

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

**RESPIRATORY SYMPTOMS AND DERMATOLOGICAL
CONDITIONS IN MUNICIPAL SOLID WASTE WORKERS IN
TEMA: THE CASE OF ZOOMLION GHANA LIMITED**

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**THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA,
LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE
AWARD OF MASTER OF SCIENCE OF OCCUPATIONAL MEDICINE
DEGREE**

JULY, 2016

DECLARATION

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

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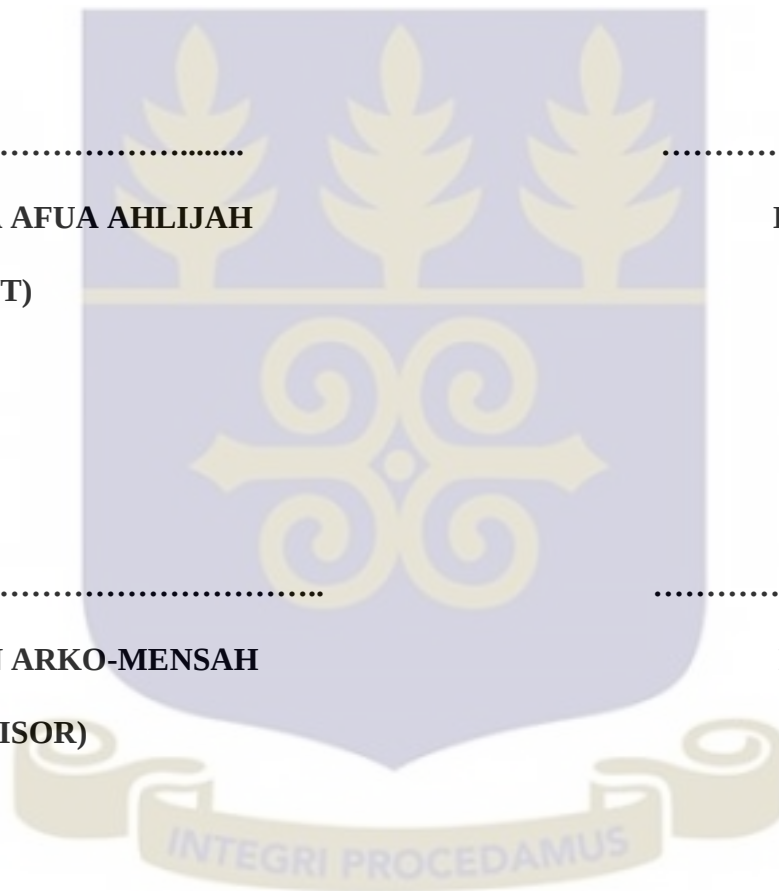
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DEDICATION

This work is dedicated to my two greatest cheerleaders (Rev. Dr. Godwin Kofi Ahlijah and Dorinda Adjo Ahlijah), my family and all the hardworking waste management workers who help to keep our communities clean.



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ABSTRACT

Background: In rapidly urbanizing cities of developing countries such as Ghana, the quantity of solid waste (SW) generated from various activities have increased over the years, and managing municipal solid waste (MSW) has become both an important economic activity as well as an issue of public health concern due to its associated health hazards. Although some studies have reported decreased pulmonary function and an increased prevalence of certain respiratory symptoms, there is still very little information on the magnitude of the adverse effects such exposures have on municipal solid waste workers in Ghana, with regards to respiratory health and dermatological (skin) condition.

Objective: The main objective of this study was to assess the respiratory health and dermatological conditions in municipal solid waste workers of Zoomlion, Ghana Limited in the Tema.

Methods: A cross-sectional analytical study was conducted from among 105 workers of the Tema District Office of Zoomlion, Ghana Limited. The respiratory health and dermatological conditions of the different categories of workers; sweepers, collectors, transporters and administrative staff who sometimes serve as field supervisors were assessed using questionnaires, direct skin examination and spirometry. Occupational related respiratory problems and dermatological present at the study time or during a 3-month recall period were noted. Statistical analysis was done in STATA software version 13 (Stata Corps, College Station).

Results: There was a higher prevalence of the common respiratory symptoms such a colds (85.2%) and prolonged or repeated sneezing (81.5%) among sweepers compared to the administrative and support staff (58.8% and 61.8% respectively). Also, pulmonary function (PF) was reduced amongst sweepers and collectors compared to the

administrative and support staff. Lower pulmonary function indices; FVC (2.6 ± 0.75) and FEV_1 (2.07 ± 0.43), which indicate poor respiratory health were lowest among sweepers. The duration of employment did not significantly affect (PF) indices (FVC and FEV_1). The overall prevalence of dermatological conditions amongst MSWWs was 60%.

Conclusion: MSWWs (collectors, sweepers and transporters) have increased prevalence of respiratory symptoms, reduced pulmonary function and higher prevalence of dermatological conditions compared to the administrative and support staff.

Keywords: Municipal solid waste workers; respiratory symptoms; dermatological conditions; spirometry.

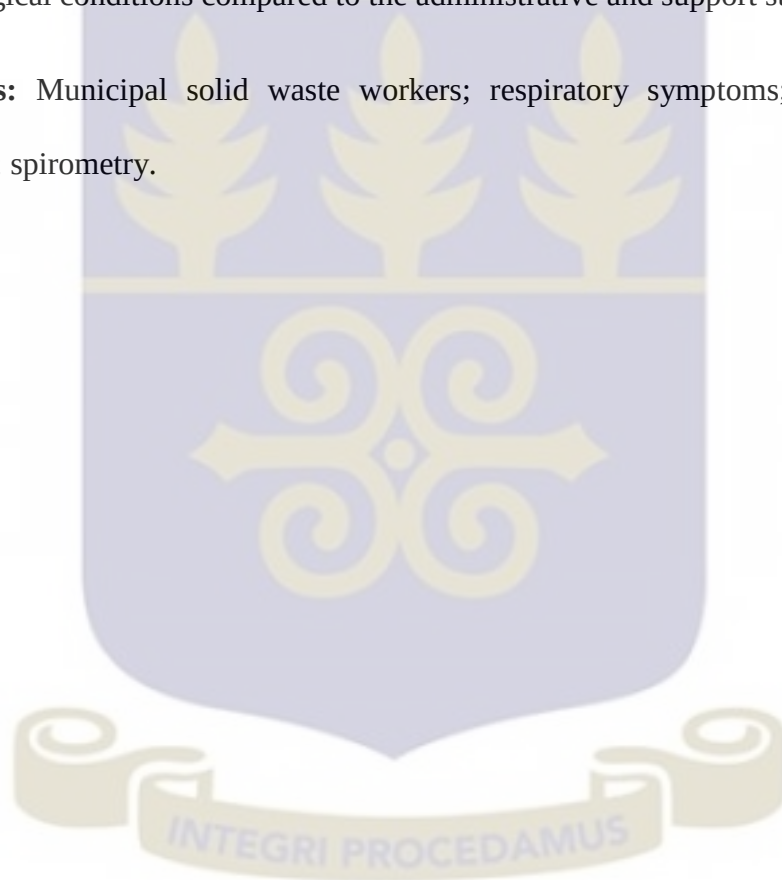


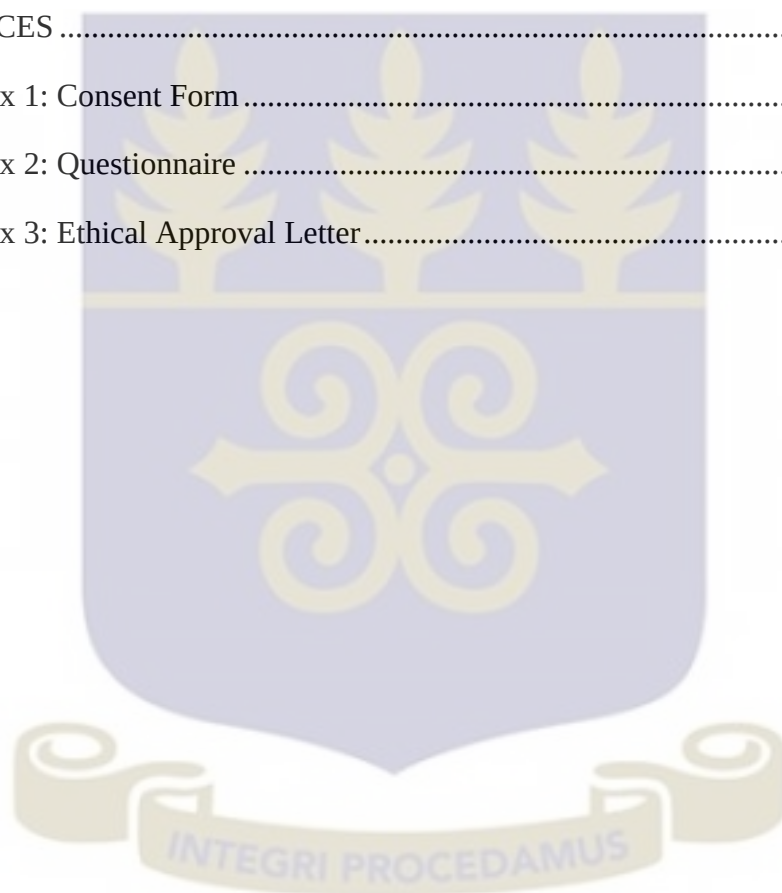
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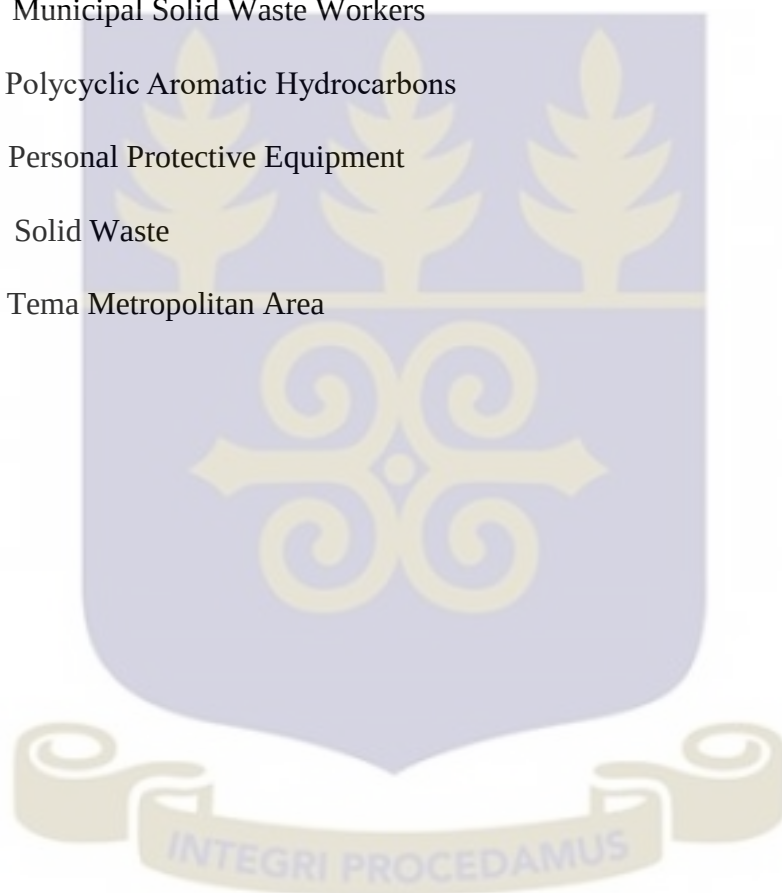
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LIST OF ABBREVIATIONS

COPD	Chronic Obstructive Pulmonary Disease
FEV₁	Forced Expiratory Volume in one second
FVC	Forced Vital Capacity
GDHS	Ghana Demographic and Health Survey
MSW	Municipal Solid Waste
MSWW	Municipal Solid Waste Workers
PAH	Polycyclic Aromatic Hydrocarbons
PPE	Personal Protective Equipment
SW	Solid Waste
TMA	Tema Metropolitan Area



OPERATIONAL DEFINITIONS OF TERMS

Hazard

A source of exposure to danger

Occupational hazard

A working condition that lead to illness or death

Occupational health

The effect of work on the health and the effect of health on health, it plays an important in helping employers to understand and meet the needs of their employees, in order to minimize sickness absence and optimize employee performance and productivity.

