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OCCUPATIONAL HEALTH HAZARDS AND RISK AMONG TRICYCLE WASTE COLLECTORS IN THE GREATER KUMASI OF THE ASHANTI REGION, GHANA

APPIAH JOSEPH

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OCCUPATIONAL HEALTH HAZARDS AND RISK AMONG TRICYCLE WASTE COLLECTORS IN THE GREATER KUMASI OF THE ASHANTI REGION, GHANA

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DECLARATION

STUDENT'S DECLARATION

I, Appiah Joseph, now declare that except for references to the works of other researchers duly cited, this work is the result of my original research and that this dissertation has neither in whole nor in part been presented for another degree elsewhere.

SIGNATURE: …………………………………

DATE: ……………………………………….

SUPERVISORS' DECLARATION

We declare that the preparation and presentation of this work were supervised by the guidelines for the supervision of the thesis as laid down by the Akenten Appiah Minkah University of Skills Training and Entrepreneurial Development

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DEDICATION

I dedicate this work to my lovely Wife Agyapomaa Mercy, my late Father Mr. Felix Osei, Madam Oforiwaa Margaret, and my Godfather, Mr. Okyere Boampong; for their unfailing love and unrelenting support throughout my education and career.

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LIST OF ABBREVIATIONS

GH¢	:	Ghana Cedis
GSS	:	Ghana Statistical Service
NHIS	:	National Health Insurance Scheme
OHS	:	Occupational Health and Safety
PPE	:	Personal Protective Equipment
US$	:	US dollar
WHO	:	World Health Organization
ZL	:	Zoomlion
KCARP	:	Kumasi Compost and Recycling Plant
KMA	:	Kumasi Metropolitan Assembly
ELISA	:	Enzyme-link Immunosorbent Assay

OPERATIONAL DEFINITION OF TERMS

Compliance: the practice of abiding with applicable rules and standards to improve outcomes and increase productivity whilst reducing the incidence of accidents.

Formal waste collectors: waste collectors who work as employees of a waste collection company or contractor

Perceive: to be aware of something.

Private waste collectors/informal waste collectors: refers to waste collectors who any company or contractor does not employ, do not belong to any company but collect wastes as individuals.

Personal protective equipment refers to anything which provides safety from hazards and accidents, taking into account the work and its risks.

Waste Collectors: Individuals and companies involved in waste collection. They include waste pickers, sweepers, janitors, tricycle riders, cart pushers, and anybody who picks up wastes at designated sites; and considers or regards such activities as an occupation.

ABSTRACT

Global solid waste generation rates are rising due to rapid population growth and urbanization in 2016, 2.01 billion tonnes of solid waste were generated with a projected annual increase rate of 70% which would lead to 3.40 billion tonnes by 2050. This study aimed to assess the occupational health hazards and risks faced by tricycle waste collectors in the Greater Kumasi area of the Ashanti Region, Ghana. The specific objectives were to determine the current practices of waste collectors on waste management and economic gains, assess the hazards and risks associated with waste collection, and evaluate the health status and diseases suffered by waste collectors. A cross-sectional research design was employed, and semi-structured questionnaires were used to collect data from 315 participants involved in waste collection and management processes. Additionally, 100 participants underwent hepatitis B screening. Data were analyzed using descriptive statistics, chi-square tests, and frequency distributions. Results of the study showed that, majority of waste collectors were male (97.46%), aged between 20-29 years (58.41%), The mean age of the participants was 25.4 (±5.87) years with a modal age group of 20–29 and had primary education (33.65%). 60% of the participants were single with majority of waste collectors identified as Muslims (71.11%), while 27.62% were Christians. More than two-thirds of the respondents had worked for five years (71.11%). Safety boots were the most commonly used personal protective equipment (PPE), with (78%). The study revealed various occupational health hazards, with back pain being the most commonly reported (34%). Additionally, 12% of participants tested positive for hepatitis B. The findings indicate a lack of awareness among waste collectors regarding the occupational health hazards associated with waste collection. This study underscores the need for improved occupational health and safety practices among tricycle waste collectors in Greater Kumasi.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Global solid waste generation rates are rising due to rapid population growth and urbanization. In 2016, 2.01 billion tonnes of solid waste were generated with a projected annual increase rate of 70% which would lead to 3.40 billion tonnes by 2050 (Rathore & Panwar, 2022). It is estimated that about 125 million tonnes of municipal solid waste (MSW) were generated in Africa per annum, of which 68 million tonnes were collected (Scarlat *et al.,* 2015). The collection rates vary depending on the country's income level and the region. High-income countries have collection rates averaging 98% while in low-income countries the average rate is 40% (Uddin *et al.,* 2021). Historically, waste collection businesses were known for their unsafe working environment due to work-related injuries which are very frequent among waste workers (Dewi & Hidayat, 2020).

