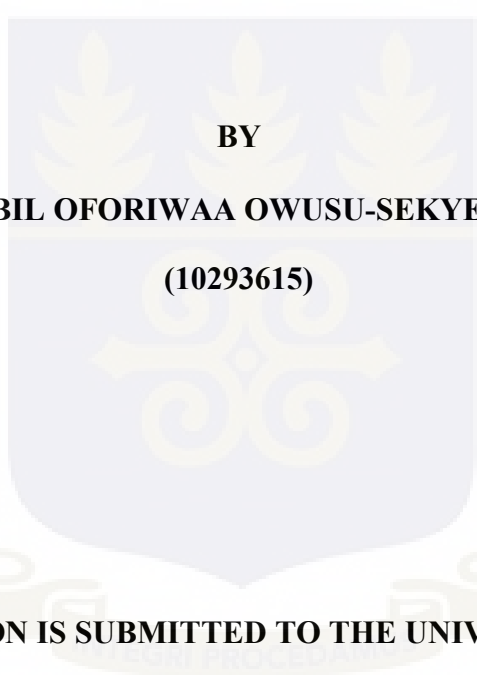


UNIVERSITY OF GHANA

SCHOOL OF GRADUATE STUDIES

**CARDIO-RESPIRATORY FUNCTION AMONG FORMAL SECTOR WORKERS AT
AGBOGBLOSHIE E-WASTE RECYCLING SITE IN ACCRA, GHANA**



BY
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**THIS DESSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA
LEGON, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE AWARD OF MASTERS IN PUBLIC HEALTH (MPH) DEGREE**

JULY, 2018

DECLARATION

I, Sybil Oforiwaa Owusu-Sekyere, hereby declare that, except for references to other people's works which have been duly acknowledged, this work is my original research and that this dissertation, either in whole or part has not been presented for the award of degree in this or any other university.

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DEDICATION

I dedicate this thesis to my supportive and loving husband Dr Frank Owusu-Sekyere, who has been with me through the most difficult part of my journey in School. Also, to my beautiful children Nigel Owusu-Sekyere and Scarlett Owusu-Sekyere and my amazing mother Madam Juliet Asiamah and sister Mrs. Astrid Marianne Dzane, for being such strong and encouraging women in my life.

ACKNOWLEDGEMENT

My sincerest and heartfelt praise goes to Jehovah God Almighty for giving me the needed strength to endure the challenges and difficulties that I encountered during my programme.

I am most grateful to my Academic supervisor's Dr John Papa Arko-Mensah and Prof Julius Fobil for their enormous contributions, patience, kindness and guidance in this dissertation.

My heartfelt gratitude goes to the Management and staff of Omni Bank, Ecobank, Sikkens paint, Pepsi brewery Limited and Japan motors all of Agboghloshie, Accra for being cooperative, understanding and patient with me during my data collection.

To my team members who worked with me Miss Kafui Kesewaa Aboagye, Mr. Justice Dogbe, Mr. Emmanuel Amponsah, Mr. Francis Frimpong and Mr. Emmanuel Baiden, I am most grateful for your hard work, commitment and support during the data gathering process, also to Dr Andrea Kaifie (Germany) for your enormous help and training in spirometry testing and reading, your help made spirometry reading easy.

Finally, I appreciate the support and encouragement from my family and friends and all those who contributed in diverse ways in making this study a success, your kind words and patience really brought a Zen to my mind and wellbeing, and I am forever grateful.

I am grateful to the West Africa-Michigan Collaborative Health Alliance for Reshaping Training, Education and Research in Global Environmental and Occupational Health (WEST AFRICA-MICHIGAN CHARTER II) for supporting this work.

ABSTRACT

Background: Crude dismantling and burning of e-waste as done at the Agbogbloshie recycling/dumpsite results in release of a myriad of toxic chemical substances such as heavy metals dust, dioxins, furans, plume of smoke containing chemical intermediates such as polyhydrogenated aromatic hydrocarbons and polycyclic aromatic hydrocarbons. Exposure to these toxic chemicals could impact negatively on both human and environmental health. Previous studies on exposure have mostly focused on either e-waste workers or contamination of the environment; air, water and soil, but not on formal workers around the e-waste site.

Objective: The aim of this study was to assess cardio-respiratory function among formal workers at Agbogbloshie.

Methods: This was a cross-sectional study involving apparently healthy office workers. A modified respiratory questionnaire was used to assess prevalence of respiratory symptoms among study participants. Also, spirometer, pulse oximeter, sphygmomanometer was used to take measurements of lung function, pulse rate and blood pressure.

The data gathered was coded and entered into Excel Microsoft 2016 and exported to Stata version 15.0 for analysis. Means, medians, standard deviations and interquartile range was calculated for continuous variables as appropriate and spearman rank correlation was used to analyze the relationship between hours of work and lung function indices.

Results: A total of 120 respondents were recruited for the study, 91(75.8%) were males and 29(24.2%) were females. The most common respiratory symptoms were common cold, cough and sneezing. Majority of the respondents had abnormal cardio vascular health indicators. There was a negative correlation between number of years worked (duration of work) or number of days worked and lung function as indicated by respiratory function indices (FEV1/FVC) by spirometry.

Conclusion: This study showed a high prevalence of respiratory symptoms; a high prevalence of blood pressure increments in the pre-hypertensive and hypertensive range and a significant association between the number of working hours and poor respiratory function indices (FEV1/FVC) among formal sector workers at Agbogbloshie.

Keywords: E-waste, hazard, occupational hazard, spirometer, lung function indices, pulse oximeter, sphygmomanometer, formal workers.

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LIST OF ACRONYMS

| | |
|-----------------|---|
| ATSDR | Agency for toxic substance and disease registry |
| BFR | Brominated flame retardant |
| BMI | Body mass index |
| CO | Carbon Monoxide |
| CO ₂ | Carbon dioxide |
| COPD | Chronic Obstructive pulmonary disease |
| EEE | Electrical and electronic equipment |
| FEV | Forced expiratory volume |
| FVC | Forced vital capacity |
| O ₃ | Ozone |
| PAH | Polycyclic aromatic hydrocarbon |
| PBDE | Polybrominated diphenyl ether |
| PCB | Polychlorinated biphenyls |
| PHAHC | Polyhydrogenated aromatic hydrocarbons |
| PM | Particulate matter |
| PVC | Polyvinyl chloride |
| WHO | World Health Organization |

CHAPTER ONE

INTRODUCTION

1.1 Background

Electronic waste workers suffer negative health effects through skin contact and inhalation, while the wider community are exposed to the contaminants through smoke, dust, drinking water and food (Robinson, 2009). Electronic waste (e-waste) comprises discarded electronic appliances, of which computers and mobile telephones are disproportionately abundant because of their short lifespan (Robinson, 2009). It includes computers, cell phones, televisions and refrigerators that have outlived their usefulness. It contains over 1000 different chemical substances which are toxic and can potentially contaminate the environment. This includes heavy metals such as Lead (Pb), Mercury (Hg), Arsenic (As), Cadmium (Cd), Selenium (Se), Hexavalent chromium (Cr), Antimony (Sb) and Iron (Fe).

Exposure to these heavy metals have deleterious effect on the nervous, digestive, immune systems as well as serious effects on the lungs and kidneys. Exposure to these heavy metals can also cause irritation to the eyes, skin and gastrointestinal tract disturbances, which may be from irritant or astringent action on the stomach. At even a relatively low exposure of these heavy metals to children and pregnant women, serious and in some cases, irreversible neurological damage and impaired development of the child has been reported (Jarup, 2003).

