases. Open dumpsites without daily soil cover can are also a source of odor, dust and litter. It is important to stress that the intensity of the environmental impacts posed by a dumpsite depends on a number of site-specific factors like the following:

• Site, soil / water conditions, Local microclimate, Local plant and organism, Solid waste streams, composition and quantity, Area covered by waste, An inordinate length of time of operation, Engineered controls in place

The diverse waste types disposed of at dumpsites determine not only their environmental but their health impacts. When open burning of solid waste is practiced (a usual practice to reduce volume), it could result in the emission of toxic substances to the air from the burning of plastics and other materials. The toxic fumes usually increase the concentration of air pollutants such as nitrogen oxides, sulfur oxides, heavy metals (mercury, lead, chromium, cadmium, etc.), dioxins and particulate matter (Akpofure Rim-Rukeh,2014).

Ghana is home to 22 million residents. The capital, Accra serves as the commercial, executive, and cultural center of the nation. Its geographical area has allowed it to function as a natural port to the Atlantic Ocean, which has in turn made it an important destination point for number of Ghanaian trading industries. It covers an area of approximately 65 square miles. (Encyclopedia 2010) It houses a full 18% of the total Ghanaian population and 30% of the country’s urban population. (Carboo, D 2004) Unlike the towns and villages spread throughout the majority of the countryside, Accra is a veritable urban Mecca for labor-seeking residents from all over Ghana. Half of Accra lives below the World Bank’s absolute poverty threshold of little less than a dollar a day (Global Project,2010)

Ghana has waste administration difficulties that extend from the state to the local municipalities, and refuse of all shapes and sizes is a common site in both urban and rural areas. These difficulties are concentrated and complicated by population pressures in the few heavily populated cities of which Accra is the most prominent. Inequality features heavily in the capital. 80 % of the city population lives in low income, high density population areas. The middle class is occupied by 17% of the population. Only 3% of Accra lives in high income, low density residential areas.

. Still, for the past two decades this city of roughly 4 million inhabitants has had an annual growth rate of 4% making it one of the fastest growing metropolis in Africa. This phenomenal growth has contributed to municipal waste production that far outstrips the city's capacity for containment and processing. (Boadi K, 2003)

In the current spate of development in Accra, Ghana, residents are contending with congestion, illegal settlements, substandard housing, and poor sanitation. This environment is the predominant experience of most city residents and is reflective of growing inequality that has come to characterize the city. The convergence of poor governance and human factors such as indiscriminate dumping has resulted in a city environment characterized by choked drains, clogged gutters, and garbage piles heaped in open spaces.

The sanitary set-up of Accra is reflective of the income levels. Only 30% of all houses have toilets that actually flush. Only 1 in every 5 houses has functioning indoor plumbing. The public latrines that have been built to accommodate these disparities are overused and often shared by 10 or more people. (Boadi K, 2003)

In Ghana, management of waste is a herculean challenge to most Metropolitan, Municipal and District Assemblies (MMDA'S) especially how to effectively dispose it. Abokobi is in no exception.
The populace of Ledzokuku-krowor, Madina-Nkwantanang, Ga-East and West and Adenta Municipalities all use Abokobi dump site of about 8,150.47 tons per month (Ga-East Municipal Environmental Health Officer, 2014). Waste pickers sift through the waste to retrieve materials considered to be of value economically. They therefore set a portion of the dump site on fire enabling them to easily obtain some materials like copper and other metallic materials.

The dangers of air pollution include high blood pressure and cardiovascular problems (Pope, C.A., et al. (2002) and Sanjay, R. (2008)

Associations between air quality and increased morbidity and mortality rates have also been reported (Schwartz, J. (2000). The World Health Organization states that 2.4 million people die each year from causes directly attributable to air pollution (WHO (World Health Organisation) (2000).

Epidemiological studies suggest that more than 500,000 Americans die each year from cardiopulmonary disease linked to breathing fine particle matter. (American Chemical Society (2008) . Another study has shown a strong association between pneumonia related deaths and air pollution from motor vehicles in UK (Knox, G. (2008) .In addition, air pollution is known to cause injuries to animals, forests and vegetation, and aquatic ecosystems. Its impacts on metals, structures, leather, rubber, and fabrics include cracks, soiling, deterioration, and erosion (Turner, D.B. and Stern, A.C. (1994).

Although open waste dumpsite are known in Ghana, there appears to be little research undertaken on them. Dumpsite can cause problems for operators on the site and nuisance for local residents and there may be potential health risks involved. If open waste dump sites are ignored, or undiscovered, the heavy metals it generate can become dangerous for our health. Assessing air, water and soil quality within the catchment area of open dump sites will help to forestall the impacts on human health and by extension even animals that could contribute to respiratory infection in adults examine its implication local residents near the dumpsite, workers and recyclable waste pickers on the other hand.