Personal Protective Equipment

Anything worn or used by a person to minimize risk to the individual's health or safety and include a wide range of clothing and safety equipment.

Respirable

Anything capable of being respired.

Utilization of PPE

Wearing of PPE

Bio-aerosol

Any aerosol containing a biologically active bacteria, spores, viruses, toxins and any similar material

Chronic Obstructive Pulmonary Disease

Any lung disease that leads to poor aeration of the lungs. Examples are emphysema, chronic bronchitis.

Spirometry

Office test used to assess lung/pulmonary function and diagnose lung conditions

Collectors

These are the workers responsible for collecting solid waste from generating sites such as homes, offices, schools and other temporary dumping steps and putting them in compactor trucks.

Transporters

This category of workers are responsible for moving municipal solid waste from the point of collection to the disposal sites such as the land-fill sites. Most of them are driver-mechanics who repair the compactor trucks when they break down

Sweepers

They are workers who use brooms to sweep and gather municipal solid waste that litter the streets, markets, lorry stations, gutters, beaches and other public spaces such dumping sites.

Administrative and support staff

This group of workers are mainly office staff who carry out administrative and supervisory duties and offer support services such as security and customer service.

Morbidity

The proportion of sickness or of a specific disease in a geographical locality.

Stadiometer

An anthropometric device for measuring height.

Anthropometric

The measurement of the size and proportions of the human body.

CHAPTER ONE

INTRODUCTION

1.1 Background

Globally, population growth and urbanization have resulted in an increase in the volumes of solid waste (SW) generated from various activities, especially in developing countries such as Ghana (Guerrero, Maas, & Hogland, 2013). Managing municipal solid waste (MSW) has not only become an important economic activity, but has also become an issue of public health concern, due to its associated health hazards. Many people depend on MSW management activities for their livelihood, but these individuals are at risk of occupational health problems (Athanasίου, Makrynos, & Dounias, 2010; Dorevitch & Marder, 2001). Notable among them are respiratory symptoms and dermatological conditions.

Solid waste is any solid material in the material flow pattern that is rejected by society; arising from human and animal activities (Vergara & Tchobanoglous, 2012). Solid waste includes solids or semi-solids and non-soluble material (gases and liquids in containers), refuse from agricultural and industrial activities as well as municipal waste (household waste). Municipal solid waste is composed of a wide variety of things ranging from food and; textiles to unwanted items from paper, cardboard, plastic, glass, and metal (Athanasίου et al ., 2010). Commercial organizations and industries also generate solid in addition to chemical and mineral waste. Unfortunately, medical and other hazardous waste products from medical facilities also find their way into the municipal solid waste management system. Agricultural waste products are usually composed of farmyard manure (Rushton, 2003) and sometimes dead farm animals, which also add to municipal waste.

In Ghana, MSW management consists of storage (at or close to the point of generation), collection, transport and final disposal at landfill sites (Boadi & Kuitunen, 2005). Municipal solid waste workers (MSWWs) have been employed by the various Metropolitan, Municipal and District Assemblies or private waste management companies to handle the SW generated by human and animal activities for disposal. These individuals are responsible for sweeping the streets and public places where refuse have been indiscriminately thrown around; collecting solid waste from homes, communal dumping sites in less affluent areas, offices, commercial and industrial facilities; transporting and finally processing the waste for disposal. They are thus exposed to diverse forms of health hazards (Abd El-Wahab et al., 2014).

Additionally, allergic and infectious dermatological (skin) conditions have been found to be more prevalent in MSWWs than the general population (Jayakrishnan, Jeeja, & Bhaskar, 2013).

It is well-known that most MSWWs work from the early hours of the morning till evening, and by the nature of their work, they are potentially exposed to disease-causing microorganisms such as fungi, viruses, bacteria, parasites and cysts (Wei Z1, Xi B, Zhao Y, Wang S, Liu H, 2007), in addition to bio-aerosols and volatile organic compounds like methane from decaying organic waste (Lavoie, Dunkerley, Kosatsky, & Dufresne, 2006). Also, exposure to toxic chemicals including heavy metals such as cadmium, lead, nickel and arsenic found in municipal waste (Zhang, He, Shao, & Lee, 2008); exhaust fumes from vehicular traffic; particulate matter such like dust and harsh weather conditions (Ray, Roychoudhury, Mukherjee, Roy, & Lahiri, 2005) is common.

Municipal solid waste workers encounter high rates of occupational health challenges as compared to other workers who are engaged in non-waste management activities, because

of the multiple risks they are exposed to (Athanasίου et al., 2010). Bio-aerosols, vehicle exhaust fumes (Ingle, Pachpande, Wagh, Patel, & Attarde, 2005) and harsh weather conditions may precipitate respiratory problems. Some of these aerosols contain allergens which may cause or worsen allergy-related respiratory conditions and decline in pulmonary function (Douwes, 2003). Additionally, allergic and infectious dermatological (skin) conditions have been found to be more prevalent in MSWWs than the general population (Jayakrishnan et al., 2013)

It is important for employers of MSWWs to ensure good health and safety of their staff by putting in place measures that will facilitate efficient and safe solid waste management. Engineering and administrative controls in addition to the provision and use of personal protective equipment (PPE) (Konya, Akpiri, & Orji, 2013) are required to achieve this. For instance, the provision of well-maintained compactor trucks, isolation and maintaining good ventilation at the work environment are some engineering control measures that will help reduce quantity of contaminants that MSWWs are exposed to. Furthermore, the role of administrative controls such as training of workers and planning their work schedule reduction in exposure time cannot be over emphasized (Amichia, 2013). The provision and use of appropriate PPE- such as overalls, gloves, goggles and face masks, respirators and boots will help protect these worker (Thirarattanasunthon, Siri Wong, Robson, & Borjan, 2012). This study seeks to explore the prevalence of respiratory and dermatological conditions in MSWWs employed by the biggest waste management company in the Tema Metropolitan Area, Zoomlion Ghana Limited.

1.2 Problem Statement

Ghana generates 12,710 tonnes of SW daily (Miezah, Obiri-Danso, Kádár, Fei-Baffoe, & Mensah, 2015). This quantity will definitely increase as the population increases.

Unfortunately, similar to other developing countries, solid waste management leaves a lot to be desired. Infectious medical waste, industrial SW and domestic waste are continually disposed together (Tiwari, 2008; Dettaglio et al., 2013). Consequently, tens of thousands of Ghanaian MSWWs who depend on waste management for their livelihood, are at risk of the occupational health problems. These are associated with the components of the materials they handle, the equipment they use and the emissions from them. The occurrence of such occupational health problems could be attributed to inadequate engineering and administrative controls and lack or underutilization of personal protective equipment (Konya et al., 2013). As the biggest waste management company in Ghana, Zoomlion, Ghana Limited is a household name and served as a good case study.

A number of studies, such as Jayakrishnan et al (2013), have reported decreased pulmonary function and increased prevalence of respiratory symptoms, allergic and dermatological conditions related to exposure to municipal SW. However, there is very little information on the scope of the untoward effects of exposure to SW on the skin and the pulmonary system of MSWWs in Ghana. There is, therefore, the need to investigate how the work of MSWWs affects their health.

1.3 Conceptual Framework

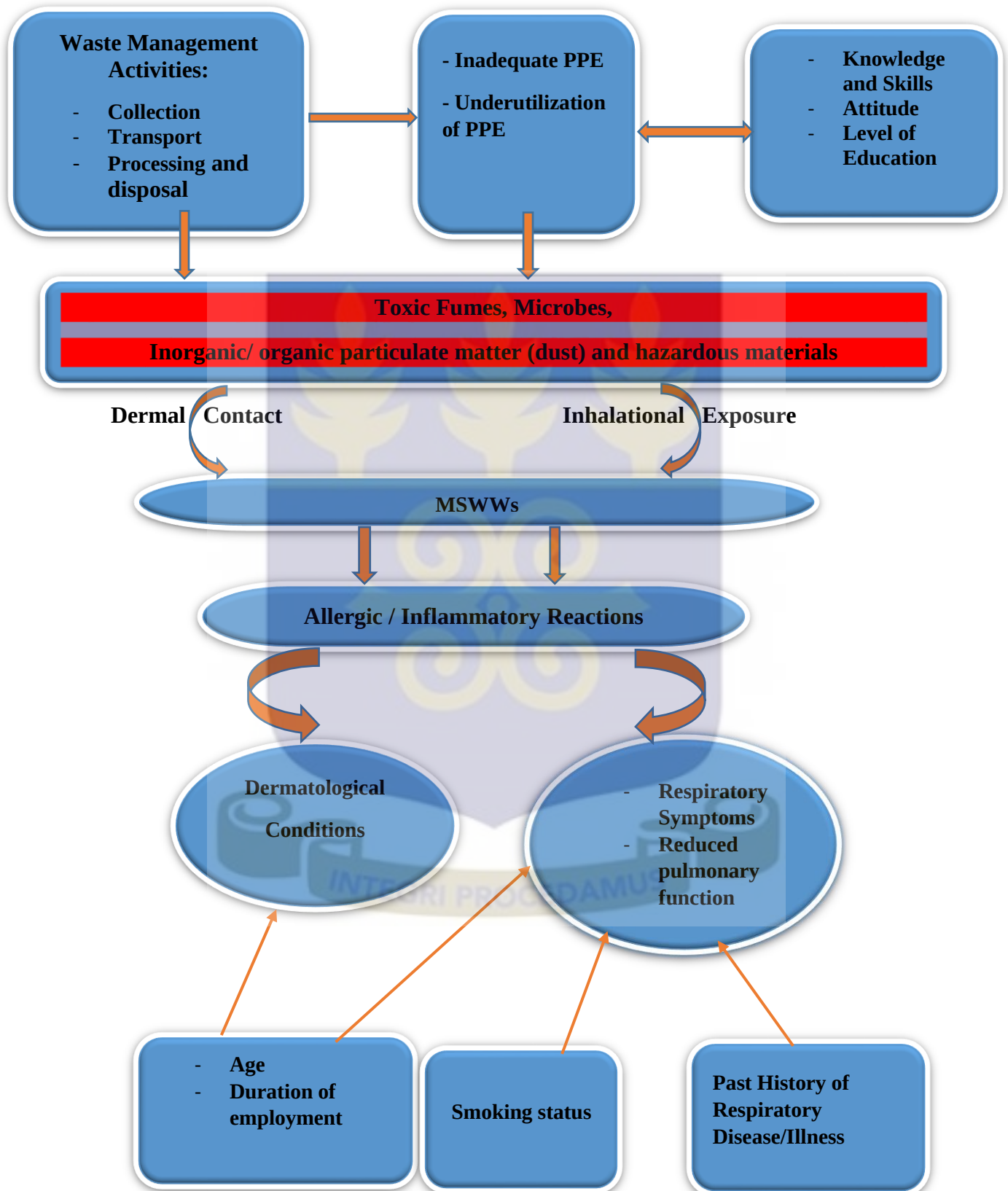
The conceptual framework illustrated by Figure 1 below, demonstrates that respiratory and dermatological health are affected by individual, environmental and administrative factors. Exposure may occur directly or indirectly. Direct factors include exposure to MSW management activities through inhalation of bio-aerosols, dust, fumes and gases; duration of exposure and also the inadequacy and underutilization of PPE. Variables such

as age, level of education, smoking status and past history of a respiratory illness account for the indirect factors (Jayakrishnan et al., 2013).