A study on human monitoring survey by Asante et al., (2012) reported that recycling workers in Agbogbloshie have high urinary levels of some metal(loid)s, particularly Fe, Sb, As and Pb (Asante, et al., 2012). All these metals have been associated with a variety of health issues including developmental neurotoxicity, immune function, cardiovascular disease, thyroid dysregulation, impaired liver and renal functions (Clarkson et al., 2007; Houston, 2011; Karagas, et al., 2012)

In addition to these heavy metals, e-waste is abundant in hydrocarbons and its derivatives. For example, several polycyclic aromatic hydrocarbons (PAH) metabolites found in e-waste have been recognized as carcinogenic (IARC, 2012). The embedded polychlorinated biphenyls (PCBs) have also been associated with reproductive failure and suppression of the immune system (Stockholm Convention). Furthermore, polybrominated diphenyl ethers (PBDEs) found in e-waste have high lipophilicity and high resistance to degradation processes and causes hepatotoxicity, embryotoxicity and thyroid effects at its endpoint (Darnerud, et al., 2001). Moreover, brominated flame retardants (BFRs) have also been shown to disrupt proper functioning of the endocrine system and may influence the levels of thyroid stimulating hormone and cause genotoxic damage, increasing the risk of developing thyroid cancer (Tsydenova & Bengtsson, 2011). Lastly, polyvinyl chloride (PVC), also found in e-waste, produces dioxins when burnt which can cause reproductive and developmental problems, immune system damage and interfere with regulatory hormones (Osugwu & Ikerionwu, 2010).

Ghana has an unregulated and unrestricted import regime for second-hand electrical and electronic equipment (EEE) except refrigerators. Thus, waste electrical and electronic equipment enter the country as second hand EEE which has a huge demand in Ghana. For example, in 2009, the EEE imports into the country added up to 215,000 tons and per capita import of 9kg (Amoyaw-Osei et al., 2011). Unfortunately, no facility exists in Ghana to manage the disposal of such huge e-waste in an environmentally friendly manner. Most of this e-waste ends up in Agbogbloshie, a suburb in Accra which has been described as the biggest e-waste dump-site in sub-Saharan Africa (Feldt, et al., 2014).

Electronic waste recyclers in Agbogbloshie employ manual dismantling and open-air burning recycling methods to salvage some valuable metals. Much of this activity is carried out by young men who use primitive equipment without protective gears. These unprotected work-

ers at the site get exposed to mixtures of toxic substances via inhalation, ingestion and dermal contact (Robinson, 2009). Organic toxins such as PCBs, and PAH have also been shown to extend to the surroundings of e-waste recycling area (Tang, et al.,2010; Wang, et al., 2012). Also, uncontrolled processes of e-waste recycling with no measures to preserve the environment can cause extreme localized contamination followed by migration of the contaminants into receiving waters and food chains. (Leung, et al., 2011).

However, studies to investigate the effect of e-waste fumes on cardio-respiratory function of formal sector workers at the Agbogbloshie e-waste environs have not yet been clearly documented even though a lot of studies have been carried out in this dump area.

1.2 Problem statement

The Agbogbloshie e-waste recycling and dump-site is one of the biggest in sub-Saharan Africa. To retrieve reusable parts, different types of end of use electrical and electronic equipment (EEE) such as computer keyboards, monitors and vehicle motors are openly dismantled with simple tools such as hammers and screw drivers. Also, open air burning of electrical and electronic cables is done using old car tyres or foam cut from discarded refrigerators as source of fuel to burn and retrieve oxidized copper. In the process, several toxic chemicals are released into the atmosphere including particulate matter, heavy metals dust, and toxic fumes from smoke (Akormedi, 2013). Studies have shown that e-waste workers are directly exposed to toxic chemicals as reflected in levels in their urine and blood (Akormedi, 2013).

Indeed, exposure to e-waste has been shown in USA to have direct association with health such as changes in thyroid function, changes in cellular expression and function, adverse neonatal outcomes, changes in temperament and behaviour, and decreased lung function. (Grant, et al., 2013). Pollutants from e-waste processing are most likely to contaminate the ambient air even beyond the e-waste dumpsite. Indeed, a mixture of dust and smoke is often

seen by the naked eye at Agbogbloshie. However, there are no studies that have focused on the health risk of ambient air pollution on formal sector workers who work mostly indoors within Agbogbloshie, who could also be exposed to a mixture of pollutants on a daily basis. This study will assess the cardio-respiratory function of formal sector workers at Agbogbloshie recycling dump-site.

1.3 Conceptual Framework

The conceptual framework (Fig. 1.1) depicts the various forms of e-waste recycling activities. Particulate matter such as dust, carbon dioxide, carbon monoxide and other gases from vehicular emissions, toxic smoke from inorganic and organic compounds released openly into the ambient environment could impact negatively on the respiratory health of exposed individuals. Signs and symptoms could range from respiratory symptoms to lung or cardiac disease. Again, variables such as duration of work, number of years worked, past history of respiratory symptoms and smoking status can account for respiratory health.

1.4 Justification

Agbogbloshie, is mostly known as home to a large open food market and site for e-waste recycling and dumping. However, it is also home to other economic activities such as banks, a paint factory, automobile dealers, a soft drink bottling plant. Although formal sector workers are mostly found indoors within their offices, pollution of the ambient environment can impact on their health, especially respiratory health.

Again, these workers not only commute everyday along the untarred Agbogbloshie road to and from their various offices daily, they also buy foodstuff and other items from the open food market, thus potentially exposing themselves to these toxic fumes, dusts and particulate matter found in the ambient air they breathe. They also spend a considerable number of hours at work which increases their risk of exposure daily.

While several studies have been carried out to assess health impacts of e-waste exposure among e-waste workers, formal sector workers who are also exposed through ambient air pollution and/or contaminated food have not been studied. Also, there is heavy vehicular traffic at Agbogbloshie leading to increased vehicular emission of carbon dioxide and carbon monoxide. All these could pose serious health challenges to all workers within Agbogbloshie including formal sector workers. Since inhalation will be the main route of exposure for office workers, it is important to assess the cardio-respiratory health among these group of workers who could also absolutely be at risk of exposure.

The findings from this study may be used to strengthen advocacy for sound environmental policies aimed at reducing health hazards associated with e-waste recycling.