Safety, therefore, becomes the highest priority for most global industries since workplace accidents and injuries substantially contribute to the loss of work time, reduction in employees' productivity, and deaths, and subsequently affect the economy. These conditions even become worse in waste industries, especially in developing countries (Uddin *et al.,* 2021). Globally, solid waste collectors are exposed to occupational health-related problems from waste materials and the physical effort they exert in waste handling (Adeleke *et al.,* 2021). Occupational hazards could include contact with human faeces, waste contaminated with toxic materials, bottles with chemical residues, metal containers with pesticide and solvent residues, sharps and other infectious wastes from hospitals, batteries containing heavy metals, and exposure to refuse truck exhaust pollutants, etc. (Chisholm *et al.,* 2021). Repetitive action, awkward working positions, intense hand exertion, and frequent physical handling all constitute the tasks of the waste collector (Rathore & Panwar, 2022).

Also, rain and dim lighting in the early morning hours are unavoidable circumstances that have the potential to lead to hazard issues. The working conditions of over 3 billion waste collectors worldwide do not meet the minimum standards and guidelines set by the World Health Organization (WHO) and the International Labour Organization (ILO) for occupational health and safety (ILO, 2014). According to the International Labour Organization (ILO), global estimates of occupational accidents and work-related diseases in 2017 stood at 2.78 million fatalities compared to 2.33 million in 2011 (Nai'em *et al.,* 2020).

Waste pickers are therefore key in the collection and transportation of solid waste (SW) from homes, villages, towns, cities, factories, and other sources in a bit to maintain a healthy and clean environment (Acquah *et al.,* 2021). Municipal waste workers are exposed to a variety of risk factors. They are prone to accidents, injuries, infections and animal bites (Adeleke *et al.,* 2021). Solid waste collectors in low-income countries have a low socio-economic status; education, housing, and nutrition, and also have low knowledge of occupational health safety (Wassie *et al.,* 2022). Those who work in the waste collection business are particularly vulnerable to occupational hazards and health problems. The waste workers are exposed to various hazards which can affect their job performance and are a recipe for occupational health-related diseases (Wassie *et al.*, 2022).

In Ghana, about 3 million tonnes of solid waste is generated annually, with an average of 0.45 kg per capita. Accra and Kumasi, the second-largest city, combine to generate about 3,000 tonnes of solid waste daily(Hussein *et al.*, 2022). Kumasi generates an average of 1,500 to 2000 tons of solid waste per day, of which 1,400 tons are collected, with the remainder ending up in drains, gutters, and open spaces. A ton of waste is equal to 16 full brown cocoa sacks (Adeleke *et al.*, 2021). That means that 100 tons of uncollected waste, the equivalent of 1,600 cocoa sacks, ends up in drains and open spaces. That exposes the city to flooding and other illnesses associated with poor sanitation (Hirpe & Yeom, 2021).