Agents in the occupational environment such as hazardous materials, particulate matter (smoke, exhaust fumes, polycyclic aromatic hydrocarbons etc.) which find their way into the lungs may initiate allergic or inflammatory reactions leading to respiratory health symptoms.



Figure 1: Conceptual Framework (Author: Lenusia Ahlijah)



Similarly, dermatological conditions result from the direct contact with solid waste as due to inadequacy or poor use of PPE. These conditions vary from infections and allergic reactions to penetrating injuries from sharp objects (Tiwari, 2008a).

1.4 Justification

This study aimed at determining the prevalence of respiratory symptoms and dermatological conditions among MSWWs of Zoomlion Ghana, Limited in the Tema Metropolitan Area. As these individuals work hard to keep Tema and its environs clean and healthy, they are exposed to a myriad of occupational health hazards. Their work entails lifting of heavy waste bins and repeated direct contacts with hazardous and infectious materials, thereby exposing them to infectious and allergic agents, which could lead to dermatological conditions (Jayakrishnan et al., 2013). Exposure to bio-aerosols, volatile organic compounds and particulate matter may also result in an increased risk of respiratory conditions with subsequent decline in pulmonary function (Stambuli, 2012).

Suffice it to say that, globally and especially in developing countries, MSWWs tend to be people of low socioeconomic status, and thus lack the resources to protect their health. (Wilson, Velis, & Cheeseman, 2006).

Although few studies have looked at the health conditions of electronic waste (e-waste) workers, there is limited data on health conditions among MSWWs. The health risks associated with the hazards MSWWs are exposed to, are of concern to both environmentalists and governmental agencies both locally and internationally, thus the need for continuous research.

Stakeholders such as the Ministry of Local Government, Ministry of Health, waste management companies, industries and policy makers may use the recommendations

made from this study to initiate and implement reforms that will improve solid waste management and ensure that the health risks of MSWWs are minimized.

Furthermore, findings of this study will benefit the MSWWs, in that it will inform them of some of the respiratory and dermatological conditions they may be exposed to. They will also be motivated to comply with safety controls put in place by their employers. This will result in an increase in productivity by reducing medical bills, loss of man hours and employee turnover.

1.5 Research Questions

1. What is the prevalence of respiratory symptoms in the MSWWs?
2. What is the relationship between duration of work and pulmonary function?
3. What is the prevalence of work-related dermatological conditions among the MSWWs?
4. Are MSWWs compliant with the use of PPE at work?

1.6 Study Objectives

1.6.1 General Objective

To assess the respiratory health and dermatological conditions in municipal solid waste workers of Zoomlion Limited in the Tema Metropolis.

1.6.2 Specific Objectives

1. To determine the prevalence of respiratory symptoms among MSWWs and assess their pulmonary function by using a spirometer.

2. To determine the relationship between duration of work and respiratory function.
3. To determine the prevalence of work-related dermatological conditions among MSWWs.
4. To assess the practice of personal protective equipment use by MSWWs.



CHAPTER TWO

LITERATURE REVIEW

2.1 Municipal Solid Waste

2.1.1 Definition

The term solid waste is defined differently by different authors, however, the most common definition is credited to Tchobanoglous et al (1993), who define solid waste as *“any material that arises from human and animal activities that are normally discarded as useless or unwanted”*. The United States Environmental Protection Agency also defines solid waste as any solid or semisolid material that is discarded by agricultural, community, industrial, medical, home or municipal processes.

According to the United Nations Environmental Programme, environmentally sound waste management includes, but not limited to waste reduction, collection, transfer, landfills and incineration. It is essential to manage waste so as to avoid the untoward effect it has on human health and the environment.

2.1.2 Generation of Municipal Solid Waste

It is instructive to note that, although globally, about 4 billion tonnes of solid waste is generated annually (Sanjeevi & Shahabudeen, 2015), the quantities and content vary according to the level of income and the rate of urbanization (Velasco Garrido, Bittner, Harth, & Preisser, 2015). It, therefore, suggests that urban areas generate more waste than the rural areas. This finding was consistent with Miezah et al (2015) who sought to characterize MSW. Their study revealed that Ghana generates 12,710 tonnes of waste daily with the bulk of it coming from urban centres such as Kumasi, Accra, Tamale and Tema.

2.1.3 Components of Municipal Solid Waste

As mentioned earlier, SW is generated from various sources, depending on the human and animal activities. These activities determine the components of MSW. In a MSW characterization study, Miezah et al (2015) affirmed that the rate at which waste was generated varied across the country, with the coastal and forest zones generating more than the northern zone. They also found out that, the organic content of the waste was 61%. Materials such as plastics, paper, metal and glass made up 16, 5, 3 and 3% of the waste respectively. The others are leather, textiles and miscellaneous (Ekor & Odewabi, 2014). This finding was in line with an earlier study by Fobil et al, who documented a 60% moisture content by weight (mostly organic waste) (Fobil, Carboo, & Armah, 2005). The finding made by Miezah et al (2015) was, however at variance with the finding of 44% in a baseline study in the desert nation of Kuwait (Al-Jarallah & Aleisa, 2014)

2.1.4 Municipal Solid Waste Management

Tchobanoglous et al (1993) defined solid waste management as “.... *That discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid waste in a manner that is in accordance with the best principles of public health, economics, engineering, conservation aesthetics and other environmental considerations and that is also responsive to public attitudes*”.

The key processes in the waste management chain have been illustrated in Figure 2. When SW is generated, it is first stored in a receptacle, which may be either a dustbin or a skip. It is then collected and taken to either a final disposal site straight away or to a site where it may be processed and items that can be recovered for recycling or reuse.

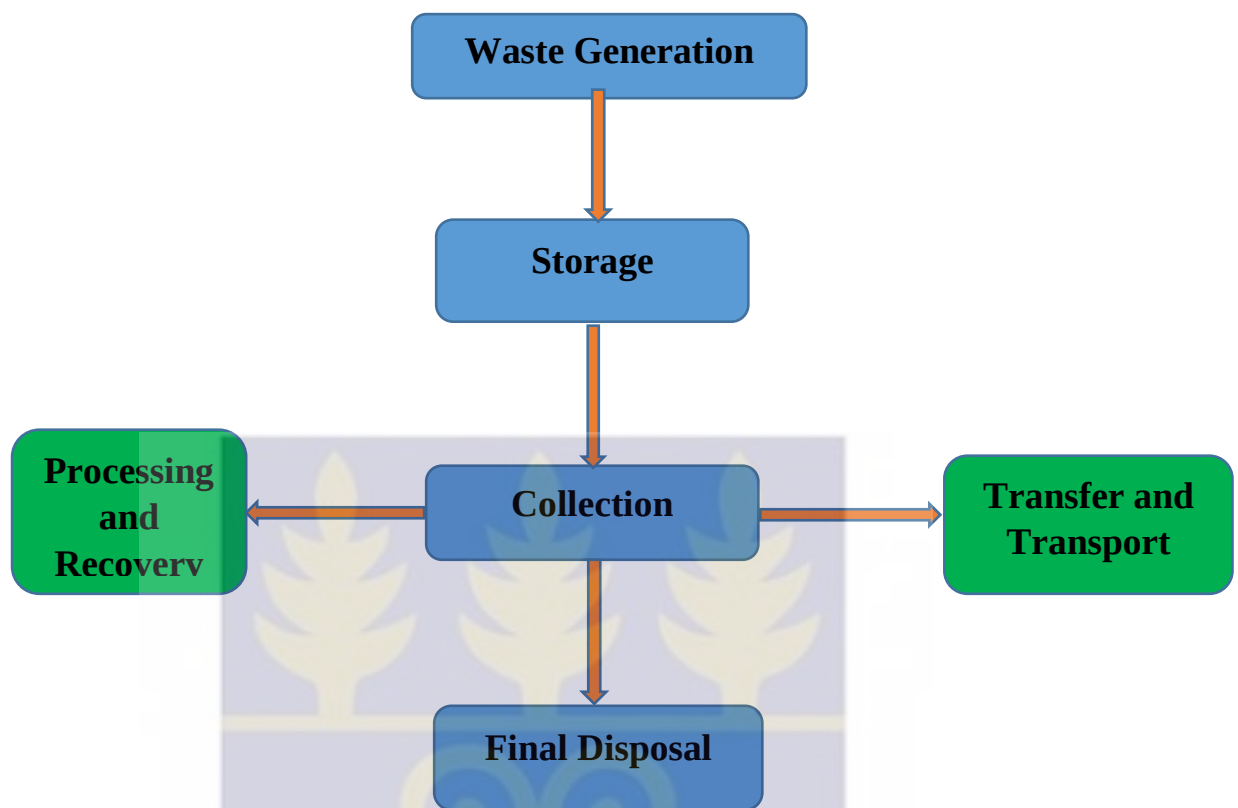


Figure 2: Key processes involved in municipal solid waste management

In other instances, SW collected, may be transferred from the generation point by a tricycle to a bigger truck or to a communal temporary dump site for final disposal. This basic system of waste management has been improved and carried out efficiently in developed countries. It has led to a reduction in occupational and environmental effects of SW (Bogale et al., 2014). For example, a prospective study done in Switzerland by Tschopp et al (2011) did not find any effects of occupational exposure of garbage and wastewater workers to bio-aerosols, probably due to good working conditions. Many European countries have very developed waste management systems, where their landfilled waste has virtually been eliminated (Vujić et ., 2015).

Unfortunately, the picture is quite different in the rapidly urbanizing developing countries like Ghana. Unsuitable bin collection methods, uncoordinated collection schedule and

poor route planning have been documented as some challenges that negatively affects effective waste management (Hazra & Goel, 2009)

As has been the practice in the last few years, cities such as Tema have their SW collected mostly by private waste management companies. According to Oduro-Kwarteng et al (2013) more than 60% of SW in Ghanaian cities are now collected by private waste management companies. One of the most prominent of such companies is Zoomlion Ghana, Limited. In Tema, 56.2% of households have their SW collected by trucks, while 21.8% send their waste to a public dump site (Ghana Demographic and Health Survey (GDHS), 2014). Some people also clandestinely dump their waste at the street corners and in open drains, to be swept and collected by employees of waste management companies. Thus adding to the already hazardous work of MSWWs.



Figure 3: A picture of Zoomlion sweepers at work

2.2 Occupational Health Hazards of MSWWs

Handling and disposing of MSW is a physically demanding job. Those involved in collecting waste have to sometimes ride on the footplates of the compactor trucks through the traffic and are often at the mercy of the weather (sun, wind and rain). They often have to manually lift and empty the receptacles in which the waste is stored in. They are also exposed to the chemical content of the waste as well as gases that emanate from the decomposing organic waste such as methane; pathogens; toxic substances, exhaust fumes from vehicles and heat stress (Athanasίου et al., 2010; Yang et al., 2001). Additionally, inadvertent exposure to hazardous waste which include infectious medical waste, old batteries that contain heavy metals (Barrett et al., 2012) as well as human faecal matter pose a threat to the health of MSWWs (Bogale et al., 2014).