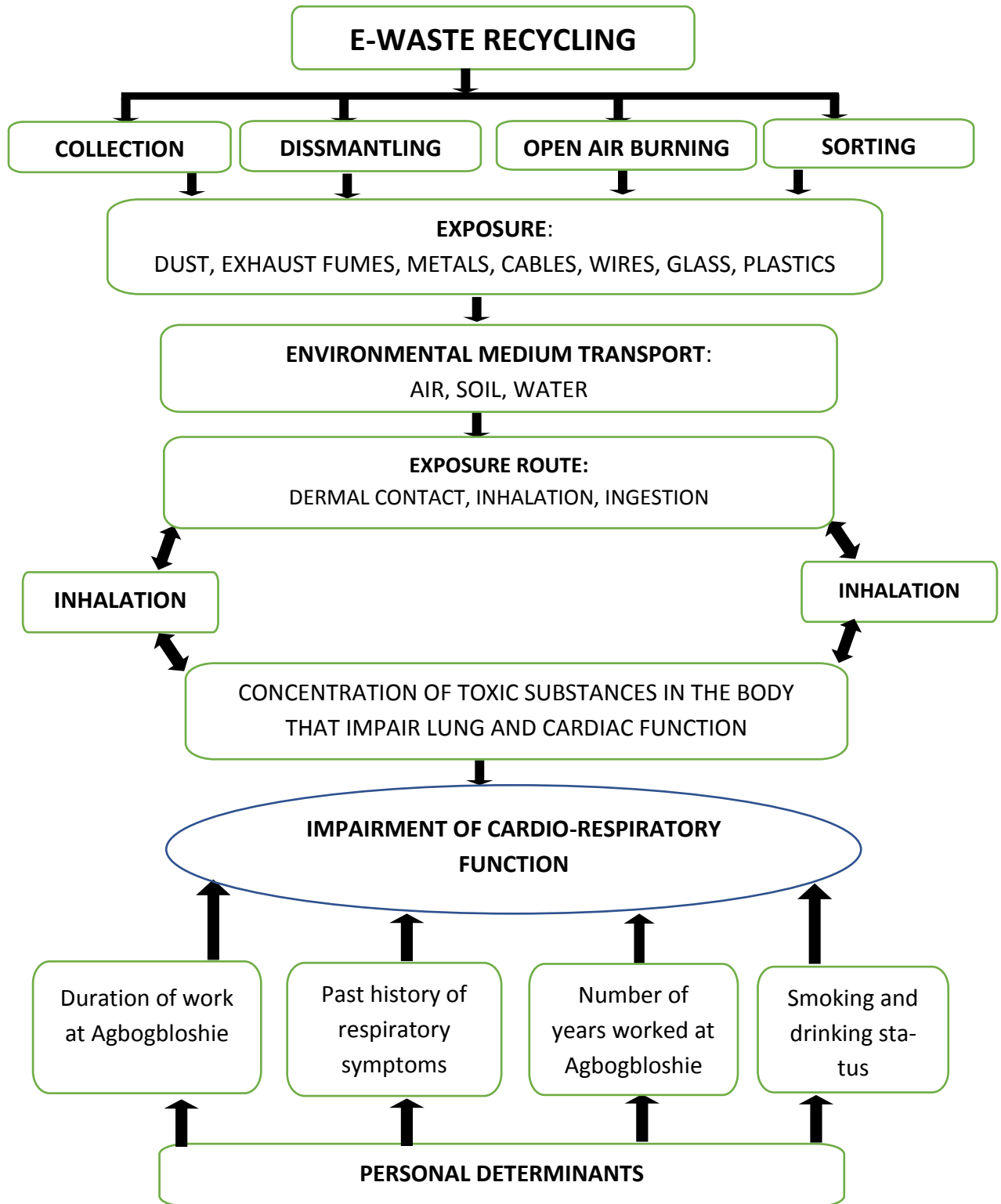


Figure.1.1 Conceptual framework of ambient air pollution on cardio- respiratory health

1.5 Research Questions

- What is the prevalence of respiratory symptoms in relation to toxic fumes among formal Workers at Agbogbloshie?
- Does duration of work and number of hours worked in a week have an effect on the respiratory health of formal workers at Agbogbloshie?
- Does cardiovascular health differ among formal workers at Agbogbloshie?

1.6 Study objectives

1.6.1 General Objectives

To assess cardio-respiratory function among formal sector workers at Agbogbloshie.

1.6.2 Specific Objectives

- To determine the prevalence of respiratory symptoms among formal sector workers in Abgogbloshie using a standardized questionnaire.
- To assess the lung function of formal sector workers in Agbogbloshie using a spirometer.
- To assess the cardiac health of formal sector workers by measuring oxygen saturation, pulse rate and blood pressure using pulse oximeter and sphygmomanometer.

CHAPTER TWO

LITERATURE REVIEW

2.1 E-waste processing and environmental pollution.

E-waste comprises discarded electronic appliances, of which computers and mobile telephones are disproportionately abundant because of their short lifespan. (Robinson, 2009). It includes outmoded computers, cell phones, televisions and refrigerators. Over a thousand different chemical substances which are toxic and can potentially contaminate the environment are embedded in these gadgets. Heavy metals found in e-waste include Lead (Pb), Mercury (Hg), Arsenic (As), Cadmium (Cd), Selenium (Se), Sexavalent Chromium (Cr), Antimony (Sb) and Iron (Fe) (Leung et al., 2011). Also found in great amount are flame retardants known to create toxic chemical intermediates such as dioxins, furans, polyhydrogenated aromatic hydrocarbons (PHAHCs) and polycyclic aromatic hydrocarbons (PAHs) when burned (Leung et al., 2011).

Due to these potential hazards on the environment, shipment and disposal of e-waste worldwide is governed by the Basel Convention (Choksi S, 2001) aimed at preventing it from getting to the environment. This notwithstanding, loopholes in the treaty are exploited such that as much as 75%- 80% of items produced in the European Union (EU) and the United States of America (USA) go unaccounted for, with many ending up in developing countries (Brigden et al., 2008).

West African nations of Ghana and Nigeria have become major destination points for e-waste deposition and recycling. Due to lack of ineffective legislation for safe recycling and disposal of this hazardous e-waste, the environment and human health have been at the mercy of these pollutants and toxicants (Amoyaw-Osei et al., 2011).

Agbogbloshie, a suburb in Accra, arguably, the biggest e-waste dump-site in sub-Saharan Africa is a typical example (Feldt et al., 2014). By employing manual dismantling and open-air burning recycling methods to salvage some valuable metals, organic toxins such as Polychlorinated biphenyls (PCBs), and Polycyclic aromatic hydrocarbons (PAH) are released into the surroundings of e-waste recycling area (Tang et al., 2010; Wang et al., 2012). Also, uncontrolled processes of e-waste recycling with no measures to preserve the environment can cause extreme localized contamination followed by migration of the contaminants into receiving waters and food chains. (Leung et al., 2011).

2.2 Impact of E-waste processing on human health

Due to unenforced laws, few infrastructure and protocols for safe recycling and disposal of hazardous e-waste at Agbogbloshie, the environment and human health have borne the brunt of pollutants and toxicants released into the environment (Amoyaw-Osei et al., 2011). E-waste recyclers in Agbogbloshie use crude methods of manual dismantling and open-air burning recycling methods to salvage some valuable metals. Workers around the vicinity of the site get exposed to mixtures of toxic substances via inhalation, ingestion and dermal contact (Robinson, 2009). Organic toxins such as Polychlorinated biphenyls (PCBs), and Polycyclic aromatic hydrocarbons (PAH) have also been shown to extend into the surroundings of e-waste recycling area (Tang et al., 2010; Wang et al., 2012). The effects of e-waste pollutants and toxic fumes have been found to go beyond those in the immediate environment to affect the wider community (Robinson, 2009). Several PAH metabolites have been recognized as carcinogenic (IARC, 2012). The PCBs can cause reproductive failure and suppression of the immune system (Stockholm Convention). Polybrominated diphenyl ethers (PBDEs) with high lipophilicity and high resistance to degradation processes has been found to be hepatotoxic, embryotoxic and deleterious thyroid effects at its endpoint (Darnerud, et al., 2001). Brominated flame retardants (BFRs) have also been shown to disrupt endocrine system func-

tions and may influence the levels of thyroid stimulating hormone and cause genotoxic damage, increasing the risk of developing thyroid cancer (Tsydenova & Bengtsson, 2011). The Polyvinyl Chloride (PVC) produces dioxins when burnt which can cause reproductive and developmental problems, damage to the immune system and interfere with regulatory hormones (Osuagwu & Ikerionwu, 2010).

2.2.1 Effect of heavy metals on cardio-respiratory health

Heavy metals contribute to air pollution with its attendant health problems. Air pollution by toxic chemicals or compounds (including those of biological origin) in the air, at high levels pose a health risk to those exposed (Brunekreef & Holgate, 2002).

Health effects of air pollution has been well studied particularly regarding the fine particulate matter in air and heavy metal pollution (Pope, et al., 2013). It places a heavy burden on the most vulnerable populations – women, children and the elderly. Several studies in Guiyu, a city in south eastern China, the largest e-waste recycling site in the world have demonstrated that residents in the city exhibit substantial digestive, neurological, respiratory, and bone problems. For example, 80 percent of Guiyu's children experience respiratory ailments, and are especially at risk of lead poisoning and its consequent health problems (Deng et al., 2006; Zeng, et al., 2016).

Cardiovascular diseases, lung damage and cancer, and decreased lung function are also associated with compounds common in e-waste, including polycyclic aromatic hydrocarbons, Hexavalent Chromium, Cadmium, Nickel, Arsenic, and Lithium. (Grant et al., 2013)

Transition metals including chromium, nickel and manganese are the essential trace elements of the human body, but excessive amounts have toxic effects on humans. The principal adverse health effect associated with transition metal exposure is predominantly respiratory. Acute and intermediate-duration exposure to moderate levels of heavy metals such as chro-

mium, Manganese and Lead generally cause mild irritation, accumulation of macrophages, hyperplasia, and inflammation and decreased lung function (Zheng et al., 2013).

Major man-made sources of ambient air pollution from heavy metals include industries, automobiles, and power generation (Mishra, 2003). Fuel combustion is the primary source of a large number of health-damaging air pollutants. Included in emissions from fuel combustion from vehicles is the heavy metal Pb with its attendant problem on the respiratory tree once inhaled (Duruibe et al., 2007).