Assessing the (Sardinia 2005, Tenth International Waste Management and Landfill Symposium)

relative health and environment hazards posed by the dumpsites existing throughout the developing countries could help prioritize, plan and initiate dumpsite rehabilitation. Identifying the risk factors of concern will allow a community to target its efforts to minimizing both the risk potential of the landfill and the cost. The research therefore seeks to identify the relationship between cadmium, mercury lead and renal dysfunction among resident (adults) close to the dumpsite and recommend appropriate interventions to check the practice. Identifying risk factors associated with disease is essential in order to prevent it from affecting even patients.

Urine Sample collection

Adults (20-60 years) will be provided with clean water and soap for hand washing before handing out to them sterile meta-free plastic urine containers for urine collection. They will be cautioned to void out the first portion of the urine stream before collecting 75 mls midstream urine into the plastic urine container. 10mls of the urine will be drawn into four sterile sample tubes (Sarstedt, S-monovette, Germany).

Blood Sample Collection

Following explanation of the test procedure, 7.5ml of whole blood will be collected from the median cubital and cephalic veins into three separate haematology tubes (Sarstedt, Smonovette, Germany), two free and one containing Z-gel, an additive carrier and a clot activator (for serum separation) using a butterfly needle and a tourniquet

Risk(s):

There is not much risk in using urine samples for analysis of heavy metals. However, 7.5mls of blood samples from 20-60 years may cause weakness. It is therefore advisable participants feed well and properly in the study before samples are taken. In case participant are found beyond

2ug/g ie (4ug/g-10ug/g) of creatinine and blood serum will be referred

Benefit(s):

The study will serve as a guide to help in various remediation activities and also to create awareness concerning exposure of heavy metals to humans.

The outcome of this research would provide an overview of the crucial state of adults living around dumpsites so stakeholders like Ministry of Health and Ministry of Environment would be properly motivated to act in the mitigation of these extensive exposures to heavy metals.

Confidentiality:
I would like to assure you that whatever information provided will be handled with strict confidentiality and will be used purely for the research purposes. Your responses will not be shared with anybody who is not part of the research team. Data analysis will be done at the aggregate level to ensure anonymity. No name will be recorded. Data collected cannot be linked to you in anyway. No name or identifier will be used in any publication or reports from this study. However, as part of our responsibility to conduct this research properly, we may allow officials from the Ecolab University of Ghana, Noguchi Memorial Institute for Medical Research (NMIMR) University of Ghana, Central Lab of Korle-Bu Teaching Hospital, Supervisors, and Committee on Human Research Publication and Ethics (CHPRE) of KNUST to have access to your records for 3-5 years upon completion of the research.

Voluntariness:
Participation in this study is voluntary and one can choose not to answer any particular question or all questions. You are at liberty to withdraw from the study at any time. However, it is encouraged that you to participate since your opinion is important in determining the outcome of the study.

Alternatives to participation:
If you choose not to participate, this will not affect you in any way.

Withdrawal from the research:
Participants do not have to answer any survey questions that they feel are an invasion of their privacy. Also, participants do not have to participate in any particular aspects of the study that they find invasive.

Consequence of Withdrawal:
There will be no consequence or loss of benefit to you if you choose to withdraw from the study. Please note however, that some of the information that may have been obtained from you without identifiers like name, before you chose to withdraw, may have been modified or used in analysis reports and publications. These cannot be removed anymore. We do promise to make good faith effort to comply with your wishes as much as practicable.

Costs/Compensation:
Subjects will receive Cash and token gift for their participation in this study. A payment of 10 Ghana cedis (approximately US$5) will be given to study participants who complete all proposed data collection elements. Compensation will be given at the time of data/specimen collection.

Contacts:
If you have any question concerning this study, please do not hesitate to contact Mr Kwadwo Opoku Boateng (Principal Investigator) on 02442599221

Further, if you have any concern about the conduct of this study, your welfare or your rights as a research participant, you may contact:

The Office of the Chairman Committee on Human Research and Publication Ethics Kumasi Tel: 03220 63248 or 020 5453785

CONSENT FORM

Statement of person obtaining informed consent:
I have fully explained this research to ______________________________ and have given sufficient information about the study, including that on procedures, risks and benefits, to enable the prospective participant make an informed decision to or not to participate.

DATE: ____________________ NAME: ______________________________

Statement of person giving consent:
I have read the information on this study/research or have had it translated into a language I understand. I have also talked it over with the interviewer to my satisfaction.

I understand that my participation is voluntary (not compulsory).

I know enough about the purpose, methods, risks and benefits of the research study to decide that I want to take part in it.