The predicament of most MSWWs is further worsened by their low socioeconomic status due to their low level of education, poor nutrition and poverty. According to Lavoie et al (2006b), many of these workers are directly exposed to health hazards, since they often work with very little or no PPE. In a study aimed at assessing occupational injuries among Addis Ababa's municipal waste collectors, Bogale et al (2014) found respiratory symptoms, irritation of the eyes, dermal injuries, gastrointestinal problems headaches, allergies, psychological issues and musculoskeletal problems as the most commonly reported health problems among MSWWs.

2.3 The Respiratory Health Effects of Exposure to Solid Waste

Several studies have linked exposure to MSW to the high prevalence of respiratory symptoms in MSWWs. The respiratory symptoms include cough, excessive phlegm production, itching eyes, cold, wheezing, sore throat and shortness of breath.

In assessing the respiratory health of MSWWs, Athanasiou et al (2010), observed an increased prevalence of respiratory problems. Furthermore, they confirmed that exposure to bio-aerosols, dust, vehicular emissions and bad weather conditions contributed significantly to the development of respiratory problems. A similar study (Darboe et al., 2014), in the Gambia reported that 83.8% of refuse collectors studied had persistent cough and phlegm production as against 22.2% of field supervisors. Also, 40.5% of the refuse collectors self-reported shortness of breath, whilst only 11.1% of field supervisors complained of this symptom. Again in Egypt, Abou-Elwafa et al (2014) documented higher prevalence rate of respiratory complaints among MSW collectors compared to service workers (Abou-Elwafa, El-Bestar, El-Gilany, & El-Toraby ISA, 2014). They also found that longer duration of employment was independently associated with impaired FEV₁/FVC. In their opinion, respiratory complaints were prevalent among the MSW collectors which is attributable to inadequate engineering, medical and legislative measures.

A more recent study by Velasco Garrido et al (2015), reported findings that corroborated the high prevalence of respiratory symptoms in MSWWs and the possible causes. They reported a prevalence of 20% for respiratory-related diseases. Moreover, several studies suggest that a longer duration of exposure to SW increases the prevalence of respiratory symptoms and decline in pulmonary function (Mariammal et al., 2012). For instance, a study that assessed the respiratory functions of conservancy workers in solid waste management sector of Chennai India by, Roopa et al (2012) corroborated this assertion.

2.3.1 The Role of Bio-aerosols

The term bio-aerosol is synonymous to organic dust. It is defined as any particulate matter of microbial, plant or animal origin (Douwes, 2003; Kummer & Thiel, 2008). Bio-aerosols

are made up of pathogenic or non-pathogenic fungi and bacteria (live or dead), viruses, high molecular weight allergens, endotoxins from bacteria, mycotoxins, beta (1-3) glucans, peptidoglycans, plant fibers and pollen grains among others (Kummer & Thiel, 2008).

Some molds or fungi may induce allergic reactions (Odewabi et al., 2013). Interestingly, only few case reports have been documented in literature as hypersensitivity pneumonitis and allergic bronchopulmonary aspergillosis (Wouters., 2002). The rarity of these allergic diseases in surveys have led to the conclusion that they cannot fully explain the occurrence of respiratory symptoms in MSWWs (Wouters I M., 2002). However, the most researched bio-aerosols; volatile organic compounds, fungi, 1-3 beta-glucans and endotoxins have been found to be extremely powerful (Heldal & Eduard, 2004). Furthermore, such compounds have the ability to induce non-allergic inflammatory activities in the airways (Athanasίου et al., 2010). The health effects related to exposure to bio-aerosols range from respiratory symptoms, influenza-like symptoms to a more complicated respiratory problem of chronic obstructive airway disease (COPD) (Wouters et al., 2006). This condition is characterized by airflow limitation caused by airway narrowing resulting from inflammation (Hasegawa et al., 2006). Not much studies have been done with regards to determining the levels of exposure to bio-aerosols in solid waste management activities. Nonetheless, studies have indicated that low endotoxin exposure and moderate exposure to beta-glucans and spores of fungi induce inflammation in the upper airway (Douwes, 2003). The process is characterized by an influx of neutrophils and activation of myeloperoxidase, interleukin-8 and eosinophil cationic protein

2.3.2 The Role of Dust

Dust is defined as any air-borne solid matter that is produced during processes such as mineral working, rock disintegrations and any construction activities (Stambuli, 2012). A particle of dust falls within the size range of 1 to 75 microns and may be classified as either respirable or non-respirable. Non-respirable dust contains particles that are bigger than 10 microns. Exposure to dust is an occupational hazard, especially for the category of MSWWs who do a lot of sweeping (Stambuli, 2012).

When dust is inhaled, the amount that is retained in the lungs depends on the chemical and physical properties of the dust particle, the size and where the particles are deposited in the respiratory tract (Schwarze et al., 2008). Ironically, coarse particles rather than fine ones have been strongly associated with the development of occupational asthma and chronic obstructive pulmonary disease (Brunekeerf, 2005). This suggests that the MSWWs who are most at risk of developing dust-induced respiratory problems are the sweepers. They inhale these particulate matter as they sweep the streets, markets, around the skips and communal dump sites, and clear construction debris in our urban settlements.

2.3.3 The Role of Inhaled Gases

Traffic-related pollution is another respiratory health hazard that MSWWs are exposed to (Jayakrishnan et al., 2013). Vehicles generate volatile organic compounds like polycyclic aromatic hydrocarbons (PAH), carbon monoxide (CO), and oxides of sulphur and nitrogen from exhaust pipes (Kampa & Castanas, 2008). Air pollution results in respiratory problems, worsen existing cardiovascular disease and also affects the body's

immune function, such that there is lung tissue damage, carcinogenesis and premature death (Ingle et al., 2005).

2.4 Dermatological Conditions in MSWWs

Municipal solid waste workers are often exposed to infective microorganisms and hazardous materials like human and animal excreta, chemicals and sharp objects when they come into direct contact with them. They also have to grapple with harsh weather conditions such as cold air, rain and excessive sun exposure depending on their working hours and the season. These harsh conditions have detrimental effects on their skin (Nayak et al., 2013), hair, respiratory system (Boadi & Kuitunen, 2005) and even cause urogenital problems (Nayak et al., 2013). Being the largest organ in the body, the skin plays a very crucial role in the body's defense mechanism. It serves as a natural barrier between the internal and external environments, but it becomes vulnerable and predisposed to disease when it is exposed to environmental stressors. These stressors have the potential of inducing dermatological conditions on the hands, faces and other exposed parts of the body (Nayak et al., 2013) of MSWWs. A study by Yang et al (2001) reported ultra violet (UV) as the most common hazard which causes harmful effects in the skin, eyes and immune system. Not only does overexposure to UV light cause sunburn, it also triggers some types of skin cancer. They also documented heat rash, chapped skin and allergic dermatitis resulting from contact with allergens or some hazardous materials, as some of the common skin conditions observed in the MSWWs (Yang et al., 2001).

2.5 The Use of Personal Protective Equipment (PPE)

Personal protective equipment is anything used or worn by an individual to reduce the risk of harm to a person's health or safety. It includes a wide range of clothing and safety

equipment. It is stipulated in Ghana's Labour Law that "*wherever workers are involved in any process involving exposure to any injurious or offensive substance or environment, effective protective equipment shall be provided and maintained by employer for the use of the persons employed*" (Labour Act, 2003).

Given the myriad of health hazards faced by MSWWs, it is crucial that their health risks are minimized, since the MSWWs play an important role in maintaining the health and hygiene in the community. The high levels of particulate matter inhaled in the course of their work makes them susceptible to serious health effects, including disability and death from respiratory and cardiovascular diseases, increased hospital admission and emergency room visits (American Lung Association State of Lung Disease in Diverse Communities, 2010).

Excessive exposure to dust can be reduced by dust control measures in addition to the appropriate use of personal protective devices, respirators, face masks, training and education of the MSWWs about the benefits and correct their use.

Other PPE such as overalls, heavy duty gloves, safety boots, head covers and are helpful in protecting them from direct contact with pathogens, hazardous substances and sharp objects. Furthermore, wearing wide-brim hats, protects the face and neck from direct sunlight.

Unfortunately, in spite of the fact that PPE use is strongly recommended, many MSWWs do not use them (Abd El-Wahab et al., 2014). For example, Konya et al, 2013 in a study aimed at evaluating the use of PPE among workers of five refuse disposal companies in Port Harcourt, Nigeria showed 28% compliance and 72% non-compliance (Konya et al., 2013). The reasons for non-compliance vary from not having them at all to feeling uncomfortable with their use (Amichia, 2013). According to Konya et al (2013), most of

the workers complained of not being comfortable using their PPE. The wearing of PPE such as gloves and boots were often reported by the users to cause hot and humid conditions within them, leading to dermatological problems (Dzodzomenyo, Rheinlä, Ayi, Fobil, & Dalsgaard, 2015)



CHAPTER THREE

METHODOLOGY

3.1 Study Area



Figure 4: Map of the Study Area

The Tema Metropolitan Area (TMA). Metropolis is a coastal district situated about 30 kilometers East of Accra. It shares boundaries with Kpone Katamanso District Assembly on the east, Ledzokuku Krowor Municipal Assembly on the west, at northwest by Adentan Municipal, on the northeast by Ashaiman Municipal Assemblies and the south with the Gulf of Guinea. The Metropolis covers an area of about 87.8 km².

It is an industrial hub and a port city with a population of 292,773. The city's major industrial products are steel, aluminum, textiles, chemicals, petroleum, cement, fish processing and food products. 100 percent of the population is urban. There are 70,797 households with 4.1 persons per household (GDHS, 2010).

3.2 Study Design

A cross-sectional study was conducted to assess the respiratory health and prevalence of dermatological conditions amongst the categories of workers of Zoomlion Ghana Limited (a waste management company) in the Tema Metropolis.

3.3 Variables of interest

Dependent Variables –

1. Measures of Pulmonary function (e.g. FEV₁, FVC and FEV₁/FVC and respiratory symptoms including cough, phlegm production, cold, sore throat, breathlessness, chest pain, wheezing, itchy ear, eyes and throat, chest tightness and difficulty in breathing.
2. Work-related dermatological conditions like fungal infections, eczema and injuries from sharps.

Independent Variables –

1. Individual Factors: Age, sex, weight, height, educational level, smoking status, job category, skill, attitude and past medical history of respiratory disease.
2. Administrative Factor: Availability of personal protective equipment (PPE).

3.4 Study Procedures

Having obtained permission from the management of Zoomlion Ghana Limited to set up a small mobile clinic at their Tema premises for questionnaire administration and clinical examination, data was collected over a six-day period.

The study was explained, clearly, to all participants. The questionnaires were administered by both the researcher and trained research assistants in the language the participant best

understood, after their consent had been obtained. The questions answered were on respiratory health, work schedule, duration of work and the use of PPE. Occupational related respiratory problems and dermatological conditions present at the study time or during a 3-month recall period were noted.

The Principal Researcher who is a clinician also carried out a clinical examination of the participants. Their Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV₁) were measured using a portable spirometer. The parts of their bodies which were exposed, such as their hands, feet, faces and necks were then examined for skin conditions such as sunburn, fungal infections, scabies, eczema and sores from injuries from sharps.

3.5 Study Population

The study population was the entire staff (collectors, sweepers, transporters and administrative and support staff) of the Tema Zonal Office of Zoomlion, Ghana Limited.

3.6 Eligibility Criteria

All the Zoomlion staff in the Tema Zonal Office who fit the inclusion criteria and gave their consent to be part of the study.

3.6.1 Inclusion Criteria

Workers who were between the ages 18 to 60 years, had worked for more than one year and consented to be part of the study.