In addition to its effects on the respiratory tree, heavy metals have been found to exert cardiovascular effects. For example, studies have shown that Pb causes inhibition of the synthesis of haemoglobin dysfunctions in the kidneys, joints, reproductive systems, cardiovascular system and acute and chronic damage to the central nervous system (CNS) and peripheral nervous system (PNS) (Ogwuegbu and Muhanga, 2005). Navas-Acien et al., 2007 in a systematic review of Pb exposure and cardiovascular disease concluded that there was a causal relationship of lead exposure with hypertension. They also concluded that sufficient evidence existed to infer a causal relationship of lead exposure with clinical cardiovascular outcomes such as heart rate variability (Navas-Acien et al., 2007).

Similarly, Blood lead and cadmium, at levels well below current safety standards have been associated with an increased prevalence of peripheral arterial disease in the general US population. Cadmium may partially mediate the effect of smoking on peripheral arterial disease (Navas-Acien, Selvin, Sharett, 2004).

2.2.2 Effect of smoke - effects of flame retardants, organics (PCBs and PAH) on cardio-respiratory health

Polychlorinated biphenyls (PCBs) are well-known environmental pollutants that bioaccumulate mainly in the fatty tissue of animals and humans. Although contamination occurs primarily via the food chain, waste combustion leads to airborne PCBs. From epidemiological studies, there is substantial evidence that PCB pollution is linked to cardiovascular diseases. Borlak et al found that a complex mixture of PCB isomers and congeners affected expression of nuclear transcription factors which play an important role in cardiac biology (Borlak & Thum, 2002).

There is strong evidence that such exposures to flame retardants increase the risk of diabetes, hypertension, cardiovascular disease, obesity, and cancer (Sly, 2016). For example. Arsenescu et al., 2008 found that PCB-77 may contribute to the development of obesity and obesity-associated atherosclerosis (Arsenescu et al., 2008). In addition, PCBs have been found to be responsible for a significant portion of respiratory infections in children (Dallaire, 2006).

2.3 Effect of particulate matter on respiratory health

Particulate matter is the sum of all solid and liquid particles suspended in air, many of which are hazardous. This complex mixture encompasses both organic and inorganic particles, like dust, pollen, soot, smoke and liquid droplets. Particulate matter is classified as coarse (PM_{2.5-10}) or fine (PM_{2.5}) particles, which allows for its deposition in several parts of the respiratory system. Particulate matter less than or equal to 10 micrometers in diameter are so small that they can easily get inhaled into the lungs causing serious health problems when exposed to high levels. Burning of metals which produces hazardous smoke and dust are all sources of ambient air pollution and particulate exposure (Ferreira et al., 2016). Harmful effects are associated with the various PM₁₀ fractions, among the chemical constituents that

appear to pose greater risks to health are those derived from the burning of biomass and fossil fuels.

Fine and respirable particulate matter (PM_{2.5} and PM₁₀), carbon monoxide (CO), sulfur dioxide, nitrogen oxides, volatile organic compounds, ozone (O₃) are by-products of fuel combustion, but others (such as O₃) are formed in the air through chemical reactions with other agents in the atmosphere. Air pollution containing PM among others, has both acute and chronic effects on human health. The association between inhaled particulate matter (PM₁₀, PM_{2.5}) and public health problems has been widely documented in epidemiological studies carried out in various parts of the world. The World Health Organization (WHO) recommends that the average annual ambient PM₁₀ level be <20 µg/m and PM_{2.5} <10 µg/m (Nandasena, 2010).

Health effects range anywhere from minor irritation of the upper respiratory system to chronic respiratory disease, heart disease, lung cancer, and death (Mishra, 2003). Particulate matter has been shown to cause acute respiratory infections in children and chronic bronchitis in adults (Zemp, 1999). It has also been shown to worsen the condition of people with pre-existing heart or lung disease. Among asthmatics, PM has been shown to aggravate the frequency and severity of attacks (Koenig, 1999). Both short-term and long-term exposures have also been linked with premature mortality and reduced life expectancy (Pope et al., 2009)

WHO reports that, about 3 million deaths each year are linked to exposure to outdoor air pollution with PM featuring prominently indoor air pollution is just as deadly. For example, an estimated 6.5 million deaths (11.6% of all global deaths) were associated with indoor and outdoor air pollution in 2012. The hardest hit are the developing countries. Again, WHO estimates that about 90% of air-pollution-related deaths occur in low- and middle-income coun-

tries, with nearly 2 out of 3 occurring in WHO's South-East Asia and Western Pacific regions (Smith, 2000) (WHO 2012).

Combustion from burning e-waste creates fine particulate matter, which is linked to pulmonary and cardiovascular disease. At the very least, short-term exposure to elevated particulate matter significantly contributes to increased acute cardiovascular mortality, particularly in certain at-risk subsets of the population. Hospital admissions for several cardiovascular and pulmonary diseases acutely increase in response to higher ambient particulate matter concentrations (Brook et al., 2004).

Irrespective of its classification as coarse (PM_{2.5-10}) or fine (PM_{2.5}) particles, there is deposition in several parts of the respiratory system so far as the size is less than 10 micrometers in diameter. Serious health problems arise when a person is exposed to high levels of PM. Burning of metals which produces hazardous smoke and dust are all sources of ambient air pollution and particulate exposure (Davidson, 2015).

2.3.1 Health Risk of Dust

Dust is a common air pollutant generated by many different sources and activities. Tiny solid and liquid substances float in the air, many of which are invisible. The type and size of a dust particle determines how toxic the dust is and how much of it is retained in the lungs once inhaled (Harrison & Yin. 2000). Dust particles small enough to be inhaled may cause irritation of the eyes, coughing, sneezing, hay fever and asthma attacks. For people with respiratory conditions like asthma, chronic obstructive airways disease or emphysema even small increases in dust concentration can worsen symptoms.

Currently there is no hard evidence that dust causes asthma, however breathing in high concentrations of dust over many years is thought to reduce lung function in the long term and contribute to disorders like chronic bronchitis and heart and lung disorders.

CHAPTER THREE

METHODS

3.1 Overview

This section explains the methods to be used in this study. It gives a description of the study area, study design, study procedures, data collection tools, data analysis and ethical considerations.

3.2 Study Area

Agbogbloshie is a former wetland and suburb of Accra, it is a known destination for both locally generated and imported used electronics. Agbogbloshie market is a trading centre which is located on the Abossey-Okai road behind the electronic waste dumpsite. The market is surrounded by the Agbogbloshie Township, Sodom and Gomorrah and a variety of companies and businesses which are located eastward to the e- waste site that employs many people such as banks, pharmaceutical companies, breweries, shops, various manufacturing companies, as well as many self-employed and petty traders.

The population of Agbogbloshie consists of economic migrants from Northern and rural parts of Ghana. Inhabitants live, eat, work and relieve themselves on the land and amongst the waste. Dwellings are wooden shacks that lack water and sanitation. Agbogbloshie has a formal and informal trading and business centers located on the Abossey-Okai road as depicted by the map below (Fig. 2).



Figure 2.1: Ariel view of Agboghloshie, Accra, Ghana.

3.3 Study design

This is an analytical cross-sectional study with a quantitative method which was conducted during the Months of May to July, 2018 by performing Spirometry measurements as well as using a simplified questionnaire to collect data on their socio-demographic characteristics, working hours and their respiratory health status prior to work and after work on formal sector workers such as bank workers, brewery workers and office workers at Agboghloshie.

3.4 Variables of interest

3.4.1 Dependent variables

Pulmonary function measurements such as forced expiratory volume per one minute (FEV_1), Forced vital capacity (FVC) and maximum ventilation volume (FEV_1/FVC %).

Respiratory tract symptoms and allergies including cough, phlegm (mucus) production, common cold, sore throat, breathlessness, chest pain, wheezing, itchy ears, eyes and throat, chest tightness and difficulty in breathing.

3.4.2 Independent Variables

- Individual Factors: Age, sex, weight, height, educational level, smoking status, duration of work, hours spent outside office, and past medical history of respiratory disease.

3.5 Study Population

The study population was all formal sector workers at Agbogbloshie area. The formal sector workers included those working in the Banks and other office workers and those in the brewery within the e-waste recycling surroundings along the Agbogbloshie road.

