

**UNIVERSITY OF GHANA**  
**SCHOOL OF PUBLIC HEALTH**  
**COLLEGE OF HEALTH SCIENCES**

**CARDIO-RESPIRATORY FUNCTION AMONG FEMALE MOBILE FOOD VENDORS  
AT AGBOGBLOSHIE – A COMPARATIVE ANALYSIS WITH ELECTRONIC WASTE  
WORKERS**

**BY**

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**DECLARATION**

I, Kafui Kesewah Aboagye hereby declare that apart from references to other people's works which have been duly acknowledged, this dissertation is a result of my own independent work under supervision and has not been submitted for the award of any degree in any institution.

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## **DEDICATION**

This work is dedicated to my little princess, Iris Olufunmilayo E.I Omo- Eboh, my amazing parents; Togbe Kwadzo Drah XI and Madam Patience Ananga as well as my entire family for their unflinching love and support

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## ABSTRACT

**Background:** E-waste contains refined mixtures of plastics and chemicals, which can be unsafe for people and the environment when not handled carefully. In developing nations like Ghana where e-waste is ripped to shreds and recycled by bare hands, dangerous substances and plastics are emitted into the atmosphere through air, water, and soil. Workers around e-waste sites and those dismantling and sweltering the electronic waste to salvage valuable metals and other constituents are exposed to unsafe chemicals such as particulate matter, dust from heavy metals and toxic organic compounds found in dust and smoke/fumes, all of which could have a deleterious effect on their health and the environment.

**Objective:** The aim of the study was to conduct a comparative analysis of cardio respiratory function among female mobile food vendors and electronic waste workers at the Agbogbloshie e-waste recycling site.

**Method:** A cross-sectional study was conducted at Agbogbloshie from May to July 2018, among female mobile food vendors and e-waste workers. Cardio respiratory function indices such as Blood pressure, Pulse, Oxygen saturation level and lung function tests were conducted and a structured questionnaire was used to gather demographic data and respiratory symptoms. Statistical analysis was done in STATA software version 15.0. Descriptive statistics including frequency and percentages were done to summarize categorical variables. Chi square analysis was used to assess the prevalence of respiratory symptoms and student T test was used to compare cardio respiratory functions between e-waste workers and female mobile food vendors. A multivariate regression analysis was done to examine the relationship between cardio-respiratory measures, and age and work-related factors

**Results:** Mean age of female mobile food vendors and e-waste workers was  $25.8 \pm 8.4$  and  $25.3 \pm 7.5$  years respectively. Common respiratory symptoms among study participants were sneezing (73.0% vs. 80.4%), easy tiredness (78.4% vs. 80.4%) and colds (78.4% vs. 69.6%). Pulse rate ( $81.4 \pm 13.3$  bpm vs.  $72.1 \pm 11.0$  bpm;  $p=0.0010$ ) and oxygen saturation levels ( $98.3 \pm 1.7$  vs.  $97.3 \pm 1.7$ ;  $p=0.0091$ ) were significantly high in food vendors than in e-waste workers. High blood pressure was more common in e-waste workers (54.1%) than in female food vendors (32.6%) and the means of FEV1/FVC ( $69.5 \pm 19.6$  vs.  $71.4 \pm 18.8$ ;  $p=0.6489$ ) and FEV1/FVC% ( $81.7 \pm 22.9$  vs.  $80.8 \pm 20.8$ ;  $p=0.8512$ ) were statistically similar.

**Conclusions:** This study showed no significant differences in cardio respiratory functions among mobile female food vendors and e-waste workers

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## LIST OF ABBREVIATIONS

As	Arsenic
BP	Blood pressure
BFR	Brominated flame retardants
Cd	Cadmium
Cr	Chromium
CRT	Cathode ray tube
CO	Carbon mono oxide
CVD	Cardio vascular disease
EEE	Electrical and electronic equipment
E-Waste	Electronic waste
ERC	Ethics review committee
Fe	Iron
GHS	Ghana health service
Hb	Haemoglobin
Hg	Mercury
O <sub>3</sub>	Ozone
Pb	Lead
PBB	Polybrominated biphenyls
PBDD/F	Polybrominated dibenzo-p-dioxins and dibenzofuram
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenyls

POP	Persistent organic pollutants
PVC	Polyvinyl chloride
PM	Particulate Matter
PPE	Personal Protective Equipment
Sb	Antimony
Se	Selenium
SPO <sub>2</sub>	Oxygen saturation
WEEE	Waste Electrical and Electronic Equipment

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background of study

Globally, Air pollution levels continue to be a menace as new information shows that in every 10 people, about 9 of them breathe air that comprises an- increased amount of contaminants like black carbon, which permeate into the lungs and cardio vascular system (“WHO | Air pollution,” 2018). Ambient air fumes in both cities and rural areas were thought to have triggered 3 million untimely deaths globally per year in 2012; exposure to minute particulate matter of 10 microns or less in diameter (PM10) may be the basis of these mortalities which cause heart and lung disease, and cancers (WHO, 2016).

There are myriad sources of air contamination including industrial processes, vehicular emissions, agricultural activities and even natural processes. However, over the last two decades, dumping and/or recycling of electronic waste has become major sources of pollution of public health concern (Hoek et al., 2013).

Damaged electronic appliances like personal computers, Television sets, refrigerators and mobile phones are among the rapidly increasing waste stream in the world. They are known as electronic waste (e-waste) and contain over 100 different harmful chemicals that have the potential to contaminate the environment (Baba et al., 2013). The processes used to recover useful metals include open air burning which could result in emission of toxic substances including heavy metals such as Mercury (Hg), Arsenic (As), Lead (Pb), Cadmium (Cd), Hexavalent chromium (Cr), Selenium (Se) Antimony (Sb) and Iron (Fe) and flame retardants (Wu et al., 2011).

Very distinct high deadly contaminants like polychlorinated biphenyls (PCBs) in transformers and capacitors, polybrominated diphenyl ethers (PBDEs), which is a brominated flame retardant in circuit board, and polychlorinated dibenzo-p-dioxins and dibenzo-furans (PCDDs/Fs) as the burned product of PVC in electric wire can be discharged in the process of recycling activities (Wang et al., 2005). A combination of all these have steered to an increase in the level of pollution in the ambient atmosphere, and further threatening the environment and dwellers' health (Wong et al., 2007; Yu et al., 2006; Deng et al., 2006)

It is unfortunate that in most countries in sub-Saharan Africa, there seems to be a gap in legislation and regulation for handling the disposal of e-waste. In this regard, e-waste ends up on the shores of Ghana as second hand electronic equipment (Zheng et al., 2008).

Exposure to the harmful chemicals such as organic toxins, Polyvinyl Chloride (PVC) and Brominated flame retardants (BFRs) and heavy metals found in e-waste can cause serious health effects in humans (Baba et al., 2013).

For example, exposure to heavy metals could affect organs such as the lungs, kidneys, nervous, digestive and immune systems and may also be fatal. In most cases, children and pregnant mothers who are exposed to these heavy metals may be at risk of irreversible neurological damage and hence impede fetal development (WHO, 2014).

A study on human monitoring survey by Asante et al. (2012) reported that workers like e-waste workers had some high amounts of metalloids in their urine samples taken. All these metals have been linked with a lot of health concerns comprising progressive neurotoxicity, immune function, cardiovascular disease, thyroid dysregulation, and impaired liver and renal functions (Clarkson, 2007).

In countries like China and India, there is enough evidence that shows that some activities at electronic waste sites like dismantling and burning, emit dangerous discharges that may have serious damaging health implications (Sepúlveda et al., 2010).

Workers like food vendors, policemen and drivers who come into contact with pollutants from the environment and outdoor pollution, even though they are not keenly observed are of great concern as studies have found a consistent increase in risk of lung cancer, which was seen in a cohort and case control studies in Europe, North America and Asia (Loomis et al., 2013)

This is the first study to describe the cardiorespiratory functions among female mobile food vendors as compared to electronic waste workers at Agbogbloshie.

## **1.2. Problem Statement**

Agbogbloshie electronic waste recycling/dumpsite is recognized as one of the biggest in Africa, and the dominant exposure of concern at Agbogbloshie is the open burning of wires and equipment for copper recovery (Caravanos, Clarke, Osei, & Amoyaw-Osei, 2013). To retrieve reusable parts and metals such as oxidized copper, recyclers adopt traditional methods of dismantling and open-air burning which result in direct pollution of the environment. Due to the nature of recycling processes, e-waste workers are exposed directly to pollutants ranging from harmful fumes, toxic metals and particulate matter. Exposure to these toxic substances could have adverse health effects such as ischemic heart disease, stroke, chronic obstructive pulmonary disease (COPD), lung cancer and acute lower respiratory infections in children (World Health Organisation, 2007). Although, much is known on the circumstances and environmental exposures under which electronic waste workers work in Ghana, no one study has examined their cardio-respiratory health and