3.6.2 Exclusion Criteria

Individuals who did not give their consent, those who had been employed for less than one year, and those who had medical or surgical contraindications.

3.7 Sampling

For small populations (for example, 200 or less), the entire population can be used as the sample to achieve a desirable level of population (Singh & Masuku, 2014). The total number of employees of Zoomlion, Ghana Limited in Tema is 135. 105 of those who were at post and met the inclusion criteria participated in the study.

3.8 Data collection Tools

The data collection tools were: a modified respiratory questionnaire (Recommended Respiratory Disease Questionnaire for Use with Adults and Children in Epidemiological Research, 1976), spirometer for measuring pulmonary function, a Seca stadiometer with an incorporated weighing scale.

3.8.1 Questionnaire

The interview questionnaire was in five parts. The first part obtained the sociodemographic information of the study participant. The second part focused on the respondent's work, with regards to issues such as their role and duration of work. The

third part enquired about respiratory symptoms and history of respiratory disease. The fourth part explored the availability and use of PPE. The final part concentrated on the history of dermatological conditions.

3.8.2 Clinical Examination

Clinical examination was performed, looking out for skin conditions on the exposed parts of the body such as the face, neck, arms and feet. The dermatological conditions of interest were fungal nail infections, ringworm, scabies, allergic dermatitis, foot rot, heat rash, ulcers on the hands and feet fissured feet and excoriated skin with scratch marks from itching (prurigo)

3.8.3 Measurement of Weight, Height and Body Mass Index

Anthropometric measurements were done using Seca stadiometer with an incorporated weighing scale. The participants' weights were recorded in kilograms (kg), whilst wearing their indoor clothes, but without their shoes. Their heights were also measured with their feet together, heels against the stadiometer, standing as tall and straight as possible, and recorded in metres (m).

The body mass index of every study participant was calculated by dividing their weight in kilograms by a square of their height in metres.

3.8.4 Assessment of Pulmonary Function by Spirometry

Each participant underwent spirometry to assess their pulmonary function using the Jones Satellite Spirometer. Forced Vital Capacity (FVC) and Forced Expiratory Volume over

one second (FEV_1) and FEV_1/FVC ratio were measured according to the American Thoracic guidelines (Miller et al., 2005).

The test was performed with participants seated comfortably, but in an upright position with both feet flat on the floor and the head slightly raised. They were instructed to take deep breath and have their lips sealed around the spirometer's mouthpiece, and then exhale as fast and as forcefully as they could over at least a 6- second period through the sensor. The FVC, FEV_1 and FEV_1/FVC were automatically measured and percentage of predicted values recorded by the spirometer. Some of the participants went through the procedure multiple times, because of difficulty in following the instructions, came back the next day to repeat the test.

3.9 Quality Control

All the 4 research assistance were adequately trained and supervised. The principal researcher was actively involved in and supervised the data collection procedures to ensure that there was no deviation from the protocol. The purpose and nature of the study was disclosed to the participants. All the completed questionnaires were given a unique identification number in order to trace every information.

Every document was handled and stored in a safe and confidential manner. All the data sheets were signed and filed by the appropriate research assistants. The data was stored on an external storage device and access to the information was restricted to the principal investigator.

3.10 Data Management

3.10.1 Data Processing

Each questionnaire was coded, for example 001, 002, 003, etc. to help prevent double entry and easy verification of any observed anomaly. Data was entered and analysed using STATA software version 13.

Means, standard errors, standard deviations, ranges, percentages as well as p-values were used in describing the data obtained. Socio-demographic data obtained were presented in frequencies and percentages in a table. The prevalence of both respiratory symptoms and dermatological conditions were presented in percentages. Graphical representation of data was done using bar charts. Differences in means of FVC values obtained from sweepers, transporters, collectors and administrative and support staff were tested using one-way Analysis of Variance (ANOVA).

ANOVA was also used to compare variables across the categories of MSWWs. *P*-values <0.05 were considered as statistically significant. Correlational analysis was conducted to determine the relationship between duration of work and respiratory/ pulmonary function.

3.11 Ethical Issues

Ethical Clearance was sought from the Ghana Health Service Ethical Review Committee before the study was started. Permission was further obtained from the Management of Zoomlion Ghana, Limited. The relevance and nature of the study was explained to the participants, and their consent was obtained before they were enrolled into the study. They were also informed that they could opt out of the study at any point if they wished to do so. The participants were assured of confidentiality and this was ensured during the data collection and processing.

Participants who were found to have impaired pulmonary function were duly notified and upon discussion with the Human Resource Department, they were referred to the appropriate specialist health facility for further investigation and management.



CHAPTER FOUR

RESULTS

4.1 Socio-demographic Characteristics of Study Participants

A total of hundred and five (105) workers who were at post at the Tema Zonal Office of Zoomlion Ghana Limited during the period of data collection were recruited for the study.

Figure 5 shows the different categories of workers who participated in the study. These were; collectors 23 (22%), sweepers 27 (26%), transporters 21 (20%) and administrative and support staff 34 (32%).

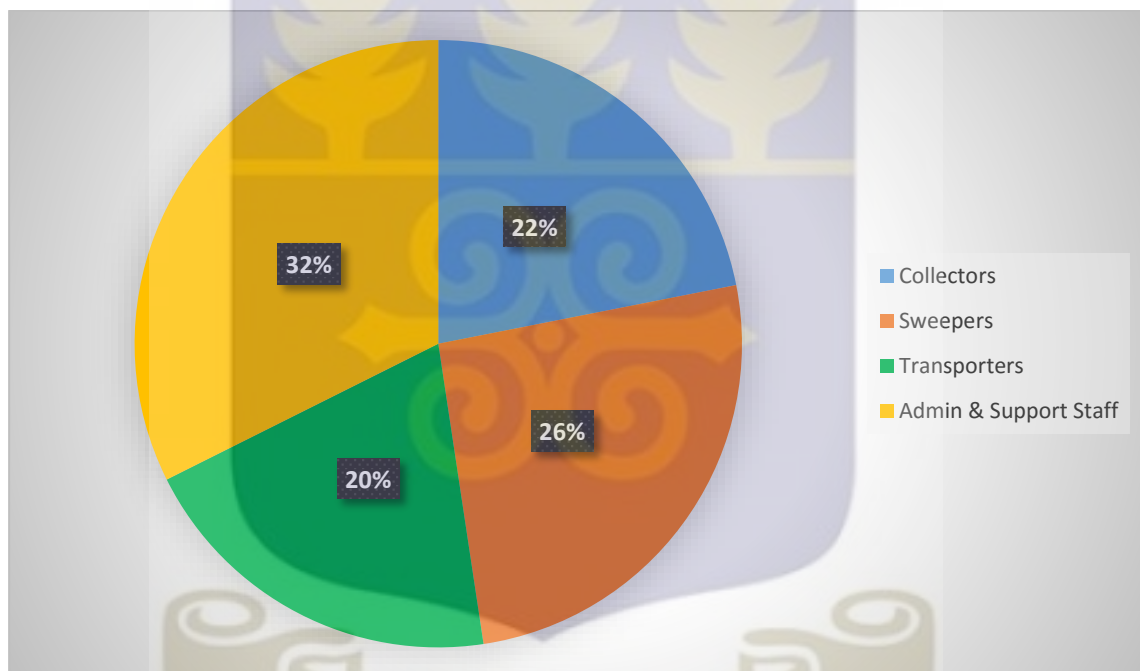


Figure 5: Categories of MSWWs who participated in the study

The socio-demographic characteristics of study participants are presented in **Tables 1 and 2a** below. The ages of respondents ranged from 18-57 years, with a male to female ratio of 2.3:1. Majority, 27 (83.9%) of the females were sweepers. Also, majority of the participants 79 (75.2%) were married. About half, 55 (53%) of the workers had no education or had been educated to at least the Junior High School level. More than half of the participants, 62 (59.0%) have worked with Zoomlion for over 5 years with only, 8

(7.6%) having worked for 1 year. Majority of the workers, 74 (70.5%) work between 7 to 12 hours a day. With regards to medical care, 61 (58.1%) and 17 (16.2%) of them relied on private insurance and national health insurance respectively.

Table 1: Socio-demographic data (N=105 study participants)

Variable	Frequency (n)	Percentage (%)
<u>Age</u>		
18-27 years	7	6.7
28-37 years	33	31.4
38-47 years	34	32.4
> 47 years	31	29.5
Total	105	100
<u>Sex</u>		
Male	74	70.5
Female	31	29.5
Total	105	100
<u>Marital Status</u>		
Single	16	15.2
Married	79	75.2
Divorced	4	3.8
Widowed/widower	5	4.8
Separated	1	1.0
Total	105	100
<u>Highest Educational Level</u>		
No formal Education	12	11
Primary	21	20
JHS	44	42
SHS	10	10
Tertiary	18	17
Total	105	100
<u>Duration of employment</u>		
1 year	8	7.6
2-3years	22	21.0
4-5years	13	12.4
>5years	62	59.0
Total	105	100
<u>Duration of work in a day</u>		
0-6hrs	31	29.5
7-12hrs	74	70.5
Total	105	100
<u>Number of days worked per week</u>		
5 days	39	37.1
6 days	66	62.9
Total	105	100

Table 2a: Medical bills, Smoking and Body Mass Index (BMI)

Variable	Frequency (n)	Percentage (%)
<u>Medical Bills Payment</u>		
National Health insurance	17	16.2
Self	27	25.7
Private health insurance	61	58.1
Total	105	100
<u>Smoking</u>		
Number of smokers	8	7.6
<u>BMI Range</u>		
18-24.9	53	50.5
25-29.9	41	39.0
30 and Above	11	10.5
Total	105	100

With regards to how the employees pay for their medical bills, more than half (58.1) have been signed on to a private health insurance scheme by the company, as shown in **Table 2a**. Only a small percentage (7.6%) indicated that they smoked cigarette. Although, about half of the study participants (50.5%) fell into the BMI range of 18-24.9 kg/m² the average BMI, as calculated in **Table 2b** below was 25.49kg/m², indicative of being overweight.

Table 2b: Weight, height and BMI of study participants

Variable	Mean	Standard Deviation	Min	Max
Weight (kg)	70.46	11.06	42.10	110.30
Height (m)	1.67	0.07	1.48	1.84
BMI (kg/m ²)	25.49	4.58	18.69	47.22

4.2 Municipal Solid Waste Workers Exposure to Environmental Hazards

Presented in **Table 3**, is a summary of possible environmental hazards MSWWs are exposed to.

Table 3: Reported Exposure of MSWWs to Environmental Hazards

Variable	Collectors (n=23) n(%)	Sweepers +(n=27) n(%)	Transporters(n=21) n(%)	Admin Staff (n=34) n(%)
Dust	23 (100)	25 (92.6)	20 (95.2)	27 (79.4)
Heat	20 (87)	20 (74.1)	18 (85.7)	22 (64.7)
Smoke	11(47.8)	8 (29.6)	12 (57.1)	16 (47.1)
Bio-aerosols	12 (52.2)	2 (7.4)	8 (38.1)	2 (5.9)
Molds	6 (21)	2 (7.4)	4 (19)	1 (2.9)
Fumes	12 (52.2)	3 (11.1)	11(52.4)	18 (52.9)
Decayed plants and Animals	19 (82.6)	16 (59.3)	18 (85.7)	20 (58.8)
Sharps	17 (73.9)	4 (14.8)	12 (57.1)	13 (38.2)
Animal Bites	12 (52.2)	13 (48.1)	11 (52.4)	18 (52.9)

Nearly all MSWWs sampled 95 (90.5%) were exposed to dust routinely, followed by heat 80 (76.2%). Exposure to decaying plants and animals was also commonly reported, especially by transporters 18 (85.7%) followed by collectors 19 (82.6). Exposure to molds (12.4%) was the least reported environmental hazard among all the categories of MSWWs. Generally, the administrative and support staff reported the least number of environmental hazards exposure.