MMDAs are overwhelmed with the management of solid wastes generated, which has an economic cost. Industrial and household owners are also confronted with heaps and tonnes of SW that are often not collected timeously and could take days or weeks before being collected, posing a health threat to the residence (Ncube *et al.*, 2021). These difficulties led to the emergence of private individual waste collectors, which have evolved to meet this growing need and demand. These novel private waste collectors employed their tricycles to collect domestic and other wastes from various institutions transporting them to designated sites or landfill sites for a fee. Solid wastes generated at homes, industries, etc. are collected for a fee depending on the quantum of the waste (Dzah *et al.*, 2022). In a bit to maximize their gains/incomes, waste pickers/collectors overload their tricycles and this often leads to accidents and breakdowns of these tricycles on their way to landfill sites resulting in injuries and exposure to occupational hazards (Dzah *et al.,* 2022). Some waste collectors would collect and transport several daily trips, increasing their occupational injury risks. Many of these waste collectors have little or no knowledge of the hazards and health risks associated with their trade (Arkorful *et al.,* 2022).

1.2 Problem Statement

Tricycle waste collectors play a crucial role in waste management systems in Greater Kumasi, Ghana. However, their occupation exposes them to various occupational health hazards and risks. These hazards and risks arise from their direct contact with potentially hazardous waste materials, poor working conditions, and the lack of proper personal protective equipment (PPE). Despite the significance of this occupational group in waste management, there is a lack of comprehensive studies that have assessed the specific occupational health hazards and risks faced by tricycle waste collectors in Greater Kumasi. Existing literature on waste management in Ghana primarily focuses on municipal waste management systems, neglecting the specific occupational hazards faced by tricycle waste collectors. As a result, there is a paucity of empirical data about their work's unique risks and challenges.

Although there are studies that examine occupational health hazards in the broader waste management sector, they often overlook the specific risks faced by tricycle waste collectors. This study, therefore, sought to fill the gaps in the current literature by conducting a comprehensive assessment of occupational health hazards and risks among tricycle waste collectors in Greater Kumasi, Ghana.

1.3 Justification

Tricycle waste collectors are exposed to various occupational health hazards such as exposure to toxic substances, biological hazards from waste materials, physical injuries from handling heavy loads, and ergonomic issues due to prolonged sitting and repetitive movements. Without a thorough assessment, it is difficult to identify the specific hazards and their potential impact on the health of tricycle waste collectors. Without a proper assessment, the existing occupational health risks tricycle waste collectors face remain unaddressed (Bonino *et al.*, 2022).

Effective risk management strategies, cannot be developed without a comprehensive understanding of the hazards and risks involved. Tricycle waste collectors play a vital role in waste management, but their health and well-being are often neglected (Wassie *et al.*, 2022). The absence of a systematic assessment denies them the right to a safe and healthy working environment. Understanding the occupational health hazards and risks these workers face is crucial for ensuring their overall well-being, reducing work-related illnesses and injuries, and improving their quality of life(Arkorful *et al.*, 2022).

Assessing occupational health hazards and risks among tricycle waste collectors provides essential data and insights to inform the development of policies and regulations. This assessment can contribute to formulating guidelines and standards for waste collection practices, ensuring compliance with occupational health and safety requirements, and fostering a safer and healthier working environment for tricycle waste collectors. Therefore, there is need for conducting a comprehensive assessment of occupational health hazards and risks faced by tricycle waste collectors in the Greater Kumasi area is necessary to safeguard the health and well-being of these workers, develop effective risk management strategies, and inform policy and regulatory frameworks related to waste management in Ghana.

1.4 Research Question

Given the above problems mentioned, this study sought to answer the following questions:

i. What are the behavioral characteristics among tricycle waste collectors that result in injuries in Greater Kumasi?

ii. What hazards and risks are associated with the working environments of municipal solid waste collectors?

iii. What is the prevalence of occupational injuries and diseases suffered among solid waste collectors in Greater Kumasi?

1.5 Objectives

The main objective of this study was to assess occupational health hazards and risks among tricycle waste collectors in Greater Kumasi.