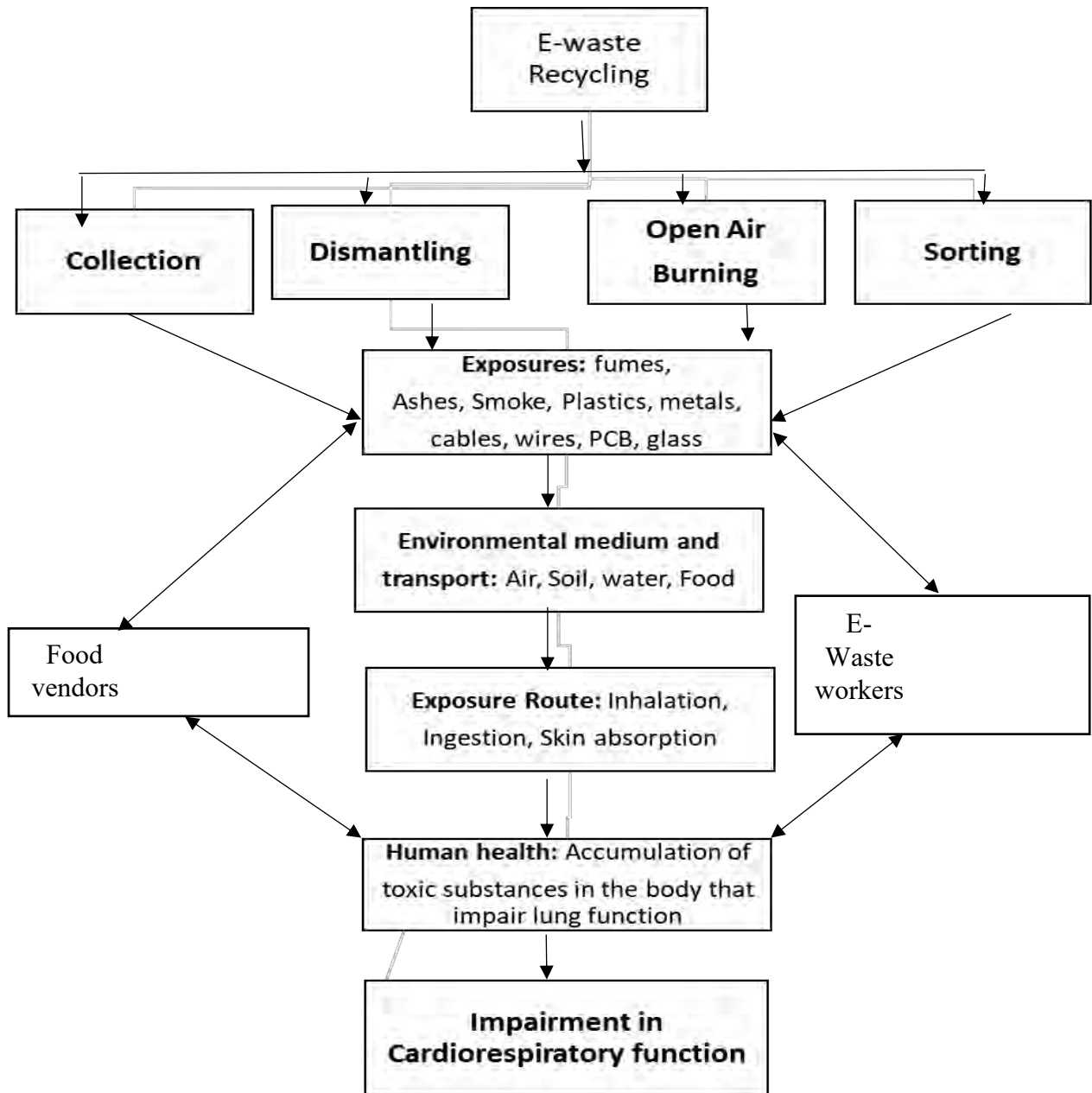
compared them with female mobile food vendors who ply their trade at the electronic waste site. Additionally, even though general pollution at Agbogbloshie is apparent e-waste workers have almost exclusively been the focus of research. However, Agbogbloshie is also home to a large food market, and it is common to find young female adults engaged in the selling of food, fruits, water and drinks. As such, these food sellers are indirectly exposed to ambient pollution which is the outcome of e-waste recycling and vehicular emissions and there is currently no data on the health effects of exposure to e-waste recycling activities among mobile food vendors in Agbogbloshie.

Like e-waste workers, female mobile food vendors work for longer hours, averaging 10 hours a day, and therefore face similar health risks as e-waste workers. In light of this, this research sought to compare the cardiorespiratory functions of both female mobile food vendors and electronic waste workers.

### **1.3. Conceptual Framework**

The traditional recycling of e-waste involves the collection, sorting, dismantling and open-air burning (Akormedi, Asampong, & Fobil, 2013). In the process of dismantling, electronic gadgets are forcefully crushed using manual tools hammers and manual crushers. This process releases particulate matter into the environment. The process of burning to retrieve useful metals such as copper releases toxic fumes, smoke and organic pollutants into the environment, exposing the electronic waste workers who directly work on the electronic waste and the food vendors in the same environment. Exposure may occur through direct deposits and contaminated working gears. Inhalation of harmful chemicals is the main route of exposure among e-waste workers (Zheng et al., 2008) and the food vendors who sell closely with them in the vicinity. When the harmful chemicals are inhaled, toxic substances

are absorbed into the organs by which the respiratory and cardiac organs are also affected by blood circulation causing impairment in lung function and cardio health.



**Figure 1: Conceptual framework of e-waste recycling activities and impact on human health (lung and cardio health)**

#### **1.4. Justification of the Study**

Crude methods have been employed in recycling electronic waste. Over the past few years, the practice of recycling e-waste in Ghana has remained unregulated. The recyclers work with little or no use of personal protective equipment (PPEs). The more e-waste is recycled with no regulation whatsoever, the more the emission of toxic chemicals into the environment. Agbogbloshie is one of the heavily populated areas in Accra, and has one of the biggest open markets for electronic waste recycling in sub-Saharan Africa. This poses a threat to the health of e-waste recyclers and other individuals engaged in economic activities. The population of interest were e-waste workers who comprised mostly men and mobile food vendors who were predominantly females and ply their trade in the same burning area of Agbogbloshie market. This study compared how the burning from electronic waste activities in Agbogbloshie affects cardiorespiratory health and functions of both mobile food vendors and e-waste workers since they are at high risk of developing cardio respiratory diseases that come as a consequence of the exposure to hazardous pollutants.

Air pollution from e-waste recycling activities such as burning is of global public health concern for which policy intervention is urgently required to curtail the harmful effects to human health and environment. Carrying out this academic exercise is significant as this would reinforce the impact of air pollution on public health and safety, sensitize government to enact laws that would monitor and standardize the disposal of these electronic waste and educate these workers on the health effects of air pollution as well as teach them ways to minimize exposure by wearing PPEs.

## **1.5 Study Objectives**

### **1.5.1 General Objective**

To assess the cardio-respiratory function among female mobile food vendors and e-waste workers at Agbogbloshie.

### **1.5.2. Specific Objectives**

1. To determine common respiratory symptoms among female mobile food vendors and e-waste workers at Agbogbloshie.
2. To assess the lung function of female mobile food vendors and e-waste workers using spirometry.
3. To assess the cardiorespiratory health status of female mobile food vendors and e-waste workers by using the digital sphygmomanometer and pulse oximeter.
4. To compare cardiorespiratory functions among female mobile food vendors and e-waste workers.

## **1.6 Research Questions**

1. Are female mobile food vendors at risk of developing respiratory health conditions like e waste workers at Agbogbloshie?
2. What is the lung function of female mobile food vendors compared to e waste workers?
3. What is the cardio respiratory status of female mobile food vendors compared to e-waste workers?

4. Is there any decline in cardiorespiratory function among e-waste workers engaged in e-waste burning as compared to female mobile food vendors who are not directly engaged in e-waste burning?

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Scope of the Review

The review was to lay emphasis on the effects of pollution as a consequence of e-waste recycling activities on cardiorespiratory functions.

#### 2.2 Importance of Recycling E-Waste

A blend of cumulative possession and reduced lifespan has led to the swift evolution in the quantities of undesirable and out-of-date electronics which are generally known as e-waste (Zhang, Schnoor, & Zeng, 2012). These discarded Electrical and Electronic Equipment (EEE) are known harmful waste products which contain valuable components that have economic value if recycled (Perkins, Drisse, Nxele, & Sly, 2014). Some of these e-waste products contain valuable elements such as indium and palladium and precious metals such as gold, silver and copper (Akormedi et al., 2013). For this reason, most developed countries have formulated laws, rules and regulations to monitor and standardize the disposal of these electronic waste (Sthiannopkao & Wong, 2013). The design of new methods and structures for electronic waste collection, recycle and reuse will reduce environmental impacts of improper e-waste recycling (Kahhat et al., 2008) such as the release of a lot of toxicants including heavy metals, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs) and polybrominated dibenzo-p-dioxins as well as dibenzofurans (PCDD/Fs) into the ambient environment as stated in a study on evidence for main emissions of PCBs in the West African Region (Gioia et al., 2011).

### **2.3 Health Effects of Improper E-waste Recycling**

The wellbeing of humans is seriously jeopardized by exposure to electronic waste activities through exposure routes such as inhalation, dust ingestion and skin absorption (Leung, Duzgoren-Aydin, Cheung, & Wong, 2008).

A number of investigations have shown relationships between exposure to e-waste and physical health effects, including thyroid function, reproductive health, lung function, growth, and changes to cell functioning (Grant et al., 2013). There have also been steady effects of exposure with an increase in spontaneous abortions (Bach et al., 2015), stillbirth (Bach et al., 2015; Xu, Zeng, Boezen, & Huo, 2015) and birth length. A study that was carried out to ascertain the association between exposure to heavy metals (such as chromium, manganese and nickel) and lung function in school children in an e-waste dismantling site showed a lower forced vital capacity (FVC) than those living in a control town with no indication of e-waste recycling activities (Guan, Zheng, Chung, & Zhong, 2016).

Electrical and electronic equipment (EEE) such as TV sets, video and computer monitors use cathode ray tubes (CRTs), which have substantial volumes of lead and the long-term exposure to these materials can cause destruction to the nervous system, the kidney, the respiratory system, bones and the endocrine system (Liu et al., 2008; Zheng et al., 2008).