I understand that I may freely stop being part of this study at any time without having to explain myself.

I have received a copy of this information leaflet and consent form to keep for myself.

NAME:____

DATE: ___________ SIGNATURE/THUMB PRINT: __________________

Statement of person witnessing consent (Process for Non-Literate Participants):

I ___________________________ (Name of Witness) certify that information given to

____________________________ (Name of Participant), in the local language, is a true reflection of what l have read from the study Participant Information Leaflet, attached.

WITNESS' SIGNATURE (maintain if participant is non-literate): ____________________

APPENDIX B: QUESTIONNAIRE

ID: AB/………/……..…

A. GENERAL INFORMATION

1. Date………………………….. Name: ,,,,,,,,,,,,,,,,,,,,,,,,,,,……………………………

2a. Age: ……………………….. 2b. Age of child:…………………………......

3a. What is your gender? □ Male □Female 3b. Gender of child? □ Male □Female

4. What is your highest level of education? □ No formal education □ Primary

□ secondary □ Tertiary □ Trade/technical/vocational training

4b. Is your child at School □ Yes □ No 4c. If yes which class? ....

4c. Is your child breastfeeding? □ Yes □ No

5. Occupation? □Employed □Unemployed □Scavenger □Dumpsite worker

6. Type of Housing? □ Brick House □ Wooden structure or Shed □ Squatter

7. Number of people in a household? 1 2 3 4 5 6

8. Proximity to Dumpsite (in kilometers)? Under 1 1 – 2 2 – 3 3 – 4 4 - 5

9. Number of years at current residence? < 1year 1-2 2-3 3-4 4-5 >5

10. Source of Water? □Borehole □Well □ Stream □Tap-water

11. Toilet Facilities? □VIP □WC □ Pour flush □Pit latrine □ Public toilet [□ KVIP,

□ WC □Pit latrine] □ Open defecation

12. Type of fuel? □Wood, □ Cow dung, □ Charcoal □ LPG

13. Does the dumpsite expose you to any of the following hazards? Tick (√) as appropriate

Dust	
Smoke	
Irritating gases and liquids	

Heat	
Fumes	

B. THE NEXT SET OF QUESTIONS IS ABOUT YOUR WORK

14. Are you exposed to any of the following hazards at your work place? Please kindly tick (√) as appropriate.

Dust	
Smoke	
Irritating gases and liquids	
Heat	
Fumes	
Aerosols	

15a. Do you think this environment can harm your health in any way? □ Yes □No □ Don 't know

15b. If Yes please specify how …………………………………

15c. Do you wear any personal protective equipment when you are working? □ Never □ Sometimes □Don't know what it is

C. THIS SET OF QUESTIONS IS ABOUT YOUR HEALTH IN RELATION TO YOUR WORKING ENVIRONMENT?

16. Do you have any illness you know about? □ Yes □ No

17a. Have you had illnesses of the liver? □ Never □ All the time □I don't know

17b.Was it diagnosed by a doctor? □ Yes □No

17c. Since when? ....

18a. Have you had any illnesses of the kidney? □ Never □ All the time □ I don't know

18b. Was it diagnosed by a doctor? □ Yes □No

18c. Since when? ....

D. THE NEXT SET OF QUESTIONS IS ABOUT YOUR HABITS/ LIFESTYLE.

19a. Do you smoke cigarettes? □No □Yes am still smoke □In the past

19b. If yes, how many sticks do/did you smoke per day? □ < 5 sticks □ 5-10 sticks □ > 10sticks.

19c.How long have you being smoking? □1-5 years □6-10 years □ >10 years

20a. Do you take alcohol? □Yes □No

20b. How long have you been taking alcohol? □1-5 years □6-10 years □ >10 years

20c.Which type of alcohol do you usually take? Please tick (√) as appropriate.

Spirits		
Bitters		
Beers		
Other		

20d. How much alcohol do you take per day? □ <5 tots □ 5-10 tots □ >10 tots

21. Do you take any medications? □Yes □No

a. If yes which one…………………… b. What is it for…………………………

c. For how long……………………… d. How often ……………………………

G: THE NEXT SET OF QUESTIONS IS ON HEALTH DATA Point Scale

0 – Never or almost never have symptoms, 1 – Occasionally have it, effect is not severe
2 – Occasionally have it, effect is severe 3 – Frequently have it, effect is not severe
4 – Frequently have it, effect is severe

22. How often do you get these symptoms?

22a. Malaria

Fever -0 1 2 3 4
Chills -0 1 2 3 4
Night sweating -0 1 2 3 4 Fatigue
-0 1 2 3 4 Stomach Pain
-0 1 2 3 4
Muscle Pain -0 1 2 3 4 Headache
-0 1 2 3 4