1.5.1 The specific objectives are:

i. Determine the current practices of tricycle waste collectors on waste management and economic gains from the trade.

ii. Assess the hazards and risks associated with waste collection among tricycle waste collectors. Assess the health status and diseases suffered by tricycle waste collectors.

iii. Assess the health status and disease suffered by tricycle waste collectors.

1.6 Scope of the Study

The study focused on tricycle solid waste collectors and disposal systems in Greater Kumasi. The study is, therefore, primarily on tricycle solid waste collectors plying their trade in the Greater Kumasi and disposing of their waste at KCARP and KMA sites. The conceptual dimension brings to the front the involvement of people who may not necessarily be in the towns but are stakeholders in waste management in the municipality. The research could not be carried out co-currently in the towns due to inadequate funding and personnel to assist.

1.7 Organization of the Study

The study is organized into five main chapters. Chapter one is an introduction to the study; it provides the background, the problem statement, and the study's objectives. It also looks at the research questions, the significance of the study, delimitations, the definition of terms, and the organization of the study. Chapter two focuses on the literature review to support the discussion of SWM issues and aspects related to the study's objectives. Chapter three outlines the methodology of the study; it considers methodological issues such as the study design, study area, sources of data, target population, sample size, sampling procedure, research instruments, pre-test of research instruments, data analysis, ethical issues arising from the fieldwork, and the challenges from the fieldwork. Chapter four was limited to the results of the presentation and the discussion of the results. Chapter five provides the summary, conclusions, and recommendations of the study.

1.8 Conceptual Framework

Figure 1.1 illustrates the Conceptual Framework, which shows that socio-demographic factors, job-related conditions, and individual behavioral characteristics that contribute to occupational injuries sustained by Solid Waste Collectors. The factors listed above could be direct or indirect causes of occupational injuries. Solid Waste Management activities, a lack of Health and Safety training for Solid Waste Collectors, the duration of exposure, and the availability, inadequacy, and under-utilization of Personal Protective Equipment are among the direct factors (Cheng *et al.*, 2021). Individual behavioral characteristics such as sleep disturbances, job satisfaction, job-related stress, and substance use (e.g., tobacco and alcohol) are also direct factors contributing to occupational injuries suffered by Solid Waste Collectors (Dzah *et al.*, 2022). Age, level of education, and marital status are examples of indirect factors that contribute to occupational injuries (Wassie *et al.*, 2022).