Research by (Caravanos, Clark, Fuller, & Lambertson, 2011) mentions that the burning of plastics are known to produce polycyclic aromatic hydrocarbons and respiratory irritant gases such as hydrochloric acid which is believed to be carcinogenic.

### **2.4 Impact of E-Waste Recycling on Cardio-respiratory Functions**

Electronic waste comprises valuable metals (Cu, platinum group) as well as possible ambient pollutants, especially Pb, Sb, Hg, Cd, Ni, polybrominated diphenyl ethers (PBDEs), and

polychlorinated biphenyls (PCBs). Sweltering Electronic waste may produce dioxins, furans, polycyclic aromatic hydrocarbons (PAHs), polyhalogenated aromatic hydrocarbons (PHAHs), and hydrogen chloride (Robinson, 2009). A lot of studies has been done on the consequences of air pollution in recent years and there is enough evidence that suggests that contact to contaminants such as aerial particulate matter and ozone has been linked with a rise in hospital admissions and deaths due to lung and heart diseases (Brunekreef & Holgate, 2002). Other studies have made available significant information that short-term exposure to particulate matter is linked with the rise in cardiorespiratory death and a whole lot of harmful respiratory effects such as reduced lung function and increased inflammation (Stafoggia et al., 2014; Stieb et al., 2017).

A study by (Newell, Kartsonaki, Lam, & Kurmi, 2017) on health outcomes of particulate ambient air contamination exposure in low and middle income countries showed an association between short-term exposure and cardiorespiratory consequences with a greater risk for mortality and morbidity than long-term ambient air pollution exposure, which appeared to be steadily linked with a greater risk for cardiovascular death.

## **2.5 Impact of E-waste Recycling on Respiratory Health**

Air pollution levels continue to be at an alarmingly high rate globally, as current information shows that for every 10 people, 9 breath in air that contains an increased level of pollutants like black carbon which is capable of infiltrating the lungs and cardiovascular system (“WHO | Air pollution,” 2018).

Developing countries like Ghana could be more exposed to lifelong, transgenerational health risks from the emission of electronic waste’s chemicals (Nartey, Vincent Nartey, & Nartey, 2016) as the processes involved in the informal running of e-waste including discarding into

landfills or burning in open space, exposing the general inhabitants and cohorts to extremely lethal chemicals through inhalation (Labunska, Santillo, Johnston, & Brigden, 2008). The open air burning releases pollutants into the environment and the air being polluted is a significant environmental risk factor with worldwide public health repercussions (Okada, 2014).

The World Health Organization (WHO) approximates that open-air pollution may have instigated 3.7 million premature deaths worldwide in 2012 (WHO, 2012). Set that older people breathes in normally about 10–15 m<sup>3</sup> of air per day, it is apparent that inhalation represents an essential exposure route to airborne pollutants in human (Roy, Reed, & Hutt, 2010). It has been discovered that even though the most familiar cause of lung cancer is long-term exposure to tobacco smoke, a predictable 10–25% of cases globally occur in never smokers (Couraud, Zalcmán, Milleron, Morin, & Souquet, 2012) It is extensively acknowledged that exposure to ambient concentrations of air contaminants can cause short-term severity in those who previously had respiratory allergies (i.e. asthma and rhinitis) as asthma aggravation counted as emergency departments visits have been often reported on days with greater levels of O<sub>3</sub> and other contaminants (Roy et al., 2010).

Studies conducted on the effect of PM on respiratory function also show that an increase in PM concentrations was strongly linked with decreases in pulmonary function for both acute and chronic exposures (Downs et al., 2007; Gauderman et al., 2007; McCreanor et al., 2007; Chang et al., 2012).

(Cesaroni et al., 2013) in their study also revealed that area based discharges of PM, among different indices of exposure to traffic related air pollution, were steadily linked with an increase in the risk of rhinitis or common colds in grown persons, especially among non

smokers, while results of Asthma were weak. Another study by (Weinmayr, Romeo, De Sario, Weiland, & Forastiere, 2010) established strong indication of effects of PM on the occurrence of asthma attacks and to a smaller degree on cough and peak expiratory flow (PEF).

## **2.6. Effects of PM and Heavy Metals Exposure on Cardiorespiratory Function**

### **2.6.1 Heavy Metals Exposure and Cardiorespiratory Function**

Exposure to non-essential heavy metals such as cadmium, mercury, lead, vanadium, platinum and palladium are likely to cause acute and chronic organ toxicity (Tintinger GR, 2011). Although cigarette smoking has been attested to be the key cause of lung cancer, recent studies have found other agents such as work-related exposure to heavy metals or asbestos, enclosed exposure to radon gas radiation and particulate air pollution (Stafoggia et al., 2014) to be associated to its development (Spyratos et al., 2014).

Cigarette smoking is a renowned source of exposure to heavy metals such as cadmium, lead and vanadium and a recognized risk for growth of respiratory bacterial infections including Tuberculosis (TB) and severe Pneumococcal disease (Brunet et al., 2011).

Repeatedly in the researches of (Agarwal, Zaman, Murat Tuzcu, & Kapadia, 2011; Menke, Muntner, Batuman, Silbergeld, & Guallar, 2006), there is enough evidence to show that heavy metals were linked to cardiovascular health. Additional studies have confirmed that cadmium (Franceschini et al., 2017; Tellez-Plaza, Jones, Dominguez-Lucas, Guallar, & Navas-Acien, 2013), lead (Nawrot & Staessen, 2006), arsenic (Menke et al., 2006), antimony (Shiue, 2014) and tungsten (Shiue & Hristova, 2014) levels are associated with hypertension, peripheral artery disease and risk of Cardiovascular diseases.

### **2.6.2. Particulate Matter (PM) Exposure and Cardio respiratory Functions**

World Health Organization (WHO) believes that around 7 million persons perish yearly from exposure to fine particles in the contaminated air that leads to ailments such as stroke, heart diseases, lung cancer, chronic obstructive pulmonary disease (COPD) and respiratory infections including pneumonia (“WHO | Air pollution,” 2018). Particulate Matter (PM), is related with the most dangerous air pollution-induced health effects and the effects of PM on the body could be determined by the size, related to its aerodynamic diameter (Daum, Stoler, & Grant, 2017; Robinson, 2009).

Governments and health organizations globally are more concerned of the ill effects of exposure to Particulate matter (PM) with a median aerodynamic diameter less than 2.5 $\mu$ m (PM<sub>2.5</sub>) and less than 10 $\mu$ m (PM<sub>10</sub>) (Halonen et al., 2009). PM with an aerodynamic size of 2.1 and 0.1 are very fine particles that may penetrate the lining of the lung alveoli and enter the bloodstream, causing cardiorespiratory morbidity and mortality (Brook et al., 2010). Even though coarse or granular particles PM<sub>10</sub> could be sifted out by the body’s protection structure and are too big to pass over alveolar epithelial cells, they have the ability to cause both pulmonary and systemic inflammatory reactions and change heart function (Wu et al., 2011).

In the study by (Halonen et al., 2009), they found out that, most particle fractions had positive relations with hospital stays for pneumonia, asthma and COPD among the elderly.

### **2.7. Differential Health Impact of Smoke from E-waste on Males and Females**

Females may be more naturally vulnerable to the ill effects of smoke than males due to the difference in metabolism (Punturieri, Szabo, Croxton, Shapiro, & Dubinett, 2009).

The airways of females are anatomically smaller and the pollutants in smoke may pose a great exposure (Aryal, Diaz-Guzman, & Mannino, 2014).

Other biological factors that may determine a sex difference in the effect of smoke exposure may be immunological, hormonal and dimensional (Becklake & Kauffmann, 1999).

A study by (Sørheim et al., 2010) found that the consequences of smoke exposure on lung function may be dissimilar by sexual characteristics as the female gender was related with lung function decrease and were more prone to lung-damaging effects of smoke at even lower levels of exposure. (Yunginger et al., 1992) explains in a study how females have a marginally greater airway reactivity than males as well as minor airways; hence the dose-response relativity might be perceived more early in women than in men (Chen et al., 2012).

## **2.8. Effect of Cigarette smoking on Cardio respiratory Health**

Cigarette smoking harms nearly every organ in the body, causes many diseases and reduces the health of smokers in general. While the adverse effects of cigarette on lung health are well established, it is becoming more evident that smoke has an important extra pulmonary toxicity (G, A, C, Geertjan, & M, 2007).

Cigarette smoking significantly increases the risk of heart diseases, lung cancer and microbial infections such as respiratory infections hence making cigarette smokers have a higher prevalence of heart and lung diseases (Janson et al., 2001).

In a study to estimate the risk of lung cancer in lifelong nonsmokers exposed to environmental tobacco smoke by (Hackshaw, Law, & Wald, 1997), there was enough epidemiological and biochemical evidence that exposure to environmental tobacco smoke is a probable cause of lung cancer as this was confirmed with supporting evidence of tobacco

specific antigens found in the blood and urine of nonsmokers exposed to environmental tobacco smoke.

Although the health risks of cigarette smoking are well documented, there is however increasing evidence that smokers have a lower incidence of some inflammation and neurodegenerative disease (Sopori, 2002).