3.6 Sampling Methods

A cross sectional study design was used to select participants for the study. A total number of 120 workers were selected using simple random sampling from each company. Ten or more participants were selected from each company. These workers were assessed using questionnaires, spirometer for lung function measurements, pulse oximeter for pulse rate and saturation levels and sphygmomanometer for blood pressure monitoring.

3.6.1 Sampling Size Determination

The companies were selected based on their location along the Agbogbloshie e-waste recycling site where the road was divided into three sections. This was to determine the extent to which the toxic fumes and particulate matter from the e-waste recycling process as well as the ambient air quality and dust particles of that environment affects the formal sector workers with respect to their location and distance from the e-waste recycling site. The first company was randomly selected from the Abossey-Okai roundabout at the beginning of the Agbogbloshie road, from the traffic light, the second selection was at the middle part of the road and the third selection was at the final third of the road of Agbogbloshie, where one (1), two (2), two (2) companies respectively were selected making a total of five (5) companies. Ten (10) were selected from Omni Bank, 10 from Ecobank, 30 from Sikkens Paint, 50 from Pepsi and 20 from Japan Motors, making a total of 120 participants in all.

3.7 Study Procedures

The participant performed the spirometry maneuver for at least three to five intervals to meet reproducibility criteria and the best effort was used for the analysis. A total of one hundred and twenty (120) workers were selected randomly from each company. These workers were assessed using questionnaires, spirometer for lung function measurements, pulse oximeter for pulse rate and oxygen saturation levels and sphygmomanometer for blood pressure monitoring.

3.8 Questionnaire

The interview questionnaire was in four parts. The first part gathered the socio-demographic information of the study participants. The second part focused on the respondent's work, their daily routine and duration of work. The third part enquired about respiratory symptoms and history of respiratory disease. Then questions on their perception of the work environment specifically related to air pollution. The fourth part captured their clinical examination pa-

rameters of weight, height, FEV, FEV1, FEV1/FVC, pulse oximeter, Oxygen saturation level (spo2%) and blood pressure.

3.9 Spirometer

The highly portable diagnostic spirometer (Diagnostic Easyone) with a colored screen monitor for measuring lung function (FVC, FEV1 and FEV1/FVC ratio). The Diagnostic Easyone spirometer is a portable, easy to read and use, battery powered equipment with disposable mouthpieces. Its major advantages include: (1) Easy accessibility using a colored screen monitor; (2) Offering the option to transfer data onto the Easy ware 2013 software and excel spread sheet which allowed for easy spirometry data reading; (3) the full flow volume and volume time curves allowed for inspection of maneuvers displayed on test-quality prompts on the screen. An additional advantage was its high memory to store up to 6,000 readings. The spirometer was used in conjunction with a Nellcor hand held pulse oximeter with a reusable probe that clips onto the finger, Secca clinical weighing scale for weight measuring and a stadiometer for height measuring.

3.10 Digital blood pressure (BP) Monitor

A portable automated blood pressure machine (Omron BP monitor) measures blood pressure (BP) accurately by self-inflation giving a reading of both the systolic and diastolic blood pressure recording with a normal range of 120/80 millimeters of mercury (MMHG) as its unit. It gives a consistent accurate reading from around the upper arm when a cuff is applied at a sitting or lying down position. It can also detect abnormal reading of the heart rate. Its clinical accuracy and validity have been tested under various major health organizations. It is a rechargeable and battery powered equipment which can be used and read easily.

3.11 Pulse Oximeter

This is a small device that allows room for the insertion of any finger of the participant to be used to measure the oxygen saturation levels in the blood, with SP02% as its unit. It can detect oxygen levels even at the extremities of the body, away from the heart with a normal range of 99-100%, as well as the pulse rate of the participant with a normal range of 60-80bpm (Beats per minute). It's a non-invasive pain free test. The device is battery powered and easy to use and read.

3.12 Anthropometric Measurements

To measure the weight and height of the participants, Secca stadiometer with an incorporated weighing scale was used. While the participants were wearing light clothes without shoes, their weight and height were measured. The readings were recorded in kilograms (KG) and meters (m) respectively.

3.13 Cardiovascular variable measurements

The formal sector workers had their blood pressure and pulse rate measured at their various offices. To measure the arterial systolic blood pressure and the diastolic blood pressure, the participant was seated in a chair with the arm raised to the level of the heart and the cuff of the digital sphygmomanometer applied to the forearm, the start button on the monitor is pressed which inflates the cuff. After some few seconds, a measurement is achieved. The participants BP is then displayed on the screen of the BP monitor, with a normal BP range of 120/80 mmhg (millimeters of mercury). Then also to measure the pulse rate of the participant, the finger of the participant is inserted into the pulse oximeter, the start button is pressed and the pulse rate reading is also achieved, with a normal range of 60-80bpm (beats per minute). This equally records the blood saturation level (SPO2%) at the same time, with a normal range of 99-100%, displaying the readings on the screen of the equipment. Cardiovascu-

lar variable measurements were performed according to the American Heart Foundation Guideline/ AHA (2015).

3.14 Lung function measurement (Spirometry)

According to global lung function initiative (2012), Lung function measurements are performed after assessing the standing weight and height of a participant in kilograms and meters respectively prior to performing the lung function test as a standardized requirement. The Secca stadiometer was used to measure the weight and height in standing position without shoes with lighter clothing worn by participant. They were asked to raise their shoulders up for accurate height reading. After data entry, which included the socio demographic data of the participants, they were assisted to perform maneuvers to measure forced vital capacity (FVC), forced expiratory volume per minute (FEV₁) and maximum ventilation volume (FVC/FEV₁%). An overall lung function test outcome is based on the participant's age, sex, height, weight and past medical respiratory history such as being asthmatic and a cut-off point of between 80-100%.

3.15 Data quality assurance

3.15.1 Training of research assistants

Two (2) professional nurses, one (1) physiotherapist and one (1) administrative assistant were recruited and trained to assist in data collection. They all assisted in performing spirometry, pulse oximetry, blood pressure measurements and administering of questionnaires for the study participants. They all had tertiary level education and conformed to the ethical guidelines of the study.

3.12 Pretest pilot study

The questionnaire was pre-tested to ensure its validity. This was done among five (5) bank workers on the John Atta Mills High street, Accra. They all shared similar characteristics. Validity and reliability of the instruments were tested and any anomalies detected were corrected in the questionnaire before the final data collection was done.

3.13 Study Procedures

Approval of the study was sought from Ghana Ethical Review Committee (GHS-ERC030/01/18). Permission was sought from the Accra metropolitan assemble (AMA), to set up a small mobile clinic at the work premises for questionnaire administration and clinical examination. Permission was also sought from the various company managers who after giving a thorough explanation about the study and the procedures being carried out, gave their approval for the study to be conducted on their desired day and date. The study was explained clearly to the participants. The questionnaire was administered by trained research assistants in the language the participant best understood, after their consent had been sought. The questions were asked based on respiratory health, normal working hours and number of years worked.

Afterwards, a clinician and the primary participant carried out an examination on study participants to assess their Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV1) using a portable spirometer.

Trained nurses also measured their blood pressure using sphygmomanometer and pulse oximeter to measure their pulse rate and oxygen saturation levels.

3.14 Eligibility criteria

All formal workers who fit the inclusion criteria and gave their consent were included to be part of the study.

3.14.1 Inclusion Criteria

- Formal workers who have been working at Agbogbloshie for at least 12 months.
- Those aged 18-60 years

3.14.2 Exclusion Criteria

- Pregnant women
- Refusal of consent

3.15 Data Analysis

The data collected was coded, cross checked for validity and verification, then entered into Excel spread sheet and exported into Stata version 15.0 for analysis and the results were presented in tables. Means, medians, standard deviations and interquartile range was calculated for continuous variables as appropriate. Proportions were computed for categorical variables. Spearman's rank Correlation analysis was used to compare the relationship between the duration of work and lung function indices. Lung function and prevalence of respiratory symptoms and diseases were compared across formal sector workers.