22b. Urinary

Persistent urge to urinate -0 1 2 3 4
Urination frequency -0 1 2 3 4
Lower abdominal or groin -0 1 2 3 4
Pain when voiding -0 1 2 3 4
Vaginal irritation -0 1 2 3 4
Foul-smelling urine -0 1 2 3 4
Blood in urine -0 1 2 3 4

H: THE NEXT SET OF QUESTIONS IS ON WASTE GENERATION

23. Whose responsibility is it to manage waste?

a. Municipal Assembly
b. Local committee
c. Private organizations
d. Self
e. Other ____

24. What methods do you use to dispose of your waste?

a. Indiscriminate (road side, open gutters, etc.)
b. Household Bin that is collected
c. Use of common areas
d. Open Burning
e. Other ____

25. How is your waste transported?

a. Self
b. Children
c. Housemaid
d. Paid Collection
e. Other______________________________

26 How often is your waste dealt with (burned, collected, dumped etc.)? ___________________

27. How many times a day do you indiscriminately dispose of your waste? _________________

28. What kinds of methods will be more effective for solid waste treatment in Accra
   a. Incineration _______
   b. Landfill ____________
   c. Compost ___________
   d. After source separation___________

29. Do you feel that household separation of solid waste is necessary?
Yes _____ No _____

30. Would you be willing to participate in household waste separation?
Yes _____ No _____

31. What if the government required it? Yes _____ No _____ 32. What would motivate you to practice household waste segregation?

33. How do you view household waste separation?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

34. What are the barriers to waste segregation?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

35. Do you see how household waste segregation can help eliminate waste? □ Yes □No

36. Do you associate household waste management to human health? □ Yes □No

37. Which ways may be the most effective to improve the opinion of household waste separation in Accra?
   a. More environmental activities and propaganda to enhance resident's awareness?
   b. Increasing the environmental control facilities?
   c. Increasing the environmental protection standards?
   d. Speeding up legislation?
   e. Other

38. Are there other comments you would like to include?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

I: THE NEXT SET OF QUESTIONS IS ON HYPERTENSION HISTORY

39. How often do you see your doctor for blood pressure checkups?
□ Monthly □ every 3-4 months □ every 6 months □ once a year

40. What was your last systolic blood pressure reading?...

41. What was your last diastolic blood pressure reading?..

42. Have you had a blood pressure reading of 140/90mmHg in the last 1 year
□ Yes □ No

43a. Has your doctor diagnosed you as being hypertensive? □ Yes □ No

44b. If yes, what was your blood pressure reading on diagnosis?..............................

45a. Have you been prescribed any medication to lower your blood pressure?
□ Yes □No

45b. If yes, list medication and dosage………………………………………

51a. Do you smoke cigarette? □ Yes □ No

52b. If yes, how many cigarettes do you smoke a day?
□ 1-9 cigarettes □ 10-19 cigarettes □ 20 > cigarettes

53a. Do you have blood relatives with history of hypertension?
□ Yes □ No

54b. If yes, who is the person?
□ Father □ Mother □ Siblings □ Child □ Grandparent □ Other

46. Have you lost any time at work because of your condition? □ Yes □ No

47. What quantity of salt do you take daily?
□ < 1 teaspoon □1 teaspoon □>1 teaspoon

48. Select the type of diet you are following

a. Diabetic	□ Yes	□ No
b. Low Carbohydrate/Sugar	□ Yes	□ No
c. Low Cholesterol	□ Yes	□ No
d. Low Salt	□ Yes	□ No
e. Weight Reduction	□ Yes	□ No
f. Vegetarian	□ Yes	□ No
g. No Salt	□ Yes	□ No
h. No Special Diet	□ Yes	□ No

49. What type of Physical activity do you do currently?
□ Aerobic Workout □ Bicycling □ Running/Jogging □ Swimming □ Walking
□ None

50. How often do you do Physical activity?
□ 1-5 times a week □ 6-10 times a week □ inconsistently □ none

55 Before your blood pressure measurement, were you aware of your hypertension status
□Yes □ No

J: THE NEXT SET OF QUESTIONS IS ON ANTHROPOMETRIC MEASUREMENTS

56. Weight__________ Kg

57. Height___________ meters

58. BMI_______________ Kg/m2

K: THE NEXT SET OF QUESTIONS IS ON ANTHROPOMETRIC MEASUREMENTS

59 BP	1st reading	2nd reading	3rd reading	Mean
Systolic (mmHg)	………….	…………..	………….	…………….
Diastolic (mmHg)	…………	…………..	………….	……………..

60a. Are you pregnant? □Yes □ No

61b. Are you on any psychotic drug? □Yes □ No

62c. If yes, state the drug………………………………………………………….

Thank you very much. We really appreciate your participation in this study