## CHAPTER THREE

### METHODOLOGY

#### 3.1 Overview

Chapter three outlines the various methods used in this study; giving descriptions of the study area, study design, sampling methods, study procedures, data collection tools and data analysis as well as ethical considerations

#### 3.2 Study Area

Agbogbloshie e-waste disposal site (fig. 2) is one of the prime electronic waste recycling sites in Sub-Saharan Africa (Akormedi et al., 2013) sited in a suburb of Accra, the capital of Ghana. The site is positioned on the bank of the Odaw River and in the upper reaches of the Korle-Lagoon. It is one of the biggest electronic waste dumpsite in sub-Saharan Africa, handling millions of heaps of e-waste each year. Agbogbloshie site started as a foodstuff market for onions and yam but has grown into a slum over the past years with people trading in all kinds of metal scrap and e-waste. Electrical and electronic equipment from households and offices end up there every month as a final resting place, where they are smashed apart to retrieve copper and other metallic constituents that can be sold (Akormedi et al., 2013). About 40,000 people live in this area under the most terrible environmental circumstances and mainly represent a migrant population from Northern parts of Ghana (Mcmichael, Barnett, & Mcmichael, 2012).



*Figure 2: An aerial photograph showing Agbogbloshie scrap yard where e-waste recycling including open air burning takes place, Accra. Source: [retroworksblogspot.com](http://retroworksblogspot.com).*

### **3.3 Study Design**

A cross-sectional study was conducted using a quantitative approach from May to July 2018 to determine the cardio-respiratory function among female food vendors and e-waste workers at Agbogbloshie.

### **3.4 Source/ Study population**

The study population included electronic waste (e-waste) workers and female mobile food vendors at Agbogbloshie, a suburb of Accra in the Greater Accra Region of Ghana. E-waste workers were chosen because they were exposed to the dangers of e-waste products and also

mostly men. Female mobile food vendors were also chosen because the mobile food vendors were predominantly females and sell in close proximity around the e-waste site and equally exposed to the hazards of e-waste products.

#### **3.4.1. Inclusion Criteria**

- Adult men and women between the ages of 18 and 50 years who are electronic waste workers and mobile food vendors in Agbogbloshie.
- Participants should have worked at least 6 months or more in Agbogbloshie
- Female mobile food vendors and electronic waste workers should not be on any medication for cardiorespiratory disorders.
- Participants should not also have any history of cardiorespiratory disorders prior to working in Agbogbloshie.

#### **3.4.2. Exclusion Criteria**

- Female mobile food vendors and electronic waste workers in Agbogbloshie outside the age brackets (18-50) years.
- Participants who have worked for less than 6 months in Agbogbloshie.
- Female mobile food vendors and e waste workers who have a history of cardio respiratory disorders or on medication for cardio respiratory disorders, prior to working in Agbogbloshie.
- Persons who are not willing or able to comply with study procedures will not be part of the study

### **3.5. Study participants recruitment**

The total number of e-waste workers and food vendors at Agbogbloshie is unknown. Based on previous studies among e-waste workers by Asante et al., 2012; Feldt et al., 2014; and Wittsiepe et al., 2015), 83 participants comprising 36 e-waste workers and 47 food vendors were selected. Each of the e-waste workers and female mobile food vendors at the site was approached during their normal working activities by the principal investigator and four research assistants, and those who satisfied the inclusion criteria and consented to take part in the study were recruited. Recruitment of the e-waste workers was done with consent and support of the front-runners of the Greater Accra Scrap Dealers Association who oversee the operations of e-waste and metal scrap recycling at the Agbogbloshie.

### **3.6 Variables of interest**

The variables measured in the study were categorized into dependent and independent variables

#### **3.6.1 Dependent Variables –**

The dependent variable is the cardio-respiratory function (lung function) among female mobile food vendors and electronic waste workers, Respiratory function variables, cardiovascular variables: Systolic and diastolic blood pressure, pulse rate,

#### **3.6.2 Independent Variables –**

The independent variables for the study include Socio-Demographic characteristics (age, religion, marital status) and Anthropometry measurements: (Height, and weight)

#### **3.6.3 The confounding factors –**

Age, sex, cigarette smoking, alcohol intake, educational level, home exposures and marital status.

### **3.7 Study Procedures**

Approval of the study was sought from the Ghana Health Service Ethics Review Committee (GHS-ERC). Approval was attained from the Ghana Association of scrap metal dealers, and from the various leaders of food vendors at the dumpsite.

The research was explained, clearly, to all participants. The pretested questionnaires were administered by both the researcher and trained research assistants in the language the participant best understood after their consent was obtained. An information sheet which contained information about the benefits, risks and the procedures involved in the research was read out and clarified to each participant before they appended their signatures or thumbprints. They had the liberty to ask questions and to seek clarifications or withdraw unconditionally.

The questionnaire addressed health issues focused on cardiorespiratory health, lifestyle and habits, workplace hazards and exposures as well as health and safety at the workplace.

Following this, the participants undertook anthropometric measurements to obtain height, weight and BMI. Cardiac and lung function measurement using the spirometer, digital sphygmomanometer and pulse oximeter was performed by Principal Researcher who is a qualified clinician. The forced vital capacity (FVC) and Forced Expiratory Volume in one second (FEV1) were measured as well as the blood pressure, pulse and oxygen saturation levels.

The participants performed the spirometry manoeuvre for at least three intervals to meet reproducibility criteria and the best effort was used for the analysis.

### **3.8 Data Collection Tools**

The data collection tools included a structured questionnaire, spirometer for lung function measurement, digital sphygmomanometer and pulse oximeter for cardiac function measurement, a weighing scale and a stadiometer for standing height measurement.

#### **3.8.1 Questionnaire**

A structured questionnaire was prepared for both food vendors and e-waste workers. The questionnaire collected data on the socio-demographic characteristics, work-related history and the cardio-respiratory symptoms of the respondents. The questionnaire also assessed information on hazard exposures, and the use of personal protective equipment (PPEs). Lastly, the questionnaire also assessed information on cardio respiratory symptoms of the female food vendors and e-waste workers.

#### **3.8.2 Spirometer**

The NDD EasyOne Plus is a diagnostic spirometer that was used for the measurement of lung function (FVC, FEV1 and FEV1/FVC ratio). The NDD EasyOne Plus spirometer is a portable, easy to use and read, rechargeable, battery powered equipment with disposable mouthpieces. Its major advantages are that it offers a mechanical assessment to projected values, pre and post bronchodilator comparisons, and test quality control that automatically assesses quality control, which spontaneously evaluates patient effort and displays easy to understand messages that aid in patient instruction. It also offers a built-in high-resolution printer and the option to print on external printers using a USB connection and the full flow volume and volume time curves allow for inspection of manoeuvres as you follow test-quality prompts on the screen. An additional advantage is that it can store up to 6,000 readings. The spirometer was used in conjunction with a stadiometer and a weighing scale for the measurement of weight and height required for performing accurate spirometry.

### **3.8.3 Digital BP Monitor**

The Omron digital BP monitor, a portable automatic digital machine that measures blood pressure very accurately by self-inflation was used for checking the blood pressure of participants. It assures consistent accuracy from any position around the upper arm and can also detect irregular heartbeat. It is clinically validated because its accuracy has been put under vigorous testing procedures by major health organizations. It is also a rechargeable, battery powered equipment, which is easy to read and use.

### **3.8.4 Pulse Oximeter**

The pulse oximeter is a small, clip like device that is attached to the finger and was used to measure oxygen saturation levels in the blood of participants. It is a non-invasive and painless test that can easily perceive even the small changes in how proficiently oxygen is being carried to the extremities furthest from the heart. The device is also battery powered and able to measure heart rate as well.

## **3.9 Clinical Examination**

### **3.9.1 Anthropometric measurements**

The weight and height of the respondents were measured using Seca stadiometer with an incorporated weighing scale. The weight was measured while wearing light clothes, without shoes and recorded in kilograms (kg). Height was measured without shoes and recorded in meters (m).

### **3.9.2 Cardiovascular variable measurements**

The blood pressure and heart rate were measured in both e-waste workers and the food vendors. Arterial systolic blood pressure and diastolic blood pressure, as well as pulse rate, were measured using a digital Sphygmomanometer and pulse oximeter.

To measure the BP, the left arm was placed at the level of the heart in the sitting position. The measurement was done three times and the average documented as the final systolic and diastolic blood pressure. The average pulse rate for each of them was also recorded. Pulse Oximetry was used to measure the oxygen saturation (%SPO<sub>2</sub>). Cardiovascular variable measurements were performed according to the American Heart Foundation Guidelines/AHA (2015).

### **3.9.3 Lung function measurement (Spirometry)**

Lung function measurements were performed according to the guidelines of the American Thoracic Society/ERS (1995). Standing height in meters and weight in kilograms were measured preceding the performance of the lung function test as measurement of stature is a requirement for the determination of the normal lung function and reference equations are grounded on stature (standing height) (Renstrøm, Andersen, Pedersen, & Madsen, 2012). The Leicester stadiometer was used to measure the height of the participants in the standing position without shoes on and the shoulders in an upright position. After data entry, the participants were assisted to perform manoeuvres for measuring forced vital capacity, vital capacity and maximum ventilation volume. Computation of lung function volumes was based on variations in the height, age, sex and respiratory history of respondents.

## **3.10 Data quality assurance**

### **3.10.1 Pre-testing**

The questionnaire was pre-tested at the Abokobi land fill site with 10 e-waste workers and 10 mobile female food vendors who share similar characteristics; to test for legitimacy and reliability of the instruments. Identified anomalies in the questionnaire were corrected before the final data collection.

### **3.10.2 Validity and reliability**

Four research assistants were recruited for the study. They were all certified health personnel who were trained intensively for two days on the techniques of questionnaire administration for quantitative data collection, on the ethical guidelines, the assessment of cardiorespiratory function and data entry. They assisted in the administration of the questionnaires and the assessment of lung function. Questionnaires returned were checked for mistakes and completeness.

All the information on the questionnaire was entered into an Excel spreadsheet. Data entered were cleaned to check for consistency and accuracy and were edited to control the quality of the collected data. Entered Excel data were exported into Stata version 15.0.