3.16 Ethical Considerations

Ethical clearance was sought from the Ghana Health Service Ethical Review Committee (ERC/GHS 030/01/18). Permission was also sought from environmental protection agency (EPA), Ghana and Accra metropolitan assemble (AMA). A written consent was taken from all the study participants after giving out an information leaflet to be read with thorough explanation. The information leaflet contained information about the benefits, risks, and the

procedures involved in the research. Participants who were found to have abnormal spirometry results, pulse oximetry reading and abnormal blood pressure readings that require treatment were advised to visit a hospital facility for further medical attention.

3.16.1 Confidentiality.

The study participants were assured that all their information was confidential and were not disclosed to anyone without their permission. This was ensured by keeping all research record and data protected from accidental loss, in appropriate disclosure or destruction in order to protect the confidentiality of the participants data. Data was kept in restricted access on a secure laptop with passcodes with routine electronic back up. An appropriate safe destruction of data was ensured.

3.16.2 Possible risk of discomfort

Participation in this study posed no major risk to participants. The procedures involved in this study were non-invasive and painless, causing no discomfort to the participants.

3.16.3 Description of level of research burden

Study participants were requested to answer a questionnaire, participate in lung function test, pulse rate and oxygen saturation monitoring and blood pressure measurements which was easy to undergo posing no burden whatsoever at all to participants.

3.16.4 Compensation

Participants were not paid but were given a cap or face towel as souvenirs.

3.16.5 Possible benefits

Any abnormality detected on participants who required treatment were referred to the nearest health facility for treatment using their health insurance policy from their various companies and immediate health education was also provided where necessary. Additionally, findings of the study will be disseminated to inform the environmental health and safety policies of the level of health impact from air pollution.

3.16.6 Provision for premature end of a particular subject's participation in the study

At any point in time, a study participant who decided to opt out of the study was permitted to do so and was not penalized in any way.

CHAPTER FOUR

RESULTS

4.1 Demographic characteristics of participants

A total of 120 respondents were recruited into the study. The median age of the respondents was 29 years with an interquartile age range between 36 years and 45 years. Majority of the respondents were males 75.8%. Most of the respondents were married 61.7%, with 36.7% being single. About half of the respondents had tertiary level of education as their highest educational qualification. Christianity was the major religion practiced by 94.5%. Only 2.5% of the respondents smoked cigarette while 38.3% of them took alcohol. The average number of working hours worked in a day was 8 hours. Table 1 gives a detailed socio-demographic characteristic of respondents.

Table 1: Socio-demographic characteristics of respondents

| Variables | Frequency | Percentage (%) |
|-----------------------|------------|----------------|
| Age (Median (LQ, UQ)) | 29 (36,45) | |
| Sex | | |
| Male | 91 | 75.8 |
| Female | 29 | 24.2 |
| Marital status | | |
| Single | 44 | 36.7 |
| Married | 74 | 61.7 |
| Divorced | 1 | 0.8 |
| Widowed/widower | 1 | 0.8 |

Highest educational level

| | | |
|--------------|----|------|
| Primary/ JHS | 15 | 12.5 |
| Secondary | 42 | 35.0 |
| Tertiary | 63 | 52.5 |

Religion

| | | |
|--------------|-----|------|
| Christianity | 113 | 94.5 |
| Islam | 7 | 5.8 |

LIFE STYLE

Smoke status

| | | |
|-----|-----|------|
| Yes | 3 | 2.5 |
| No | 117 | 97.5 |

Frequency of daily smoke

| | | |
|-------------|---|------|
| <5 sticks | 1 | 33.3 |
| 5-10 sticks | 2 | 66.7 |

Alcoholic intake

| | | |
|-----|----|------|
| Yes | 46 | 38.3 |
| No | 74 | 61.7 |

Frequency of alcohol intake

| | | |
|--------------|----|------|
| Occasionally | 30 | 65.2 |
| Daily | 2 | 4.5 |
| Weekly | 8 | 17.5 |
| Monthly | 4 | 8.7 |

WORK FACTORS**Years of work (n=112)**

| | | |
|-------|----|------|
| One | 24 | 21.4 |
| Two | 26 | 23.2 |
| Three | 20 | 17.9 |
| Four | 42 | 37.5 |

Hours worked in a Day median (LQ, UQ) 8(8.0, 10.5)

Days worked in a Week (median (LQ, UQ)) 6 (5,6)

NB: All percentages not adding up to 100% were due to non-response. SD: Standard deviation. LQ: Lower quartile. UQ: Upper quartile.

4.2 Prevalence of respiratory symptoms

Table 2 shows the levels of prevalence of respiratory symptoms among the formal sector workers in Agbogbloshie. Overall, the commonest respiratory symptoms experienced by respondents was common cold experienced by 70% of respondents. Out of these, 65.8% had the symptoms some of the time while 4.5% had the symptoms all the time. The next major respiratory symptom was cough which was experienced by 58.3% of the respondents. By way of the severity of the cough, 55% reported intermittent cough while 3.3% of respondents admitted to always coughing. Other respiratory symptoms experienced by respondents, in decreasing order, were prolonged sneezing 54.5%, sore throat 49.9%, chest pain 44%, excessive production of mucus (phlegm) 40.8%, tightness of the chest 22%, difficulty in breathing 21.2%, shortness of breath 17.5% and wheezing 12.7%. Majority of the respondents 50.8% admitted to getting tired easily sometimes with 14.5% being always tired. Table 2 gives a breakdown of the various respiratory symptoms experienced by the respondents.

Table 2: Prevalence of respiratory symptoms experienced among formal workers during work.

| Symptoms | Always n(%) | Sometimes n(%) | Never n(%) |
|-------------------------------|----------------|-------------------|---------------|
| Cough | 44(36.7) | 66(55.0) | 4(3.3) |
| Cold | 31(25.8) | 79(65.8) | 5(4.5) |
| Prolonged/Repeated sneezing | 48(40.0) | 59(49.5) | 6(5.0) |
| Easy tiredness | 36(30.0) | 61(50.8) | 17(14.5) |
| Chest pains | 54(45.0) | 47(39.5) | 5(4.5) |
| Sore throat | 50(41.7) | 58(48.3) | 2(1.7) |
| Bringing out excessive phlegm | 57(47.5) | 43(35.8) | 6(5.0) |
| Itchy ears and throat | 53(44.5) | 52(43.3) | 6(5.0) |
| Itchy and watery eyes | 69(57.5) | 39(32.5) | 4(3.3) |
| Wheezing | 79(65.8) | 14(11.7) | 1(0.8) |
| Shortness of breath | 85(70.8) | 19(15.8) | 2(1.7) |
| Difficulty in breathing | 86(71.7) | 23(19.5) | 2(1.7) |
| Chest tightness | 76(63.3) | 21(17.5) | 5(4.5) |
| Skin Irritation/skin Disease | 63(52.5) | 34(28.3) | 6(5.0) |

* n: mean

4.3 Health related indices of formal Agbogbloshie workers

The mean weight (kg) and height (m) of the formal workers was 74.1 ± 12.6 kg and 1.44 ± 0.1 m respectively. The mean Body mass index (BMI) of the formal sector workers was 25.8 ± 4.4 kg/m² out of which 42.5% were overweight, 41.7% had normal BMI. About 13.3% were obese while 2.5% were underweight.

The median systolic blood pressure of the respondents was 128 mmHg with an interquartile range from 118mmHg to 141mmHg, while the median diastolic blood pressure was 80mmHg with an interquartile range from 73mmHg to 88mmHg. About 43.3 % of respondents were pre-hypertensives (with a systolic BP range of 120-139mmHg or diastolic range of 80-89mmHg), 35.8% were hypertensive (systolic BP above 140 or diastolic pressure of 90mmHg) and (20%) of them had normal blood pressure level.

The median FEV1/FVC lung function recorded among the formal workers was (75.8%) with an interquartile range from 64.8 to 83.9, while the median FEV1/FVC percentage recorded was 91.5 with an interquartile range from 79.0 to 88.0. In all, 80% of the formal workers had abnormal cardiovascular health status mainly from being pre-hypertensives and established hypertensives. The table below gives a detailed explanation of the health status of the respondents.