4.3 Self-Reported Chronic Respiratory Illnesses in MSWWs

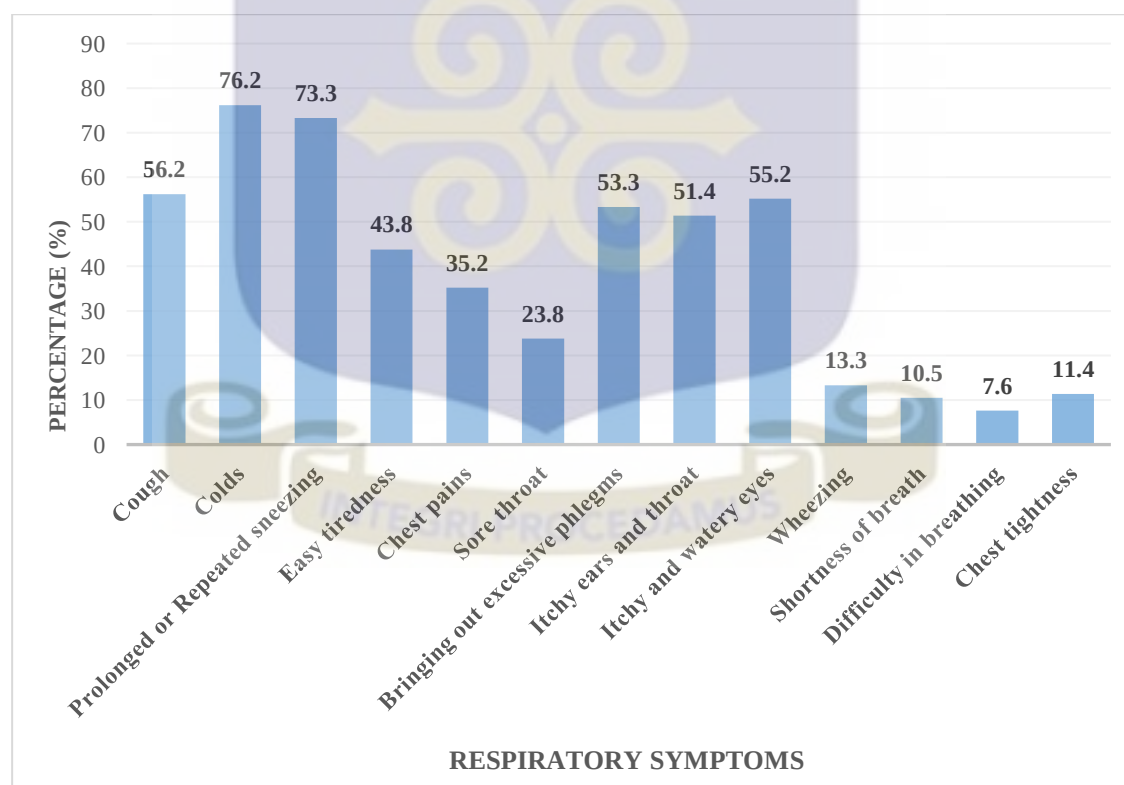
A summary of chronic respiratory illness among study participants is presented in Table 4 below. Only 2 (7.4%) sweepers and 4 (11.8%) administrative and support staff had reported having been previously diagnosed with a chronic respiratory disease.

Table 4: Chronic Respiratory Illnesses in MSWWs

Variable	Collectors (n=23) n (%)	Sweepers (n=27) n (%)	Transporters (n=21) n (%)	Admin Staff (n=34) n (%)
Chronic Bronchitis	0(0)	0(0)	0(0)	0(0)
Emphysema	0(0)	0(0)	0(0)	0(0)
Asthma	0(0)	2(7.4)	0(0)	4(11.8)
Lung Cancer	0(0)	0(0)	0(0)	0(0)
Tuberculosis	0(0)	0(0)	0(0)	0(0)
Others	0(0)	0(0)	0(0)	0(0)

4.4 Overall prevalence of Respiratory Symptoms among MSWWs

Prevalence of respiratory symptoms experienced within the last 3 months among MSWWs is presented in **Figure 7** below. Most MSWWs had high prevalence of colds, 80 (76.2%); coughs, 59 (56.2%) and prolonged/repeated sneezing 77 (73.3%). However, symptoms such as wheezing, chest tightness, shortness of breath as well as difficulty in breathing were not commonly reported.

**Figure 6: Overall Prevalence of Respiratory Symptoms among MSWWs**

4.4.1 Prevalence of Respiratory symptoms among different categories of MSWWs

Figure 7 shows the prevalence of respiratory symptoms among each category of MSWWs. Symptoms such as colds and prolonged or repeated sneezing were highly prevalent among collectors, sweepers and transporters. These symptoms were moderately prevalent among the administrative and support staff. Furthermore, sweepers consistently reported allergic symptoms such as itchy ears and throat, excessive production of phlegm and itchy and watery eyes.



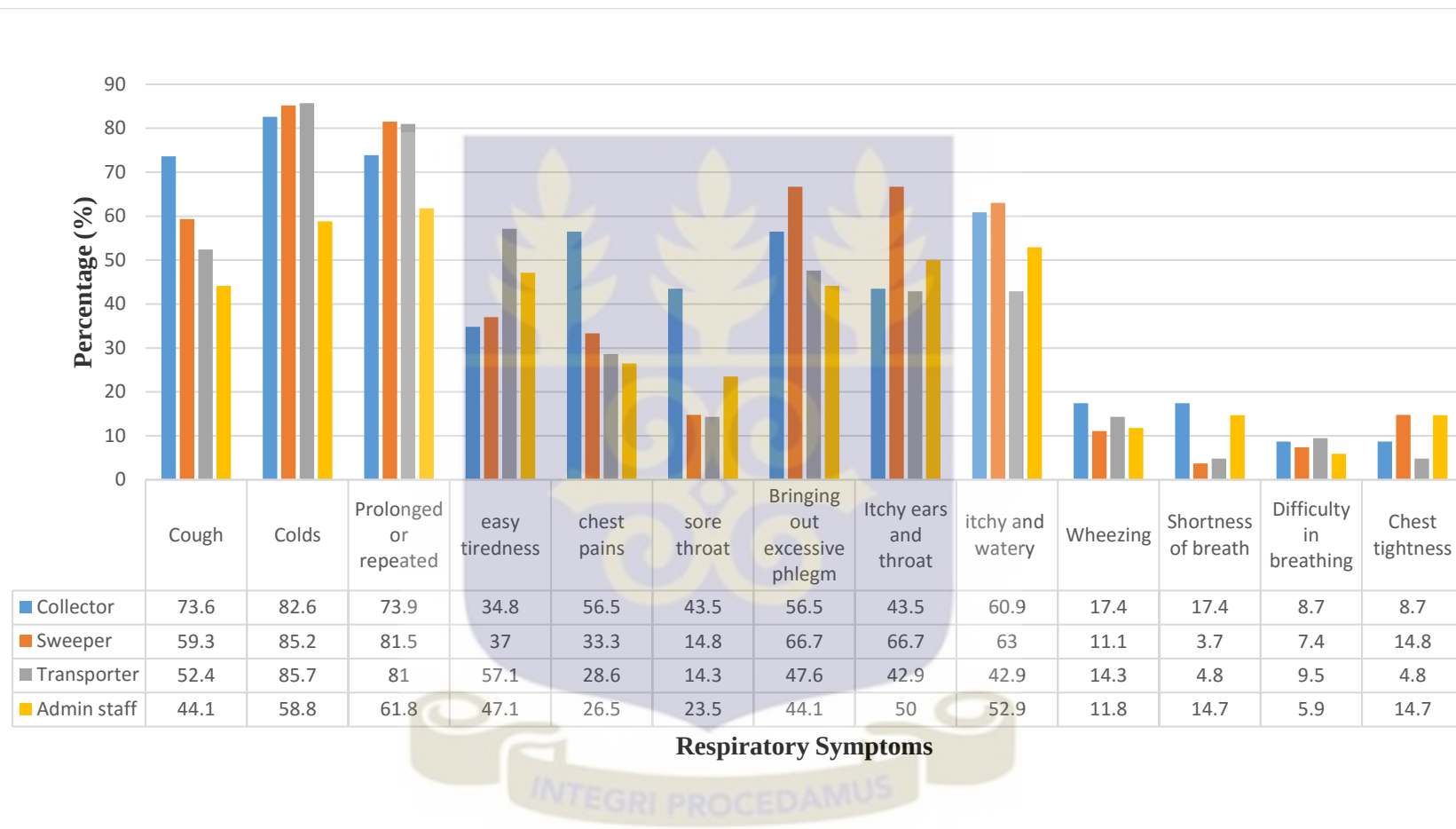


Figure 7: Prevalence of Respiratory Symptoms among different categories of MSWWs.

4.4.2 Pulmonary function indices of different categories of MSWWs.

Average pulmonary function indices (FVC, FEV₁ and FEV₁/FVC) measured in all categories of MSWWs are represented in **Table 5**, below. Sweepers had the lowest pulmonary function test values (suggestive of impaired pulmonary function), whilst the administrative and support staff recorded the highest values (suggestive of satisfactory pulmonary function). Analysis of Variance (ANOVA) of FVC ($p=0.00$) and FEV₁ ($p=0.00$) revealed a statistically significant difference.

Table 5: The Mean Pulmonary Function Indices among Different Categories of MSWWs.

Respiratory Function	Collectors Mean $\pm$ SD	Sweepers Mean $\pm$ SD	Transporters Mean $\pm$ SD	Admin Staff Mean $\pm$ SD	<i>p</i> -value
FVC	3.22 $\pm$ 0.69	2.62 $\pm$ 0.75	3.24 $\pm$ 0.69	3.34 $\pm$ 0.53	0.000
FEV ₁	2.77 $\pm$ 0.54	2.07 $\pm$ 0.43	2.78 $\pm$ 0.46	2.86 $\pm$ 0.44	0.000
FEV ₁ /FVC	0.87 $\pm$ 0.09	0.82 $\pm$ 0.13	0.87 $\pm$ 0.08	0.87 $\pm$ 0.89	0.141

4.5 Relationship between duration of work and pulmonary function

Positive correlations were found between duration of employment, working hours and FVC and FEV₁ pulmonary indices as presented in **Table 6**. However they were all not statistically significant.

Table 6: Relationship between Duration of Work and Respiratory Function

Variables	Pearson's Correlation Coefficient (R)	<i>p</i> -value
<u>FVC</u>		
Duration of employment	0.127	0.156
Working hours	0.138	0.072
<u>FEV₁</u>		
Duration of employment	0.102	0.160
Working hours	0.326	0.149
<u>FEV₁/FVC</u>		
Duration of employment	-0.003	0.200
Working hours	0.346	0.154

4.6 Prevalence of dermatological conditions

4.6.1 Prevalence of dermatological conditions reported by different categories of MSWWs

As shown in **Table 7** below, the most commonly reported dermatological conditions were heat rash and ulcers and scars on the hands and feet. A higher proportion of collectors (56%) reported ulcers and scars on their hands and feet, compared to any other category of workers. Although, collectors, sweepers and transporters generally reported more skin conditions, administrative and support staff reported more foot rot (17.6%) than sweepers (11.1%) and transporters (14.3%). The least reported dermatological condition among the different categories of MSWWs were; foot rot, ringworm, fissured feet, scabies and pruritus (itching).