### **3.11 Data Analysis**

Data collected were analyzed in STATA version 15.0. Descriptive statistics including frequency and percentages were done to summarize categorical variables. Graphical representation of data was done to improve the clarity of data. Chi-square analysis was used to evaluate the prevalence of respiratory symptoms and diseases/conditions in E-waste workers and female food vendors. Continuous variables (anthropometric variables, and cardio-respiratory function variables) were summarized in mean with standard deviation and were compared between E-waste workers and food vendors by independent sample t-test. Multivariate regression was used to study the relationship between cardiorespiratory indices and age and work-related factors. A  $p < 0.05$  was set as the significant level for all statistical procedures.

### **3.12 Ethical Consideration**

The study was approved and ethical clearance was given by the Ghana Health Service Ethics Review Committee (GHS-ERC025/01/18). Approval was also obtained from the Ghana Association of scrap metal dealers, and from the various leaders of food vendors at the dumpsite. The objective and rationale for the study were explained to respondents and a written informed consent obtained before they were registered in the study. Involvement in the study was voluntary and the participants could opt out of the study at any point if they wish to do so without any deleterious consequences on them.

#### **3.12.1 Privacy and confidentiality**

All information provided by the respondents and research records were protected from accidental loss, inappropriate disclosure, or destruction to protect the confidentiality of the study participants' data. Data were kept under restricted access on a secure laptop with passcodes. The study materials; spirometry results, questionnaires and consent forms were labelled with a unique identification number for each study participant and their names of the participants were never used in any part of the study reports.

## CHAPTER FOUR

### RESULTS

#### 4.1 Background characteristics of respondents

Table 4.1 presents the background characteristics of the study respondents. A total of 83 respondents (46 food vendors and 37 E-waste workers) were included in the study. The mean age of the mobile food vendors was  $25.8 \pm 8.4$  years whereas that of the E-waste workers was  $25.3 \pm 7.5$  years. All mobile food vendors were females whereas the e-waste workers were males. Majority of the mobile food vendors and e-waste workers were single (72.6% vs 73.0%). Most of the mobile food vendors were Christians (71.7%) compared to e-waste workers who were mostly Muslim (59.5%). More of the e-waste workers had attained a Senior High School education compared to the food vendors (21.6% vs 17.4%). Cigarette smoking was prevalent among the e-waste workers (35.1% vs 0.0%) and they had more relatives who were smokers (70.3% vs 19.6%) compared to the mobile food vendors. More e-waste workers were current (24.3% vs 4.3%) or previous (5.4% vs 0.0%) alcohol users compared to food vendors. More e-waste workers were on recreational drugs compared to food vendors (32.4% vs 0.0%). More e-waste workers than food vendors work for over 8 hours per day (78.4% vs 34.8%), 6-7 days per week (97.3% vs 58.7%) and had worked for over 5 years (43.2% vs 8.7%).

**Table 4. 1: Background characteristics of respondents (n=83)**

<b>Characteristics</b>	<b>Total, n(%)</b>	<b>E-waste workers, n(%)</b>	<b>Food vendors, n(%)</b>
Age in years( <i>Mean</i> + <i>SD</i> )	25.6 $\pm$ 8.0	25.3 $\pm$ 7.5	25.8 $\pm$ 8.4
<b>Sex</b>			
Male	37(44.6)	37(100.0)	
Female	46(55.4)		46(100.0)
<b>Marital status</b>			
Single	59(71.1)	27(73.0)	32(72.6)
Married	18(21.7)	10(27.0)	8(17.4)
Divorced	4(4.8)	0(0.0)	4(8.7)
Co-habiting	2(2.4)	0(0.0)	2(4.3)
<b>Religion</b>			
Christian	48(57.8)	15(40.5)	33(71.7)
Muslim	35(42.2)	22(59.5)	13(28.3)
<b>Educational level</b>			
No formal education	19(22.9)	6(16.2)	13(28.3)
Primary	20(24.1)	13(35.1)	7(15.2)
Junior High School	28(33.7)	10(27.0)	18(39.1)
Senior High School	16(19.3)	8(21.6)	8(17.4)
<b>Smoking status</b>			
Smoker	13(15.7)	13(35.1)	0(0.0)
Non-smoker	70(84.3)	24(64.9)	46(100.0)
<b>Relative smokers</b>			
Yes	35(42.2)	26(70.3)	9(19.6)
No	48(57.8)	11(29.7)	37(80.4)
<b>Alcohol use</b>			
Current user	11(13.3)	9(24.3)	2(4.3)
Never	70(84.3)	26(70.3)	44(95.7)
Previous user	2(2.4)	2(5.4)	0(0.0)
<b>Recreational drugs</b>			
Yes	12(15.6)	12(32.4)	0(0.0)
No	65(84.4)	25(67.6)	46(100.0)
<b>Years of work</b>			
6months-1 year	29(34.9)	10(27.0)	19(41.3)
2-3 years	26(31.3)	7(18.9)	19(41.3)
4-5 years	8(9.6)	4(10.8)	4(8.7)
Over 5 years	20(24.1)	16(43.2)	4(8.7)
<b>Hours of work per day</b>			
< 4 hours	4(4.8)	0(0.0)	4(8.7)
4-5 hours	10(12.0)	0(0.0)	10(21.7)
6-7 hours	12(14.5)	2(5.4)	10(21.7)
8 hours	12(14.5)	6(16.2)	6(13.0)
Over 8 hours	45(54.2)	29(78.4)	16(34.8)
<b>Number of working days</b>			
3 days	2(2.4)	0(0.0)	2(4.3)
4 days	6(7.2)	0(0.0)	6(13.0)
5 days	12(14.5)	1(2.7)	11(23.9)
6-7 days	63(75.9)	36(97.3)	27(58.7)

## 4.2 Prevalence of respiratory symptoms

Table 4.2 shows the prevalence of respiratory symptoms experienced by the food vendors and e-waste workers within the last few months prior to the interview. More of the e-waste workers experienced excessive phlegm discharge (83.8% vs 58.7%;  $p=0.013$ ), and chest pain (64.9% vs 34.8%;  $p=0.006$ ) compared to the food vendors. Sneezing (78.3% vs 73.0%;  $p=0.576$ ), easy tiredness (80.4% vs 78.4%;  $p=0.818$ ), and cold (69.6% vs 78.4%;  $p=0.366$ ) were equally common in both food vendors and e-waste workers. Difficulty in breathing was more common in food vendors than in E-waste workers (43.5% vs 24.3%;  $p=0.164$ ).

**Table 4. 2: Prevalence of respiratory disease symptoms**

Symptoms	Total, n(%)	E-waste workers	Food vendors	Chi-square $p$ -value
Cough	52(62.7)	22(59.5)	30(65.2)	0.590
Cold	61(73.5)	29(78.4)	32(69.6)	0.366
Sneezing	63(75.9)	27(73.0)	36(78.3)	0.576
Easy tiredness	66(79.5)	29(78.4)	37(80.4)	0.818
Chest pain	40(48.2)	24(64.9)	16(34.8)	0.006*
Sore throat	38(45.8)	17(46.0)	21(45.7)	0.979
Excessive phlegm	58(69.9)	31(83.8)	27(58.7)	0.013*
Itchy ears and throat	49(59.0)	24(64.9)	25(54.5)	0.333
Itchy and watery eyes	53(63.9)	27(73.0)	26(56.5)	0.121
Wheezing	16(19.3)	7(18.9)	9(19.6)	0.941
Short breath	27(32.5)	10(27.0)	17(37.0)	0.337
Difficulty in breathing	29(34.9)	9(24.3)	20(43.5)	0.069
Skin diseases	36(43.4)	18(48.7)	18(39.1)	0.384

\* $p<0.05$

### 4.3 Cardiorespiratory health status of E-waste workers and food vendors

The cardiorespiratory health status of e-waste workers and food vendors are presented in Table 4.3. The mean weight ( $66.8 \pm 8.1$  kg vs  $60.6 \pm 11.3$  kg;  $p < 0.0001$ ) and height ( $1.7 \pm 0.1$  m vs  $1.6 \pm 0.1$  m;  $p = 0.0066$ ) were significantly higher in e-waste workers than in food vendors. The systolic blood pressure was significantly higher in E-waste workers compared to the food vendors ( $124.1 \pm 14.5$  vs  $116.3 \pm 14.2$ ;  $p = 0.0164$ ), but diastolic blood pressure was similar among the E-waste workers and food vendors ( $76.8 \pm 9.6$  mmHg vs  $76.0 \pm 10.9$  mmHg;  $p = 0.7219$ ). About 42% of the participants had high blood pressure. Pulse rate ( $81.4 \pm 13.3$  bpm vs  $72.1 \pm 11.0$  bpm;  $p = 0.0010$ ) and oxygen saturation levels (SpO<sub>2</sub>) ( $98.3 \pm 1.7$  vs  $97.3 \pm 1.7$ ;  $p = 0.0091$ ) were significantly higher in food vendors than in E-waste workers. Majority of the participants had normal pulse (88.0%) and oxygen saturation levels (95.2%).