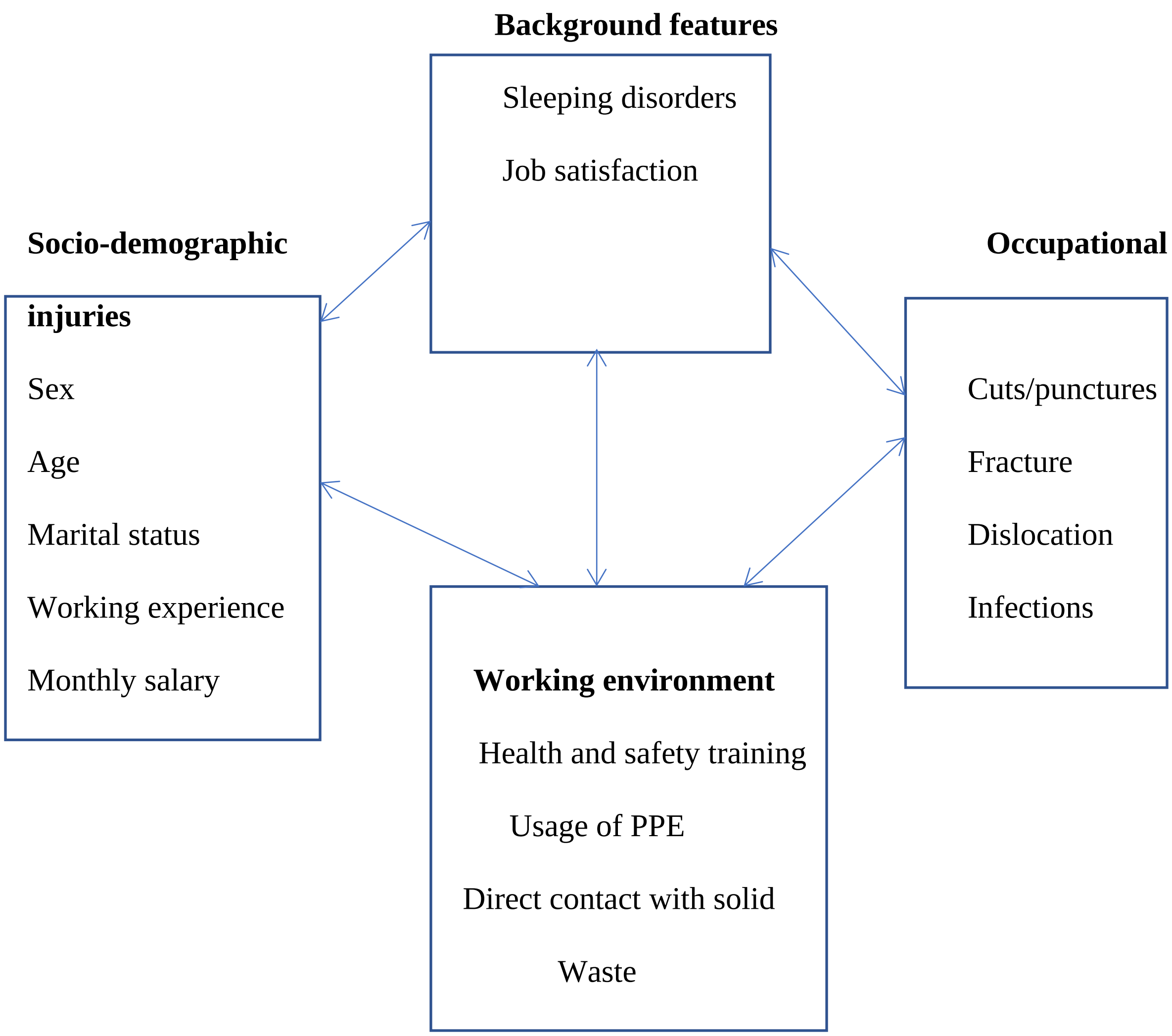


Figure 1.1 Conceptual framework

CHAPTER TWO

LITERATURE REVIEW

2.1 Municipal Solid Waste

Solid waste is unwanted or needless solid materials that result from residential, industrial, and commercial activities (Ojolowo and Onifade, 2019). Solid waste is classified into three types: biodegradable, non-biodegradable, and inert. Based on its source of generation, solid waste can also be classified as domestic, industrial, commercial, construction, or institutional waste (Eliasu *et al.*, 2022). Again, based on the content of the waste, it can be classified as organic, glass, metal, or plastic. Other researchers categorize waste based on its hazardous nature. Waste can be classified as toxic, nontoxic, flammable, radioactive, infectious, and so on (Salami *et al.*, 2019). Solid waste is unwanted and discarded solid materials generated by sources such as households, industries, healthcare, construction, agriculture, commercial, and institutions (Kombiok *et al.*, 2021). Solid waste management is one of every country's top environmental and public health concerns, particularly in developing countries. Solid waste is known to have negative effects on the environment and human health if not properly managed (Dzah *et al.*, 2022).