Table 7: Dermatological conditions reported by the different Categories of MSWWs

Skin Condition	Collectors n(%)	Sweepers n(%)	Transporters n(%)	Admin Staff n(%)
Fungal nail infection	0 (0)	4 (14.8)	0 (0)	3 (8.8)
Ringworm	3 (13)	1 (3.7)	1 (4.8)	1 (2.9)
Scabies	2 (8.7)	1 (3.7)	0 (0)	0 (0)
Allergic dermatitis	2 (8.7)	0 (0)	3 (14.3)	3 (8.8)
Foot rot	6 (26.1)	3 (11.1)	3 (14.3)	6 (17.6)
Heat Rash	10 (43.5)	13 (48.1)	10 (47.6)	12 (35.3)
Ulcers & scars on hands & feet	13 (56.5)	9 (33.3)	10 (47.6)	7 (20.6)
Fissured feet	3 (13)	0 (0)	2 (9.5)	0 (0)
Prurigo	3 (13)	4 (14.8)	1 (4.8)	2 (5.9)

4.6.2 Prevalence of Dermatological Conditions Observed During Clinical Examination

The overall prevalence of dermatological conditions observed during clinical examination of the MSWWs was 60% as presented in Table 8 below.

Table 8: Prevalence of Dermatological Conditions Observed During Clinical Examination

Category	Collectors (n=23)	Sweepers (n=27)	Transporter (n=21)	Admin Staff (n=34)
No of MSWWs	n (%)	n (%)	n (%)	n (%)
Prevalence	16 (69.6)	10 (37)	19 (90.5)	18 (52.9)

4.7 Level of Personal Protective Equipment use.

4.7.1 PPE available for use by MSWWs.

The most common PPE available to all the categories of workers were hand gloves, nose/mouth masks, overalls and boots as described by shown in **Figure 8**. It also shows the proportions of MSWWs who have PPE available and those who actually use them.

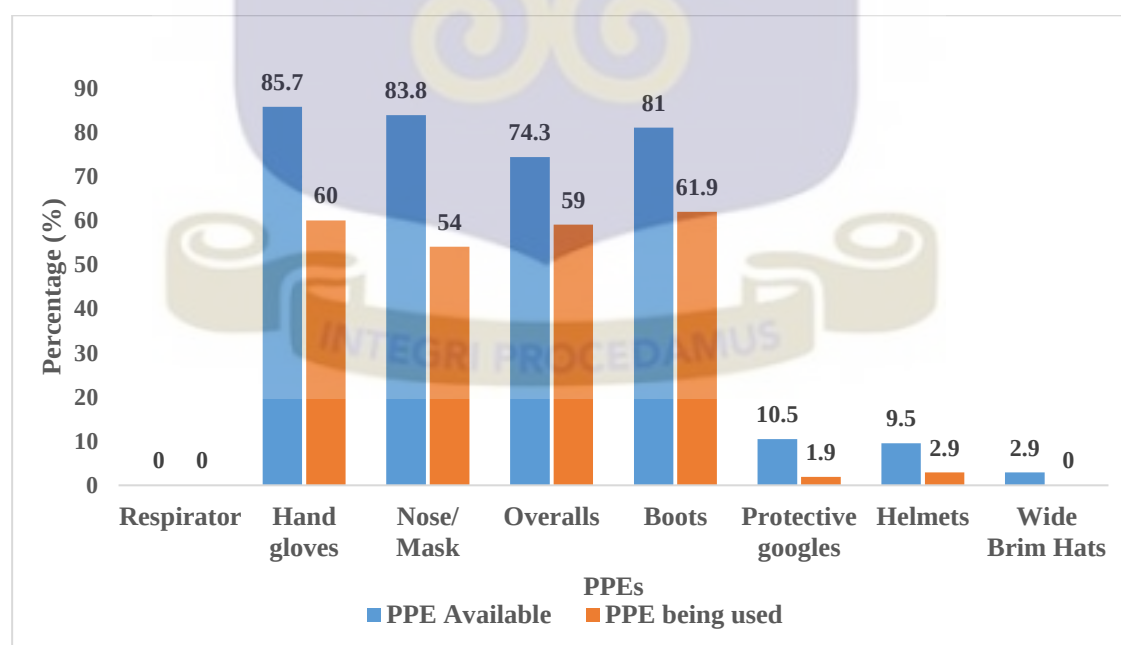


Figure 8: Overall PPE availability and usage

The proportions of MSWWs who reported the availability of PPE and their use are presented in **Table 9** below.

Table 7: PPE availability and usage among the different Categories of MSWWs

	Collectors (n=23) n(%)	Sweepers (n=27) n(%)	Transporters (n=21) n(%)	Admin Staff (n=34) n(%)
<u>PPE Availability</u>				
Respirator	0(0)	0 (0)	0 (0)	0 (0)
Hand gloves	22 (95.7)	26 (96.3)	18 (85.7)	24 (70.6)
Nose/ Mask	21 (91.3)	23 (85.2)	19 (90.5)	25 (73.5)
Overalls	17 (73.9)	23 (85.2)	9 (42.9)	25 (73.5)
Boots	17 (73.9)	24 (88.9)	17 (81)	27 (79.4)
Protective googles	2 (8.7)	0 (0)	1 (4.8)	8 (23.5)
Helmets	0 (0)	0 (0)	0 (0)	6 (17.6)
Wide Brim Hats	1 (4.3)	0 (0)	0 (0)	2 (5.9)
<u>PPE Usage</u>				
Respirator	0 (0)	0 (0)	0 (0)	0 (0)
Hand gloves	15 (65.2)	22 (81.5)	14 (66.7)	12 (35.3)
Nose/ Mask	15 (65.2)	14 (51.9)	15 (71.4)	11 (32.4)
Overalls	15 (65.2)	23 (85.2)	7 (33.3)	17 (50)
Boots	16 (69.6)	16 (59.3)	14 (66.7)	19 (55.9)
Protective googles	1 (4.3)	0 (0)	0 (0)	1 (2.9)
Helmets	0 (0)	0 (0)	0 (0)	3 (8.8)
Wide Brim Hats	0 (0)	0 (0)	0 (0)	0 (0)

CHAPTER FIVE

DISCUSSION

5.1 Socio-demographic Characteristics

Males outnumbered females with a male to female ratio of 2.3:1. However, all sweepers were females, a finding consistent with previous studies which attributed the hiring of more female sweepers to their ability to sweep and clean better than their male counterparts (Amichia., 2013; Kretchy., 2013; Bogale et al., 2014). The fact that waste collection was dominated by males is understandable since it is a physically demanding job where lifting heavy bins is a routine activity. Nearly half (50%) of study participants had less than 9 years of formal education, a finding corroborated by other studies that also found SWM activities as source of income for individuals with no or low level of formal education (Athanasίου et al., 2010). El-Wahab and co-workers also reported similar findings, where only about 50% of the MSWWs studied had more than primary education (El Wahab et al., 2014).

5.2 Exposure of Municipal Solid Waste Workers to Environmental Hazards

The study showed that nearly all MSWWs were exposed to dust and heat. Exposure to decaying plants and animals was a predominant complaint from transporters (85.7%) and collectors (82.6%). Hazards such as fumes, smoke and exposure to sharps and animal bites were moderately common. Exposure to molds (12.4%), was the least reported environmental hazard among all the categories of MSWWs. These environmental hazards have been mentioned in some earlier studies to be associated with adverse health effects such as respiratory, dermatological and gastrointestinal disorders (Dorevitch & Marder., 2001). The activities of collectors, sweepers and transporters, unlike the administrative and support staff, put them directly at risk since they come into contact with municipal

solid waste on daily basis (Abou-ElWafa, et al., 2014; Athanasiou et al., 2010) In their study among street sweepers in India, Sabde et al. (2008) found anaemia, hypertension, upper respiratory tract infection and chronic bronchitis as common health conditions presented by street sweepers.

In this current study, some of the administrative and support staff who were involved in supervising the other categories of MSWWs were found to have respiratory and dermatological conditions, because they were also exposed to environmental hazards.

5.3 Prevalence of Respiratory Symptoms of MSWWs

The common respiratory symptoms reported by the MSWWs were colds and prolonged or repeated sneezing, cough excessive production of phlegm, itchy and watery eyes as well as itchy ears and throat. The prevalence of respiratory health symptoms were higher among those categories of MSWWs who often come into direct contact with solid waste (collectors, sweepers and transporters) compared to the administrative and support staff.

MSWWs, particularly sweepers, were found to have reduced pulmonary function indices compared to the administrative and support staff. This observation has been documented in many studies. For example a study conducted in Chennai, India reported higher respiratory symptom prevalence rates and reduction in pulmonary function among sweepers, compared to loaders/collectors (Roopa et al., 2012).

Several studies have documented that waste collection activities, especially sweeping expose workers to air pollutants such as dust, air toxins from fumes, smoke and bio-aerosols which are not adequately prevented by the nose/mouth masks provided. The inhalation of ambient particulate matter such as dust results in their interaction with lung cells, leading to lung pathology (Johncy S, G, Samuel T, K T, & Bondade, 2013).

5.4 Prevalence of Dermatological Conditions

This study found that 60% of study participants had one form of dermatological condition or the other, which compares to the 70.3% reported by Aimuddin et al. (2015). Most of these dermatological conditions result from infections or immune inflammatory reactions from direct contact with components of municipal solid waste (Abd El-Wahab et al., 2014).

Again, heat rash, ulcers and scars on the hands and feet were the most commonly reported dermatological conditions. Generally, collectors, sweepers and transporters all reported higher prevalence of skin conditions.

The single most prevalent skin condition reported and observed, with respect to the different categories of MSWWs, was scars and ulcers on hands and feet. More than half (50%) of collectors had been injured by sharp objects, falls, slips and burns whilst at work. In Ghana, waste generated is often dumped on the ground, or in open receptacles/bins that require being picked using ones hands. Collectors are thus at greater risk of direct contact with solid waste and its attendant health risk of dermatological conditions.

5.5 PPE Use Among Municipal Solid Waste Management Workers

The use of PPE can reduce the myriad of health hazards that MSWWs are exposed to. In this regard, the management of Zoomlion Ghana Limited has done well in providing most of the relevant PPE for their staff. Although most of the MSWWs indicated that they had been provided with basic PPE such as hand gloves, overalls, boots and nose/mouth masks, it appears majority of MSWWs do not comply with company policy and therefore seldom use PPE provided. Generally, with the exception of the wearing of boots, the sweepers were the most compliant with PPE use. In spite of the fact that some administrative and

support staff who were field supervisors had access to PPE, they reported the lowest adherence to PPE use. This probably accounted for some of the respiratory symptoms and dermatological conditions such as heat rash and foot rot reported by this category of MSWWs. Some of the reasons MSWWs gave for not using their PPE ranged from not being aware of their availability to poor fit, consistent with an earlier finding by Thirarattanasunthon et al. (2012). This finding underscores the recommendation made by Amichia (2012), for constant provision of PPE and training for MSWWs.



CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study demonstrates that:

1. MSWWs (collectors, sweepers and transporters) have increased prevalence of respiratory symptoms and reduced pulmonary function indices (FVC, FEV₁ and FEV₁/FVC), compared with administrative and support staff.
2. There is a higher prevalence of dermatological conditions amongst MSWWs (collectors, sweepers and transporters) than the administrative and support staff.
3. In spite of the reported availability of PPE to Zoomlion MSWWs, proportion of those who use them is relatively low.