The means of FVC ( $4.2 \pm 1.9$  vs  $2.8 \pm 1.3$ ;  $p = 0.0001$ ), FVC% ( $100.9 \pm 41.1$  vs  $80.0 \pm 25.4$ ;  $p = 0.0057$ ), FEV<sub>1</sub> ( $3.3 \pm 3.4$  vs  $2.0 \pm 0.9$ ;  $p = 0.0192$ ) and FEV<sub>1</sub>% ( $77.9 \pm 19.5$  vs  $65.8 \pm 20.0$ ;  $p = 0.0070$ ) were significantly higher in E-waste workers than in food vendors. The means FEV<sub>1</sub>/FVC ( $69.5 \pm 19.6$  vs  $71.4 \pm 18.8$ ;  $p = 0.6489$ ) and FEV<sub>1</sub>/FVC% ( $81.7 \pm 22.9$  vs  $80.8 \pm 20.8$ ;  $p = 0.8512$ ) were similar in e-waste workers and food vendors. More than half of participants (59.0%) had abnormal FEV<sub>1</sub>/FVC whereas about 65% of them had normal FEV<sub>1</sub>/FVC%. There were no differences in the lung function between food vendors and e-waste workers.

**Table 4. 3: Cardiorespiratory health status of e-waste workers and food vendors**

<b>Signs</b>	<b>Total, n(%)</b>	<b>E-waste workers, n(%)</b>	<b>Food vendors, n(%)</b>	<b>p-value</b>
<b>Weight (kg)</b>	63.3+10.4	66.8+8.1	60.6+11.3	0.0066*
<b>Height (m)</b>	1.6+0.1	1.7+0.1	1.6+0.1	<0.0001*
<b>BMI (kg/m<sup>2</sup>)</b>	38.4+5.6	39.4+4.4	37.5+6.3	0.1190
Overweight	6(7.2)	1(2.7)	5(10.9)	
Obese	77(92.8)	36(97.3)	41(89.1)	0.153
<b>Systolic BP (mmHg)</b>	119.7+14.8	124.1+14.5	116.3+14.2	0.0164*
<b>Diastolic BP (mmHg)</b>	76.4+10.3	76.8+9.6	76.0+10.9	0.7219
<b>Hypertension</b>				
Normal	35(42.2)	11(29.7)	24(52.2)	
Pre-hypertension	13(15.6)	6(16.2)	7(15.2)	0.095
Hypertension	35(42.2)	20(54.1)	15(32.6)	
<b>Pulse (bpm)</b>	77.2+13.1	72.1+11.0	81.4+13.3	0.0010*
Normal	73(88.0)	32(86.5)	41(89.1)	0.713
Abnormal	10(12.0)	5(13.5)	5(10.9)	
<b>SpO<sub>2</sub></b>	97.9+1.8	97.3+1.7	98.3+1.7	0.0091*
Normal	79(95.2)	35(94.6)	44(95.7)	0.823
Abnormal	4(4.8)	2(5.4)	2(4.3)	
<b>Lung function</b>				
<b>FVC</b>	3.4±1.8	4.2±1.9	2.8±1.3	0.0001*
<b>FVC%</b>	89.3±34.7	100.9±41.1	80.0±25.4	0.0057*
<b>FEV<sub>1</sub></b>	<b>2.6±2.4</b>	<b>3.3±3.4</b>	<b>2.0±0.9</b>	<b>0.0192*</b>
<b>FEV<sub>1</sub>%</b>	71.2±20.5	77.9±19.5	65.8±20.0	0.0070*
<b>FEV<sub>1</sub>/FVC</b>	<b>70.6±19.0</b>	<b>69.5±19.6</b>	<b>71.4±18.8</b>	<b>0.6489</b>
Normal	34(41.0)	15(40.5)	19(41.3)	0.944
Abnormal	49(59.0)	22(59.5)	27(58.7)	
<b>FEV<sub>1</sub>/FVC%</b>	81.2±21.6	81.7±22.9	80.8±20.8	0.8512
Normal	54(65.1)	25(67.6)	29(63.0)	0.667
Abnormal	29(34.9)	12(32.4)	17(37.0)	

\*p&lt;0.05

#### **4.4 The relationship between cardio-respiratory indices, and age and work-related factors**

A multivariate regression was done to examine the relationship between cardio-respiratory measures, and age and work-related factors. The results are shown in Table 4.4 and 4.5. The multivariate regression revealed that there was no significant correlation between the respiratory measures, and age and work-related factors among both the study groups (see Table 4.5).

**Table 4.4 The relationship between cardiovascular measures, and age and work-related factors**

Factors	Multivariate regression, coefficient(p-value)							
	Systolic BP		Diastolic BP		Pulse		SPO2	
	e-waste	Food vendor	e-waste	Food vendor	e-waste	Food vendor	e-waste	Food vendor
Age	-0.11(0.769)	0.20(0.435)	0.42(0.094)	0.06(0.759)	0.14(0.616)	0.43(0.067)	0.02(0.686)	0.01(0.965)
Working hours per day	-0.31(0.948)	1.01(0.517)	-1.68(0.596)	1.09(0.095)	3.18(0.388)	0.45(0.752)	-0.21(0.724)	-0.02(0.906)
Working days per week	-15.64(0.304)	1.20(0.630)	-11.33(0.261)	-0.68(0.722)	-13.54(0.248)	-3.26(0.155)	-0.74(0.700)	0.34(0.253)
Duration of working	-2.89(0.208)	-3.50(0.141)	-1.02(0.495)	-3.04(0.095)	-2.40(0.174)	1.36(0.524)	0.13(0.650)	0.18(0.511)

p&lt;0.05

**Table 4.5 The relationship between respiratory measures, and age and work-related factors**

Factors	Multivariate regression, coefficient(p-value)			
	FEV1/FVC		FEV1/FVC%	
	e-waste	Food vendor	e-waste	Food vendor
Age	-0.19(0.710)	-0.09(0.796)	-0.10(0.870)	0.13(0.740)
Working hours per day	3.79(0.577)	-0.85(0.692)	4.38(0.583)	-1.37(0.563)
Working days per week	-14.89(0.489)	1.71(0.616)	-17.82(0.480)	2.15(0.568)
Duration of working	-0.88(0.783)	1.58(0.624)	-0.98(0.794)	1.81(0.610)

p&lt;0.05

## CHAPTER FIVE

### DISCUSSION

#### **5.1. Summary of main findings**

The study assessed the cardiorespiratory functions among female mobile food vendors and electronic waste workers at Agbogbloshie e-waste dump site in Accra. Sneezing, easy tiredness and cold were the most common respiratory symptoms among female mobile food vendors and e-waste workers. High blood pressure was more common in e-waste workers than female mobile food vendors and there were no significant differences in lung function among the two groups

#### **5.2. Methodological Validity**

To the best of my knowledge, this is the first study to assess the cardiorespiratory functions among female food vendors, compared with E-waste workers at Agbogbloshie. This study was a cross-sectional study, hence restricting the ability to establish cause and effect relationship.

Questionnaires administered and clinical examinations including lung and cardiac functions assessment were carried out objectively to eliminate any information bias. Age, cigarette smoking, alcohol use and educational levels were important confounders that were also controlled.

The language barrier was a challenge as most of the e-waste workers spoke and understood mainly Dagbani, a local dialect not spoken nor understood by the researcher. A native Dagomba was employed to assist with the interpretation of questionnaires and general communication.

The major limitation was the small sample size, thereby reducing the power of the study to detect any effect, hence cause and effect may only be inferred.

### **5.3. Comparing study results with previous findings**

In Agbogbloshie, inhalation characterizes the ultimate route of exposure to air borne pollutants among e-waste workers and female food vendors as reported by Roy et al., (2010). Burning during e-waste recycling activities produces substantial airborne emissions that affect human life. Air borne pollutants when inhaled may cause inflammation in the respiratory system, producing symptoms, such as colds, coughs, chest pains and easy tiredness. The most common respiratory symptoms reported by both female mobile food vendors and e-waste workers were sneezing, colds and easy tiredness and this supports the findings by Cesaroni and co-workers that reveals that ambient air pollutants were linked with an increase in common colds in adults especially nonsmokers who were mostly mobile food vendors in this study (Cesaroni et al, 2013). Chest pains and excessive phlegm discharge were more common among e-waste workers than in female mobile food vendors and this is in line with the study by Caravanos et al., (2013) who also reported similar findings in an exploratory health assessment of chemical exposures at Agbogbloshie in Ghana. Air sampling is needed to better recognize the types of materials emitted into the air so that short and long term interventions will be applied to decrease the chemical risk to the people working in this population.

Most e-waste workers were found to have high blood pressure, consistent with data presented in a systematic review and meta-analysis done by Newell et al., (2017) that found out that long term ambient air pollution exposure seemed to be associated with an amplified risk in cardiovascular diseases. Previous studies have shown an association between heavy metals exposure and hypertension and cardiovascular diseases among e-waste workers Agarwal et al. (2011) and Menke et al., (2006). Also, a study to assess long term exposure to ambient air pollution and prevalence of cerebrovascular event from some European countries by Stafoggia et

al. (2014) reported a possible association between exposure to PM (fine particles) and cerebrovascular diseases. Suffice it to say, regulation in Europe on emissions is more stringent, and mobile food vendors and e-waste workers in this study are probably exposed to higher amounts of particulates than that of Europe.

Compared to food vendors, more e-waste workers smoke cigarette which can predispose them to lung and heart diseases. Dual exposure to heavy metals and cigarette smoke smoking is a risk factor in development of respiratory bacterial infections including tuberculosis (Brunet et al.,2011). A review that was done by Tintinger, (2011) on harmful interactions of non-essential heavy metals revealed how simultaneous exposure to tobacco smoke may exacerbate the danger of pulmonary malignancy.

There is an interdependent relation between cigar smoking and alcohol consumption with respect to the risk of cancers of the respiratory tract. Even though the health risks of tobacco smoking are well acknowledged, a study by Sopori suggested that smokers have a lower incidence of some inflammatory and neurodegenerative diseases and that, the nicotine in cigarette might have a healing potential as a neuroprotective and anti-inflammatory agent (Sopori, 2002). This interesting finding might explain why e-waste workers in this study had rather normal lung function indices than mobile food vendors. Additional studies on the synergistic effect of cigarette smoking and e-waste emission exposure on cardiorespiratory functions may help us understand the cause and effect of these parameters.