2.1.1 Global solid waste generation

Globally, the amount of solid waste produced is increasing. Cities worldwide generate approximately 2.01 billion tonnes of solid waste annually, with an average of 0.74 kg per person per day, which is expected to increase to 1.44 kg per person per day by 2025 (Debrah, 2022). As a result of indiscriminate solid waste disposal, African cities are experiencing serious public health and environmental issues. Africa generates about 125 million tonnes of solid waste annually, with sub-Saharan Africa accounting for roughly 65% of that total (Scarlet *et al.,* 2015). Rapid solid waste generation in sub-Saharan African cities has resulted in ineffective management (Anbazu *et al.,* 2022), as stated by (Addo-fordwuor & Seah, 2022). Africa is the world's least developed region, with 38 % urbanization but generates a massive amount of municipal garbage, which significantly impacts people's well-being and safety (Afrane *et al.,* 2022). The challenges with solid waste management are linked to the bulk density of household solid wastes generated and improper disposal practices among urban dwellers (Afrane *et al.,* 2022). It has been identified that household waste disposal practices are one of the major causes of African waste management challenges (Uddin *et al.*, 2021) and it’s a vexing and widespread drawback in waste management in both urban and rural areas (Arkorful *et al.,* 2022). Many cities have severe waste management problems with a large amount of refuse poorly collected, treated, and disposed of by residents, posing a threat to the environment and health (Adzawla *et al.,* 2019).

2.1.2 Generation of municipal solid waste in Ghana

Ghana is faced with enormous difficulties with solid waste disposal as evidenced by large volumes of solid waste uncollected and littered around the country’s cityscape. Ghana generates about 12,710 tonnes (0.51 kg per person per day) of which about 7,020 to 8,775 tonnes are not collected and properly disposed of (Dzah *et al.,* 2022). Household waste represents 55–80% of the country’s solid waste generated (Addo-fordwuor & Seah, 2022). Disposal methods practiced by inhabitants largely influence improper solid waste collection in Ghana. In Ghana, open dumping, using private containers, burying and burning, and dumping at public waste disposal sites are the prevailing solid waste disposal systems (Adzawla *et al.*, 2019). Although several attempts have been made by city authorities in Ghana to prevent and reduce improper solid waste disposal, the menace remains. Indiscriminate solid waste disposal practiced among residents in urban communities creates an unsatisfactory and unpleasant living environment (Arkorful *et al.*, 2022). Kumasi the second-largest city together with Accra, the capital city generates about 3,000 tonnes of solid waste daily (Mochache *et al.*, 2020). Kumasi marginally generates more solid waste than the capital city (Accra), with 0.75kg/person/day and 0.74kg/person/day, respectively (Coker *et al.*, 2016).

2.1.3 Composition of municipal solid waste

The two major types of solid waste are organic and inorganic materials. Organic components of solid waste include putrescible, fermentable, and non-fermentable materials. Putrescible waste is made up of unwanted items that decompose quickly (Dzah *et al.*, 2022). The biodegradation of fermentable wastes is faster than that of non-fermentable wastes, which are difficult to decompose (Owusu-Ansah, 2014). Plastics, metals, and other non-decomposable materials are examples of inorganic solid waste (Amoah & Kosoe, 2014).

Pesticides, medical waste, electrical waste, herbicides, fertilizers, and paints are among the hazardous components of MSW (Ziad *et al.*, 2021). Mixing these wastes with general municipal waste poses many health risks and should be avoided. Organic matter accounts for a higher proportion of the solid waste content generated in developing countries than developed countries (Awodele *et al.*, 2016). Components of municipal solid waste across Ghana have shown that the southern zones produced more than the northern zone (Ojo, 2018). The organic content of solid waste in Ghana is 61%., and plastics, paper, metal, and glass accounted for 16%, 5%, 3%, and 3%, respectively (Ojo, 2018). The higher percentage of organic content could be used as materials for composting. However, if not properly managed, it could pose a risk to the environment and human life (Dzah *et al.*, 2022).