6.2 Recommendations

1. There is a need for a thorough pre-employment medical examination and the establishment of a robust medical surveillance system for all waste management companies, such as Zoomlion Ghana Limited. These programmes will ensure proper placement of employees and also assist in early detection and management of respiratory and other medical condition.
2. The provision of additional internationally recommended PPE such as respirators, protective goggles, helmets, appropriate and comfortable protective footwear and wide-brim hats is highly recommended. The use of the PPE provided must also be strictly enforced.

3. Pre-employment training on job safety and hygiene is very important. This training must include effective skin regime, with emphasis on the use of barrier skin products.

Finally, there is the need for further research other adverse health effects of waste management activities on MSWWs and how their health and safety can be protected.

6.3 Limitations

Errors could occur in the spirometry measurement, because the procedure depends, to a large extent, on participant's understanding of the maneuvers and their effort during measurement. However, participants who had difficulty were allowed multiple attempts in order to improve the accuracy of the results.

Secondly, for fear of probably losing their jobs, some of the employees may have held back some information concerning their health.

Another limitation of the study is the fact that its cross-sectional design precludes the determination of a temporal relationship



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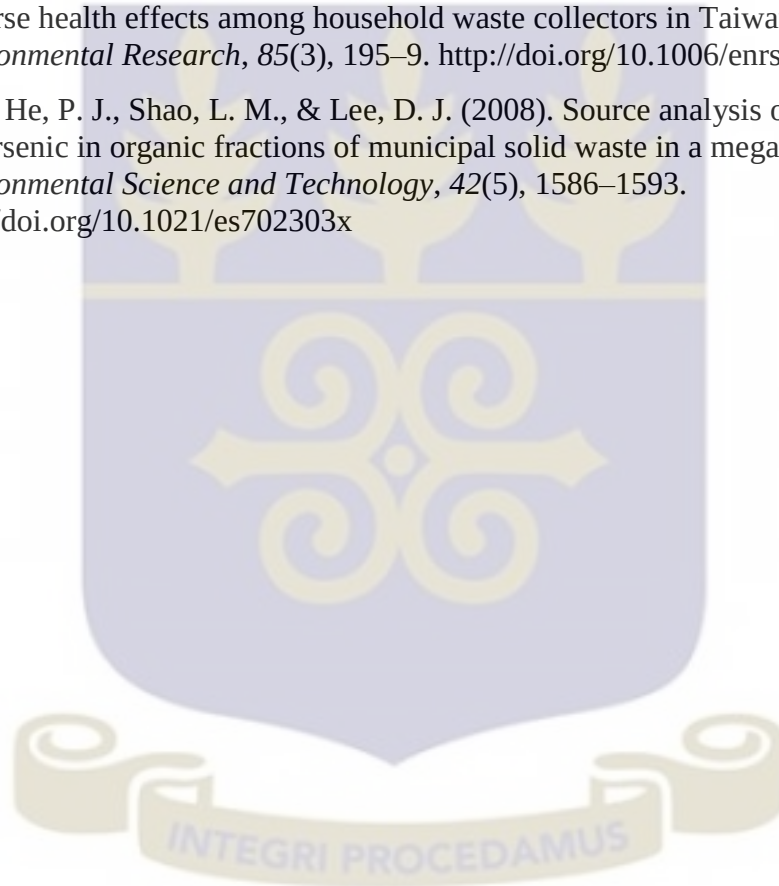
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APPENDICES

Appendix 1: Consent Form

Title: Respiratory symptoms and dermatological conditions in municipal solid waste workers in Tema: The case of Zoomlion, Ghana Limited

Principal investigator: Lenusia Afua Ahlijah

Qualification: MBChB, MWACP, MGCPS

Address: School of Public Health, University of Ghana, Legon.

General information about the research

This research is being conducted to assess how the respiratory health and the skin of solid waste management workers in Tema are affected by their work. The entire research will over a 3-month period.

The collection, transporting and the final disposal of waste, exposes them to dust, infectious particles and gases from decaying material and fumes from vehicles which are injurious to human health.

The study is purely an academic exercise and it forms part of the researcher's work towards the award of a Master of Science Degree in Occupational Medicine.

Possible risk of discomfort

There are no major risks associated with participating in this study. The procedures involved in this study are non-invasive and will not cause any discomfort to the participants. However, a few participants may transient experience dizziness during the lung function measurement.

Description of level of research burden

Study participants would be requested to answer a questionnaire, participant in lung function test and be clinically examined for skin conditions.

Possible benefits

The benefit to the participants is that, those who require treatment for their skin conditions will be referred to the nearest health facility for treatment. Additionally, findings of the study will inform the health and safety policies of the employers and other stakeholders to minimize the health challenges of municipal waste management.

Confidentiality

Confidentiality will be assured. The study participants will be assured that all their information will be confidential and will not be disclosed to anyone without their permission.

Data security

All information obtained, will be kept in locked files by the principal investigator with secured pass codes.

Plans for record keeping

The study materials (laboratory data and results, questionnaires, informed consents) will not be labeled with participant's names but rather a unique identification number for each study participant.

Person responsible and phone number

The person responsible for the data storage will be

Lenusia Afua Ahlijah (Student)

School of Public Health, University of Ghana, Legon.

Mobile number: 0244644332.

Voluntary participation and the right to leave the research

Participating in this is entirely voluntary. Declining to enter the study, answer a question or ending the interview will have no negative consequences.

Contacts for additional information

Please call the person responsible for this study, Lenusia Afua Ahlijah, on 0244644332 if you have questions about the study. If you have any questions about your rights as a research participant or feel you have not been treated fairly, you may contact any of the following:

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

for further clarification or redress.

Your rights as a participant

This research has been reviewed and approved by the Ghana Health Service Ethical Review Board. If you have any further questions about your rights as a research participant, you may contact the chairman of the Board.

Consent Form

The above document describing the benefits, risks and the procedures for the research title (“Respiratory symptoms and dermatological conditions in municipal solid waste workers in the Tema: The case of Zoomlion, Ghana Limited”) has been read and explained to me. I have been given the opportunity to ask questions and all the questions that I have asked about the research have been answered to my satisfaction. I agree to participate as a volunteer.

.....

Date

.....

Signature or Thumbprint of Participant

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

.....

Date

.....

Signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

.....

Date

.....

Signature of person who obtained consent

Appendix 2: Questionnaire

Dear Participant,

We would be very grateful if you would assist in helping us carry out an important study at the School of Public Health at the University of Ghana.

This study will provide you with some helpful job-related health information that will help you to maintain good health.

Could you please help us complete this questionnaire by answering a few questions about yourself, your occupation, respiratory health and medical history. Your participation is vital to the success of this research project.

We would like to assure you that whatever information you give us will be confidential and will be known by only the researchers. The information will be reported in statistical summary form only.

Should you have any questions about the study, or 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 in this important research project.

Contact:

Dr. Lenusia Afua Ahlijah (Student)

Phone number: 0244644332

Email: ladzadzi@yahoo.com

PART A

1. Questionnaire number <input type="text"/> <input type="text"/> <input type="text"/>	2. Date of Interview DD/MM/YYYY <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
Time <input type="text"/> <input type="text"/> . <input type="text"/> <input type="text"/> hours Interviewer name	
A. DEMOGRAPHIC DATA	
3. Age: 18-27 years 1 ☐ ☐ 28- 37years 2 ☐ ☐ 38- 47years 3 ☐ ☐ 48-57 years 4 ☐ ☐ Above 58 years..... 5 ☐ ☐	
4. Sex: (Please tick as appropriate) Male 1 ☐ ☐ Female..... 2 ☐ ☐	
5. Marital Status: (Please tick as appropriate) Single..... 1 ☐ ☐ Widowed/widower.....4 ☐ ☐ Married.....2 ☐ ☐ Separated.....5 ☐ ☐ Divorced.....3 ☐ ☐	
6. How are you paying for your medical care? National Health Insurance.....1 ☐ ☐ Private Health Insurance.....3 ☐ ☐ Self.....2 ☐ ☐ Family.....5 ☐ ☐	
7. What is your highest level of education? No formal education.....1 ☐ ☐ Primary.....2 ☐ ☐ Junior High School.....3 ☐ ☐ Senior High School.....4 ☐ ☐ Tertiary.....5 ☐ ☐	
8a. Do you smoke cigarettes? Yes.....1 ☐ ☐ No.....2 ☐ ☐	
8b. If yes, how many sticks do you smoke in a day? < 5 sticks.....1 ☐ ☐ 5-10 sticks2 ☐ ☐ >10sticks.....3 ☐ ☐	
8c. How long have you been smoking? 1-5 years.....1 ☐ ☐ 6-10 years.....2 ☐ ☐ > 10 years3 ☐ ☐	

PART B (Work)

9. What does your work entail? Please tick as appropriate.	
Collection.....1 []	Sweeping
.....2 []	
Transporting.....3 []	Administration and Support
Staff.....4 []	
10. How long have you been working with Zoomlion?	
6 months – 1 year.....1 []	4-5 years.....3
[]	
2-3 years.....2 []	> 5 years4
[]	
11. How many hours o you work a day?	
0-6 hours.....1 []	7-12 hours.....2 []
[]	
12. How many days do you work in a week?.....days	
13. Does you your work expose you to any of the following? Please tick as appropriate.	
Dust.....1 []	Fumes.....6
[]	
Heat.....2 []	Decaying plant and animal products...7
[]	
Smoke.....3 []	Sharp Objects.....8
[]	
Bio-aerosols.....4 []	Animal Bites.....9
[]	
Mold.....5 []	

PART C (Health)

14a. Have you ever been diagnosed of any chronic respiratory illness?	
Yes.....1 []	No.....2 []
14b If your answer is yes, what was it? Please tick as appropriate.	
Chronic Bronchitis.....1 []	
Emphysema.....2 []	
Asthma.....3 []	
Lung Cancer.....4 []	
Tuberculosis.....5 []	
14c. Has your present job made the illness worse? Yes.....1 [] No.....2 []	

15. Have you experienced any of the following symptoms in the course of your work in the last 3 months? Please tick as appropriate

Symptoms	Yes	No
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		
If you answered yes to any question please give details:		

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

16. Do these symptoms stop when you are away from your work place?

Yes.....[] No.....[]

17. Have you experienced any of the following skin conditions since you started working at your present unit?

Skin Condition	Yes=1	No=2
Fungal nail infection		
Ringworm		
Scabies		
Allergic Dermatitis (Eczema)		
Foot rot (Tinea pedis)		
Heat Rash		
Ulcers and scars on hands and feet from penetrating injuries		
Fissured feet		
Pruritus (Itching)		
Others		

PART D

18. Which of the following PPE are available for your use?

Type of PPE	Yes=1	No=2
Respirator		
Hand gloves		
Nose/Mouth mask		
Overalls		
Boots		
Protective Goggles		
Helmet		
Wide-brim hats		

19. Which of the following PPE do you use at work?

Type of PPE	Yes=1	No=2
Respirator		
Hand gloves		
Nose/Mouth mask		
Overalls		
Boots		
Protective Goggles		
Helmet		
Wide-brim hats		

CLINICAL EXAMINATION

Weightkg

Height.....m

20. Check List for skin conditions

Skin Condition	Yes=1	N=2
Fungal nail infection		
Ringworm		
Scabies		
Allergic Dermatitis		
Foot rot (Tinea paedis)		
Heat Rash		
Ulcers and scars on hands and feet from penetrating injuries		
Fissured feet		
Pruritus (Itching)		
Others		

SPIROMETRY

FVC.....

FEV₁.....FEV₁/FVC.....

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

Appendix 3: Ethical Approval Letter