Although e-waste workers work for longer periods and have worked for more years compared to mobile food vendors, they had a slightly better lung function indices in this study where female mobile food vendors had a higher level of abnormal lung function (27%) compared to e-waste workers (22%). Mobile food vendors move freely at the e-waste site, and are therefore similarly

exposed to all kinds of pollutants, including PM and smoke known to impact on respiratory health and lung function. The relatively poor lung function observed in food vendors may be attributable to sex difference, as suggested by Sørheim et al. (2010), who found that females were more associated with lung function reduction and were more prone to lung-damaging effects of smoke at lower levels of exposure in Norway. Another probable cause could be the difference in metabolism of men and women as reported by Punturieri et al. (2009) that the biological make-up of women may make them more disposed to the ill effects of smoke. These findings bring to the limelight the need to carry out a study to assess the cardio respiratory functions among same sex groups exposed to e-waste recycling activities as this may rule out the differences in the health outcomes as a result of different sex observations and establish a causal relationship. Stafoggia et al. (2014) and Stieb et al. (2017) also found significance in short term exposure to PM with decreased lung function and this was evidenced in this current study where female food vendors, often exposed intermittently at different parts of the dumpsite, had slightly worse or abnormal lung functions.

## CHAPTER SIX

### CONCLUSIONS AND RECOMMENDATIONS

#### 6.1. Conclusion

In conclusion, this study showed common respiratory symptoms among e-waste workers and female food vendors which included, sneezing, easy tiredness and colds. Cardiac functions were generally normal with high blood pressure being very common among the e-waste workers and there were no significant differences in lung functions between female food vendors and e-waste workers. However, almost half of the respondents had abnormal lung functions with a higher number of female food vendors having the most abnormal lung functions than the e-waste workers.

#### 6.2. Recommendations

- To reduce health effects on the workers and people around Agbogbloshie, enforcement of regulations on e-waste recycling activities and training of workers are needed to prevent environmental contamination.
- E-waste workers need to be educated on the damaging effects of the indiscriminate burning of e-waste by e-waste workers and how detrimental it is to their health and those around them.
- Female mobile food vendors need to be advised on the need to avoid inhalation of smoke from burning e-waste or minimize the time spent at the e-waste site as the smoke can be damaging to their health.

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## APPENDICES

### APPENDIX 1: PARTICIPANT INFORMATION SHEET

Title of study: Cardiorespiratory function among female food vendors at Agbogbloshie – A comparative analysis with electronic waste workers.

#### **Introduction**

I am a master's student of the School of Public Health, University of Ghana, Legon. As part of the program, we carry out research work. My work is on the health effects of ambient air pollution on the cardio respiratory function among male food vendors in comparison with electronic waste workers. E-waste recyclers in Agbogbloshie use the manual dismantling and open-air burning to retrieve some valuable metals which render them and the food vendors in the vicinity to mixtures of poisonous substances such as fumes of lead, mercury and arsenic through breathing, by mouth and through the skin. These chemicals are known to have severe negative health effects on all organs in human body.

It is hoped that the findings of this study will help identify the association between coming into contact with e-waste and breathing in contaminated air from the open air burning of e waste among food vendors and e waste workers in Agbogbloshie.

#### **Purpose of the study**

The study aims at assessing the cardio respiratory function among male food vendors as compared to e-waste workers at Agbogbloshie recycling site.

### **Eligibility criteria**

Anyone who is 18 years or older and has been involved in the e-waste recycling process and mobile food vending business for not less than 6 months can take part in the study. Persons who are not willing or able to understand or comply with study procedures will not be allowed to be part of the study.

### **Study Procedure**

A short interview will be conducted to obtain the contact information, age, sex, highest educational level, ethnicity, type of work (food vendor, e waste worker) one is engaged in, hours of work per week, use of protective clothing, location and distance of your work area from burning site, smoking habits, alcohol use and current medications that you are taking.

Instruments like the digital sphygmomanometer, pulse oximeter and spirometer will be used to check the blood pressure, oxygen saturation and lung function respectively.

### **Risks and Benefits**

This research will increase our understanding regarding the possibility of harm to the cardio respiratory system when you come into contact with ambient air pollution and fumes from e waste recycling practices. A better understanding of these relationships may provide information to put in place measures to protect the workers and people in the vicinity. Furthermore, this research may provide evidence to support the need for infrastructure in Ghana for the safe recycling of e-waste and provide critical environmental and occupational health research practical for the principal investigator, Kafui Kesewah Aboagye at the School of Public Health, University of Ghana. The health screening will be done for free.

Possible risks/ complications of taking blood pressure measurement test doesn't have any risks to your health. The squeezing of an inflated blood pressure cuff on your arm may be uncomfortable, but it should last only a few seconds. Risks associated with using a pulse oximeter are minimal and rare. Lung function tests are usually safe for most people. However, because the test may require you to breathe in and out quickly, you may feel dizzy and there's a risk that you might faint. The test may cause you to have an asthma attack if you have asthma. These risks will be avoided by ensuring that all participants follow instructions given before the tests. For instance, not taking medications that open the airway such as those used for asthma or bronchitis. Pain medications may also affect the results of the test so they also need to be avoided before the test.

It's important that you don't eat a large meal before testing. A full stomach can prevent your lungs from inhaling fully. You should also avoid food and drinks that contain caffeine, such as chocolate, coffee, and tea, before your test. Caffeine can cause your airways to open. You should also avoid smoking and strenuous exercise before the test.

Be sure to wear loose-fitting clothing to do the test. Tighter clothing may restrict your breathing. You should also avoid wearing jewelry that might affect your breathing. If you wear dentures, wear them to the test to ensure that your mouth can fit tightly around the mouthpiece used for the test.

Freedom to participate/ Voluntary withdrawal

Participant opinions and experiences are important to us, so we want you to be honest and truthful in answering our questions. Your participation is completely voluntary and you may refuse to participate at any time. You may ask me to stop the interview or blood sample

collection at any point or you may also decline to answer any question if it makes you uncomfortable.

### Privacy and Confidentiality

To ensure confidentiality and privacy we will not mark any of the samples with study participant's names: rather we will code numbers to the results and keep an encrypted file that coordinates numbers to names on a secure laptop.

### **Protection of subjects' privacy**

Participants do not have to answer any questions that they feel are an invasion of their privacy. Also, subjects do not have to participate in any aspects of the study that they find invasive. Results from their cardio respiratory and lung function test will be communicated directly to them through the contact details they will provide. Additionally, client with abnormal test results will be assisted with a referral letter to the appropriate facility

### Provision to prematurely end a 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 will be concluded.

### **Compensation for participants**

Compensation will be given at the time of data collection. Compensation is not payment for participating in this study but serves as a token of appreciation for participants' time as these workers will in a normal working day earn more than the compensation reward. Refreshments

will be provided for all participants who agree to participate in the study. Additionally, a payment of GH¢ 10 will be given to study participants who complete all aspects of the study.

### **Data storage and protection**

All research records, data and results of tests will be protected against inappropriate use or disclosure, or malicious or accidental loss or destruction. Data will be locked with restricted access on a secure laptop. There will be safe disposition/destruction of data or devices, as appropriate (e.g., shredding paper documents, secure erasure of electronic media) after the study.

The data and results of tests will be destroyed after this study.

### **Declaration of conflict of interest**

I Kafui Kesewah Aboagye (Principal Investigator), declare that, to the best of my knowledge, there is no actual, perceived or potential conflict of interest that will or may arise as a result of my involvement with this study.

### **Who to contact**

In cases of any questions regarding the research, you can contact:

- GHS/ Ethical Review Committee administrator, Hannah Frimpong (mobile: 0507041223)
- School of Public health, University of Ghana, Legon.

or

- Kafui Kesewah Aboagye

Mobile number: 0246589371

Email: [kafuikaboagye@yahoo.com](mailto:kafuikaboagye@yahoo.com)

Before taking Consent

Do you have any questions you wish to ask about the study? Yes

No

(If yes, please, indicate the questions below).....

## **APPENDIX II: INFORMED CONSENT FORM**

Date of Consent: .....

Consent Form No: .....

STUDY TITLE: CARDIO- RESPIRATORY FUNCTION AMONG FEMALE FOOD VENDORS AT AGBOGBLOSHIE, A COMPARATIVE ANALYSIS WITH ELECTRONIC WASTE WORKERS.

You have been invited to take part in this study for the research titled above. Your role is to fill out a questionnaire where you will answer some few questions on the subject matter, and some noninvasive measurements will be carried out on you without any pain.

You acknowledge that the research procedures have been explained to you and all questions have been answered to your satisfaction.

Information we collect on you in this study will be kept confidential and secure. The information will only be available to the researchers conducting the study.

You are to understand that taking part in the research is entirely voluntary. You are further to note that you may refuse to take part or withdraw from the study at any time without anyone objecting.

If there is anything that you do not understand, or you have questions or concerns about this research, do not hesitate to contact Miss Kafui Kesewah Aboagye, School of public health, university of Ghana, Tel: 0246589371 and GHS/ Ethical Review Committee administrator, Hannah Frimpong (mobile: 0507041223) to seek further clarification when needed.

Statement of consent

I ....., declare that the purpose, procedures to be followed, risks and benefits of the study have been read/ had been explained and every question(s) have been answered to my satisfaction. I hereby give consent to participate in this study.

Signature/Thumbprint of participant..... Date...../...../.....

Statement by the Researcher

I, undersigned, have explained this consent form to the subject in the language that he/she understands on information regarding this study. I agree to answer any future questions concerning the study and adhere to the approved protocol.