Table 3: Characteristics of health-related indices of the formal Agboglobshie workers

| Health related variables | Frequency | Percentage |
|---|------------------|-------------------|
| Weight (kg) | 74.1 ± 12.6 | |
| Height (meters) | 1.4± 0.1 | |
| BMI (Mean ± SD) | 25.9 ± 4.4 | |
| Underweight | 3 | 2.5 |
| Normal | 50 | 41.7 |
| Overweight | 51 | 42.5 |
| Obese | 16 | 13.3 |
| SBP (mmHg) (Median (LQ, UQ)) | 128(118.0,141.0) | |
| DBP (mmHg) (Median (LQ, UQ)) | 80.0(73.0, 88.0) | |
| Hypertension | | |
| Normal | 24 | 20 |
| Prehypertension | 52 | 43.3 |
| Hypertension | 43 | 35.8 |
| OXYGEN SATURATION (SPO2) (Mean ± SD) | | |
| Normal | 116 | 96.7 |
| Abnormal | 4 | 3.3 |
| Pulse Rate in Bpm (Mean ± SD) | | |
| Normal | 116 | 96.7 |
| Abnormal | 4 | 3.3 |
| Lung Function | | |
| FEV1/FVC | 75.8 (64.8, 84) | |

| | | |
|-------------------------------------|------------------|-------------|
| FEV1/FVC% | 91.5(79.0, 88.0) | |
| Abnormal | 16 | 17.02 |
| Normal | 78 | 82.9 |
| Cardiovascular health status | | |
| Normal | 20 | 16.7 |
| Abnormal | 100 | 83.3 |

SD: standard deviation. LQ: lower quartile. UQ: Upper quartile. SBP: systolic blood pressure. DBP: diastolic blood pressure. Normal BP:120/80mmhg, pulse: 60-80bpm, Spo2%:99-100%, FEV1/FVC% 80-100%.

4.4 Relationship between cardiovascular measures and work-related factors

Table 4 shows the strength of association between some cardiovascular measures and the work activities of the formal Agbogbloshie workers using the spearman's rank correlation coefficient. There was significant negative correlation between FEV1/FVC and the number of days worked in a week by the workers with a correlation of (**-0.30**) and a (p-value = **0.008**) by the formal workers.

Table 4: Relationship between cardiovascular measures and work-related factors of study participants

| Work activity | Spearman rank correlation (p-value) | | | |
|-----------------------|-------------------------------------|-----------------------|---------------|--------------|
| | FEV1/FVC | FEV1/FCV% | pulse | SPO2 |
| Hours worked in a Day | 0.18(0.1219) | 0.22(0.0566) | -0.17(0.1356) | 0.05(0.6825) |
| Days worked in a Week | -0.30**(0.008) | 0.30**(0.0089) | 0.03(0.8293) | 0.03(0.7812) |
| Age | -0.07(0.5236) | 0.09(0.4023) | 0.02(0.8506) | 0.08(0.4636) |

*: p-value<0.05. **: p-value<0.01. ***: p-value<0.001

4.5 Differences in respiratory functions systems

The mean pulse rate among the male respondents was 76.5bpm with a standard deviation of 11.5bpm and that among female respondents was 87.1bpm with a standard deviation of 25bpm. There was a significant difference between the mean pulse rate of male formal sector workers compared to female formal workers (p-value = 0.0372), indicating that the female formal sector workers had a significantly high mean pulse rate compared to the male formal workers at Agbogbloshie. The mean pulse rate of the formal sector workers with normal blood pressure was 73bpm (± 11.86 bpm), the mean pulse rate of the pre-hypertensive formal workers was 78bpm (± 11.83 bpm) and the mean pulse rate of the hypertensive formal workers was 84.3bpm (± 21.17 bpm). There was a significant difference between the mean pulse rate of the hypertensive groups (p-value = 0.0141). More on the differences between the various respiratory functions among groups of the formal sector workers can be read from table 5.

Table 5: Comparing some cardiovascular measures among groups of the respondents

| Groups | FEV1FVC | | FEV1_FCV% | | Pulse | | SPO2 | |
|------------------------|--------------------|---------|---------------------|---------|---------------|----------------|--------------|---------|
| | Median (LQ, UQ) | p-value | Median (LQ, UQ) | p-value | Mean ± SD | p-value | Mean ± SD | p-value |
| Sex | | 0.7056 | | 0.2951 | | 0.0372* | | 0.1877 |
| <i>Male</i> | 76.05(65.55,83.95) | | 93.00(80.00,100.00) | | 76.48 ± 11.46 | | 97.58 ± 1.54 | |
| <i>Female</i> | 74.00(63.60,83.10) | | 86.00(75.00,96.00) | | 87.11 ± 25.00 | | 98.07 ± 1.72 | |
| BMI | | 0.9436 | | 0.9919 | | 0.1928 | | 0.3226 |
| <i>Underweight</i> | 52.90(21.70,84.10) | | 52.90(21.70,84.10) | | 79.33 ± 11.59 | | 99.00 ± 1.73 | |
| <i>Normal</i> | 74.70(64.90,85.15) | | 74.70(64.90,85.15) | | 77.98 ± 12.61 | | 97.90 ± 1.58 | |
| <i>Overweight</i> | 76.00(64.95,82.80) | | 76.00(64.95,82.80) | | 77.86 ± 12.77 | | 97.53 ± 1.42 | |
| <i>Obese</i> | 76.60(64.80,83.10) | | 76.60(64.80,83.10) | | 87.44 ± 30.55 | | 97.56 ± 1.99 | |
| Hypertension | | 0.7341 | | 0.8161 | | 0.0141* | | 0.4036 |
| <i>Normal</i> | 75.90(68.10,85.60) | | 90.00(81.00,101.00) | | 72.67 ± 11.86 | | 97.54 ± 1.93 | |
| <i>Prehypertension</i> | 75.40(83.10,61.80) | | 90.00(74.00,100.00) | | 77.94 ± 11.83 | | 97.96 ± 1.45 | |
| <i>Hypertension</i> | 76.05(68.10,83.90) | | 94.50(82.00,99.00) | | 84.30 ± 21.17 | | 97.58 ± 1.52 | |

LQ: Lower quartile, UQ: Upper quartile. SD: Standard deviation. *: p-value<0.05. **: p-value<0.01. ***: p-value<0.001.

CHAPTER FIVE

DISCUSSION

This study, to the best of my knowledge, is the first to assess cardio-respiratory function among formal workers at Agbogbloshie. Toxic chemicals or compounds (including those of biological origin) in the air, at high levels have been found to pose a health risk to those exposed (Brunekreef & Holgate, 2002). The health effects of ambient air pollution range from minor irritation of the upper respiratory system to chronic respiratory disease, heart disease, lung cancer, and death Mishra et al., (2013). According to WHO, health hazards of air pollution are not limited to outdoor pollution but also indoor air pollution which could equally impact on respiratory health (WHO, 2000). For example, an estimated 6.5 million deaths (11.6% of all global deaths) were associated with indoor and outdoor air pollution in 2012. The offices of the formal workers recruited for this study are close to both the Agbogbloshie open food market and e-waste recycling site. The main road traversing the food market and e-waste site is untarred and dust is often seen suspended at Agbogbloshie. Also, there is heavy vehicular traffic and coupled with smoke from e-waste burning, all making the ambient environment around Agbogbloshie heavily polluted. Although the study participants are termed office workers, they commute daily on these roads, and often shop at the food market. Also, majority come out of their offices, even if briefly each day, thus exposing them to the ambient environment. It is therefore possible that these workers would be exposed to particulate matter, heavy metals dust, and toxic smoke from vehicles and e-waste burning, and may explain why most of these workers showed poor cardio respiratory indices.

It was found that the number of years one has worked at Agbogbloshie and number of working hours was significantly associated with poor lung function as determined by spirometry. This is not surprising since the development of occupational diseases are usually dependent on duration and frequency of exposure. A prospective study that takes a baseline spirometry

and some years after exposure may be able to establish a causal relationship using a control population.

It has been suggested that exposure to flame retardants increase the risk of diabetes, hypertension, cardiovascular disease, obesity, and cancer Sly et al (2016). The study also found that more than forty percent of study participants were overweight (42.5%), with (13.3%) of them being obese. The study also found a high prevalence of pre-hypertension, i.e. blood pressure (43.3%) and hypertensives (35.8%) suggesting that an exposure to the toxic environment may be impacting negatively on study participants. Again, a more robust study, that monitors the ambient levels of these toxins may establish a causal relationship.

In investigating the health effects of heavy metals in Nigeria, Ogwuegbu, and Muhanga (2005) found that in addition to its effects on the respiratory tree, heavy metals exerted cardiovascular effects on exposed individuals. For example, Pb causes inhibition of the synthesis of haemoglobin, dysfunctions in the kidneys, joints and reproductive systems, cardiovascular system and acute and chronic damage to the central nervous system and peripheral nervous system. Navas-Acien et al (2007) in a systematic review of lead exposure and cardiovascular disease concluded that there was a causal relationship of lead exposure with hypertension. They also concluded that sufficient evidence existed to infer a causal relationship of lead exposure with clinical cardiovascular outcomes such as heart rate variability. The findings of cardiac health being high (80%) among formal sector workers also attests to previous findings.

Dust pollutants from different sources and activities was found by Harrison et al (2000) to cause irritation of the eyes, coughing, sneezing and common cold. The participants in the present study experienced respiratory symptoms of cough, common cold and sneezing which all

raise a question about whether their polluted environment is a cause or not. Again, a study designed to establish a causal relationship may be able to confirm this finding.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study showed an increased prevalence of self-reported respiratory symptoms among the formal workers. The commonest symptoms were common cold and cough. Also showed in this study was the high prevalence of blood pressure increment in the pre-hypertensive and hypertensive range. There was a significant association between the number of working hours and respiratory function indices (FEV1/FVC).

6.2 Recommendation

It is recommended that there should be a regular health screening of the formal workers to assess their cardiovascular health and respiratory health due to the increased number of hypertensives and pre-hypertensives that were found during the study.

Finally, a more robust study should be conducted to determine indoor air quality on respiratory health because of the high prevalence of respiratory symptoms of formal workers at Agbogbloshie.

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APPENDICES

QUESTIONNAIRE

PART A

Questionnaire Number.....

Date of Interview DD/MM/YYYY..... Time __. __ Hours

Demographic Data

1. Age: yrs.
2. Sex M (1) F (2)
3. Marital status: (Please tick as appropriate)
Single..... 1 () Married.....2() Divorced.....3()
Separated.....4 () Widowed/ widower.....5()
4. Highest level of Education
Primary 1() Junior High 2() Senior High 3() Tertiary 4()
Doctorate/ Higher.....5()
5. Religion
Christian 1() Muslim 2() Traditionalist 3() Other 4()
6. When was the last time you checked your Blood pressure?
Everyday1 () Monthly 2() Quarterly 3() Bi annually 4() Annually 5() Never 6()
- 7a. How often do you smoke if applicable?
Yes.....1() No.....2()
- 7b. If yes, how many sticks do you smoke a day?
<5 sticks.....1() 5-10 sticks.....2() >10 sticks.....3() 1 pack.....4()
8. Do you take in any Alcoholic beverage?
Yes 1() NO 2()
- 8a. If yes, how often do you drink any alcoholic beverage?
Occasionally 1() Daily 2() Weekly 3() Monthly 4()

PART B (WORK)

9. How long have you been working at your current job?

6 months- 1 years.....1() 2-3 years.....2() 4-5 years.....3()

10 years and above.....4()

10. How many hours do you work in a day?

1.....

11. How many hours do you normally spend in your vehicles when commuting to work?

1..... hours

12. Do you normally roll your car windows down when driving or in a vehicle?

Yes 1() No 2()

13. Do you roll your car windows up when driving or in a vehicle?

Yes 1() No 2()

14. How many days do you work in a week?

1.....Days

15. Does your work expose you to any of the following? Please tick as appropriate.

Dust.....1() Fumes.....2() Smoke.....3()

16. Do you come out of your office during your working hours?

Yes 1() No 2()

16a. How many hours do you spend outdoors?

1-2 Hours 1() 3-4 Hours 2() 5-6 3()

PART C (Health)

17a. Have you ever been diagnosed with any chronic respiratory illness?

Yes....1() No....2()

17b. If your answer is yes, what was it? Please tick as appropriate.

Chronic Bronchitis.....1() Emphysema.....2() Asthma.....3()

Lung cancer.....4() Tuberculosis.....5()

18. Has your present job made your condition worse?

Yes.....1() No....2()

19. Do you experience any of these symptoms during work? (Please tick as appropriate)

| SYMPTOMS | ALWAYS | SOMETIMES | NEVER |
|---|--------|-----------|-------|
| Cough | | | |
| Cold | | | |
| Prolonged/Repeated sneezing | | | |
| Easy tiredness | | | |
| Chest pains | | | |
| Sore throat | | | |
| Bringing out excessive phlegm | | | |
| Itchy ears and throat | | | |
| Itchy and watery eyes | | | |
| Wheezing | | | |
| Shortness of breath | | | |
| Difficulty in breathing | | | |
| Chest tightness | | | |
| Skin Irritation/skin Disease | | | |
| If you answered yes to any question please give details | | | |
| | | | |

20. Do these symptoms stop when you are away from work?

Yes.....1() No.....2()

21. Do you live within the Agbogloboshie area?

Yes 1() No 2()

21a. If yes, for how long?

22. Do you regularly burn wastes materials at home?

Yes 1() No 2()

23. What is your source of fuel for cooking at home?

LGP Gas 1() Charcoal 2() firewood 3()

CLINICAL EXAMINATION

Weight.....kg Height.....m

Spirometry FVC..... FEV₁..... FEV₁/FVC.....

Remarks.....

Pulse oximetry Bpm...../SpO₂%.....

Blood pressuremm/Hg

Heart Rhythm

THANK YOU FOR YOUR TIME. YOUR PARTICIPATION WAS REALLY APPRECIATED.

APPENDIX 2.0

INFORMED CONSENT

Institutional Affiliation School of Public Health, College of Health Sciences, University of Ghana.

Dear Participant,

It would be a great pleasure if you could assist in helping me carry out an important study at the School of Public Health at the University of Ghana.

The benefit of this study will provide you with some informative work-related health issues that will serve as a precautionary measure in maintaining good health.

kindly help in completing this questionnaire by answering a few questions about yourself, your occupation, respiratory health and medical history. Your participation is extremely important to the success of this research project.

Your confidentiality would be assured and any information obtained will only be known by the researchers. Information obtained will be reported in statistical summary form only.

Plans for Record Storage and Protection.

All research record and data are protected from accidental loss, inappropriate disclosure, or destruction in order to protect the confidentiality of the study participants' data. Data has been kept in a restricted access on a secure laptop with passcodes with Routine electronic back up. An appropriate safe destruction of data would be employed later.

Plans for record keeping

The study materials; spirometry results, pulse oximetry results, blood pressure results, questionnaires and consent forms were not labeled with participant's names but with a unique identification number for each study participant.

In case of any doubt or questions about the study, or any problems with questions in this questionnaire, please do not hesitate to contact the Principal Investigator whose contact information is provided below.

Thank you for your willingness to participate.

Contact:

Mrs. Sybil Oforiwaa Owusu-Sekyere (PRINCIPAL INVESTIGATOR).

Phone number: 0244136018

Email: Sybil.harrison@yahoo.com

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.



Research & Development Division
Ghana Health Service
P. O. Box MB 190
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Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com
16th April, 2018

MyRef: GHS/RDD/ERC/Admin/App/18/046
Your Ref. No.

Sybil Oforiwaa Owusu-Sekyere
University of Ghana
School of Public Health
Legon, Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

| | |
|------------------|--|
| GHS-ERC Number | GHS-ERC: 030/01/18 |
| Project Title | Cardio-Respiratory Function among Formal Workers at Agbogbloshie E-Waste Recycling Site in Accra |
| Approval Date | 16 th April, 2018 |
| Expiry Date | 15 th April, 2019 |
| GHS-ERC Decision | Approved |

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report **after completion** of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
PROFESSOR MOSES AIKINS
(GHS-ERC VICE-CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra



Figure 3.1 Toxic fumes from e- waste burning