Signature .....

Date...../...../.....

**APPENDIX III: QUESTIONNAIRE**

**QUESTIONNAIRE TO ASSESS CARDIO-RESPIRATORY FUNCTION  
AMONG FEMALE FOOD VENDORS AT AGBOGBLOSHIE. A  
COMPARATIVE ANALYSIS WITH ELECTRONIC WASTE WORKERS.**

**A: GENERAL INFORMATION**

Participants code: .....

Name of participant: .....

Contact information: .....

Name of interviewer: .....

Date of interview: .....

Place of interview: .....

**B: PARTICIPANT'S INFORMATION/DEMOGRAPHICS**

1. Date of birth: ...../...../..... (DD/MM/YY) Age: .....yrs
2. Sex  1 Male  2 Female
3. Marital Status:  1 Single  2 Married  3 Divorced  4 Co-habiting
4. Religion:  1 Christian  2 Moslem  3 Traditionalist  4 Other (Specify).....
5. Highest level of education.  1 No formal education  2 Primary  3 JHS  4 SHS

**C: LIVING CONDITIONS**

6. Are you a resident of Agbogbloshie?  1 Yes  2 No (If No, GO TO *number 8*)
7. If Yes, how far is your house from the dump site?  1 Scrapyard  2 Galaway  
 3 Market  4 Other (Specify).....
8. The usual place you sleep is?  1 Rented Room/ Block  2 Rented Kiosk/Shop  
 3 Open space (no walls and/or no ceiling)  4 Mosque  5 Own Home  
 6 Family Home  7 Mud House
9. How long have you been living there?  
 1 6 months – 1 year  2 2-3 years  3 4-5years  4 over 5years
10. Where you currently usually live, does anyone do cooking indoors?  1 Yes  2 No

10a. If **Yes**, do you sleep in the same room as where the cooking is done? <sub>1</sub> Yes <sub>2</sub> No

10b. If **No**, Where is the cooking usually done? <sub>1</sub> In a separate room from where I sleep, but in the same compound <sub>2</sub> Outdoors <sub>3</sub> No cooking is done, I only buy food <sub>4</sub> Other Please specify: .....

11. What types of fuel are used for cooking? Check ALL that apply

- <sub>1</sub> Electricity <sub>2</sub> Kerosene <sub>3</sub> Charcoal <sub>4</sub> Wood/ firewood  
<sub>5</sub> LPG / Gas <sub>6</sub> Other Please specify: .....

12. Which of the following applies to you?

- <sub>1</sub> E-waste worker <sub>2</sub> Non E-waste worker (please specify your job .....

**D: OCCUPATIONAL INFORMATION (E-WASTE WORKERS ONLY)**

13. Which recycling activity do you undertake?

- <sub>1</sub> Burning <sub>2</sub> Dismantling <sub>3</sub> Collector <sub>4</sub> Sorting

14. How long have you worked in this job?

- <sub>1</sub> 6 months – 1 year <sub>2</sub> 2 -3 years <sub>3</sub> 4 -5years <sub>4</sub> over 5years

15. How many hours do you work per day?

- <sub>1</sub> Less than 4 hours <sub>2</sub> 4 – 5 hours <sub>3</sub> 6 – 7 hours <sub>4</sub> 8 hours <sub>5</sub> 8 hours +

16. How many days do you work per week?

- <sub>1</sub> 1 day <sub>2</sub> 2 days <sub>3</sub> 3 days <sub>4</sub> 4 days <sub>5</sub> 5days <sub>6</sub> 6 – 7 days

17. Does your work expose you to any of the following hazards? Tick (✓) as appropriate

Dust	
Smoke	
Irritating gases and liquids	
Heat	
Fumes	
Aerosols	
Other	

Other, please specify.....

18. Do you use/wear any personal protective equipment (PPE) at work? <sub>1</sub> Yes <sub>2</sub> No

18a. If yes, Tick (✓) what applies (*Please refer to images on the next page*)

Face / Eye protection e.g. safety glasses, face shield	
--	--

Hand protection e.g. safety gloves	
Body protection e.g. overall coat, aprons	
Foot protection e.g. safety boots	
Inhalation protection e.g. nose masks	
Head protection e.g. Helmets, hard hats	
Hearing protection e.g. ear plugs	

Other, please specify.....



**E: HEALTH IN RELATION TO YOUR WORK OR STAY AT AGBOGBLOSHIE**

19. Are you exposed to any of the following hazards at home? Please kindly tick (√) as appropriate.

Dust	
Smoke	
Irritating gases and liquids	
Heat	
Fumes	
Aerosols	
Molds/ dampiness	
Other	

Other, please specify.....

20. Do you have any illness you know about? <sub>1</sub> Yes <sub>2</sub> No

20a. If Yes, please specify the illness. ....

21. When was the last time you had your blood pressure checked?  Less than 6 months

<sub>1</sub> 6 – 11 months      <sub>2</sub> 1 – 2 years      <sub>3</sub> 3 – 5 years      <sub>4</sub> 6 years or more

<sub>5</sub> Don't Know      <sub>6</sub> Never had it checked (you may go to **question 26**)

22. The LAST time you had your blood pressure checked, was it normal or high?

<sub>1</sub> Normal      <sub>2</sub> High      <sub>3</sub> Don't Know/Not Sure

23. Have you ever been told by a doctor that you have high blood pressure (other than during pregnancy)? <sub>1</sub> Yes      <sub>2</sub> No      <sub>3</sub> Don't know

23a. If Yes, when were you diagnosed? <sub>1</sub> Less than 6 months      <sub>2</sub> 6 – 11 months

<sub>3</sub> 1 – 2 years      <sub>4</sub> 3 – 5 years      <sub>5</sub> 6 years or more      <sub>6</sub> Don't Know

24. Have you ever taken pills regularly for high blood pressure (other than during pregnancy)?

<sub>1</sub> Yes      <sub>2</sub> No      <sub>3</sub> Don't know

25. Are you currently taking pills regularly for high blood pressure?

<sub>1</sub> Yes      <sub>2</sub> No      <sub>3</sub> Don't know

26. Have you had any respiratory illnesses? <sub>1</sub> Never      <sub>2</sub> During childhood      <sub>3</sub> All the time

27. Was it diagnosed by a doctor? <sub>1</sub> Yes      <sub>2</sub> No

28. Is the illness brought on or made worse by the work you do or while you live here?

<sub>1</sub> Yes      <sub>2</sub> No

29. Do you experience from any of the following symptoms in while you work or stay at Agbogbloshie? Please tick (✓) as appropriate

Symptoms	Always (1)	Sometimes (2)	Never (3)
Cough			
Colds			
Prolonged or 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 or skin disease			

Adapted from: (Recommended Respiratory Disease Questionnaires for Use with Adults and Children in Epidemiological Research, 1976)

30. Do these symptoms stop when you are away from Agbogbloshie? <sub>1</sub> Yes <sub>2</sub> No

31. Are your chest symptoms caused by, or made worse by any of the following:

- <sub>1</sub> Contact with animals/pets <sub>2</sub> Heavy exercise <sub>3</sub> Dusts or sprays
- <sub>4</sub> Exposure to open fires <sub>5</sub> Tobacco smoke <sub>6</sub> Change in weather
- <sub>7</sub> Other (Please specify).....

32. Have you been diagnosed of the following conditions or experienced such symptoms in the course of your work

- Hypertension (or any heart disease) <sub>1</sub> Yes <sub>2</sub> No
- Bronchitis <sub>1</sub> Yes <sub>2</sub> No
- Pneumonia <sub>1</sub> Yes <sub>2</sub> No
- Cough <sub>1</sub> Yes <sub>2</sub> No
- Acute asthma <sub>1</sub> Yes <sub>2</sub> No
- Acute respiratory tract infections <sub>1</sub> Yes <sub>2</sub> No
- Hospitalization for asthma <sub>1</sub> Yes <sub>2</sub> No
- Hospitalization for acute respiratory tract infections <sub>1</sub> Yes <sub>2</sub> No

32a. If you answered Yes to any question please give details:

.....

**F: HABITS/ LIFESTYLE**

33. Do you smoke cigarettes? <sub>1</sub> Yes <sub>2</sub> No (Please go to **number 33c**) <sub>3</sub> In the past

33a. If yes, how many sticks do you smoke per day? .....

33b. How long have you being smoking? .....

33c. If No, does any of your relatives smoke at home? <sub>1</sub> Yes <sub>2</sub> No <sub>3</sub> In the past

34. Do you take alcohol? <sub>1</sub> Yes <sub>2</sub> No <sub>3</sub> In the past

34a. If Yes, How long have you being taking alcohol?

<sub>1</sub> 1 – 5 years <sub>2</sub> 6 – 10 years <sub>3</sub> more than 10 years

34b. Which type of alcohol do you usually take? Please tick (✓) as appropriate.

Spirits	
Bitters	
Beers	

Other, please specify.....

34c. How much alcohol do you take per day? <sub>1</sub> < 5 tots <sub>2</sub> 5 – 10 tots <sub>3</sub> > 10 tots

35. Have you used any recreational drugs in the last 3 months? <sub>1</sub> Yes

<sub>2</sub> No

35a. If yes, please specify the type.....

## F: CLINICAL EXAMINATION

Height .....m

Weight.....kg

BMI.....kg/m<sup>2</sup>

## VITAL SIGNS

Blood pressure.....mmHg

Pulse (HR) .....bpm

Heart Rhythm.....

Pulse oximetry.....SpO<sub>2</sub> %

## SPIROMETRY

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

Remarks.....

*Thank you for your time. Your participation is very much appreciated.*