2.1.4 Municipal solid waste management

Solid waste management (SWM) entails the control of generation, storage, collection, transport or transfer, processing, and disposal of solid waste materials in a manner that best addresses the range of public health, conservation, economics, aesthetic, engineering, and other environmental considerations (Boadi & Kuitunen, 2014). MSW also includes activities or procedures that include administrative planning, financial, engineering, and legal functions. Experts such as public health practitioners, city and regional planners, political scientists, geographers, sociologists, economists, communication and conservationists, demographers, engineers, and material scientists play an essential role in the success of SWM (Fei-baffoe *et al.*, 2014). There are differences in solid waste management practices across different geographical areas, as seen between developed and developing countries (Oteng-ababio, 2016).

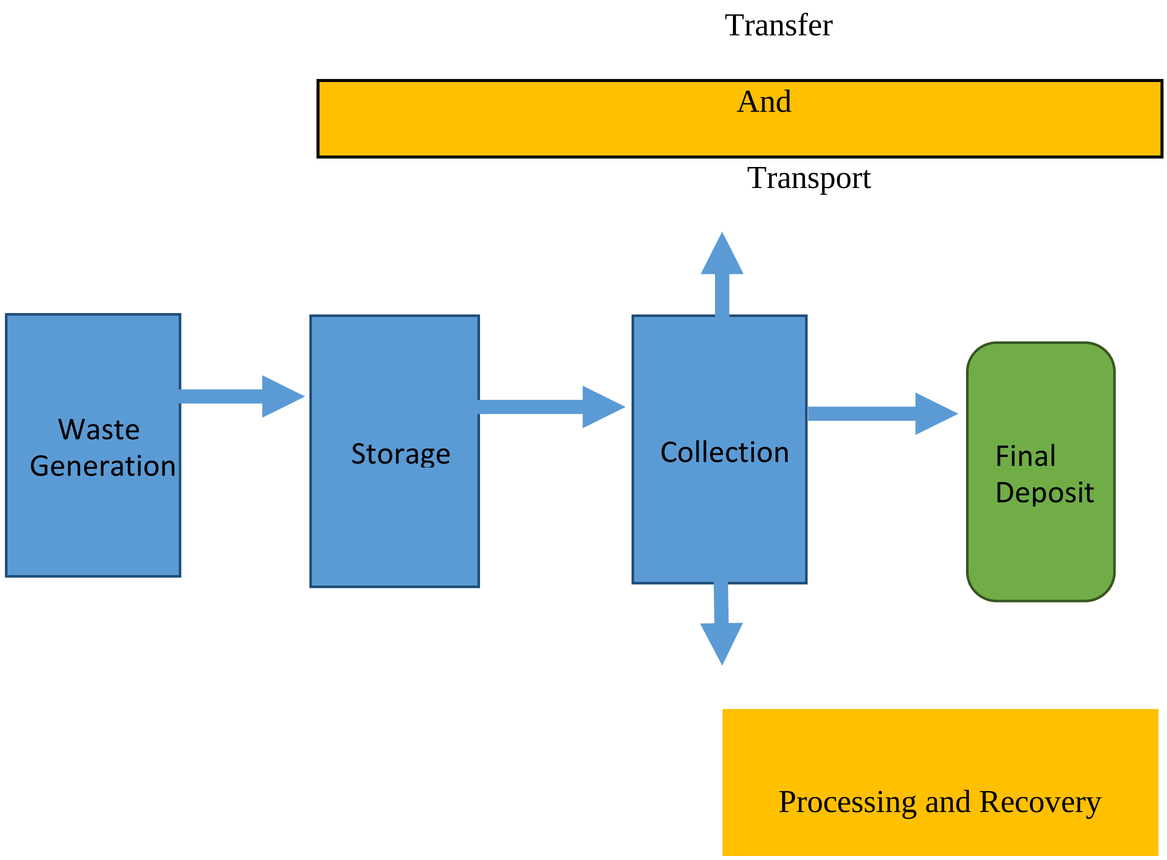


Figure 2.1: Fundamental processes involved in solid waste management

The basic processes involved in solid waste management are depicted in Figure 2.1. These processes entail identifying no longer usable items and storing them in waste bins to facilitate more accessible collection. Waste is collected and transported using waste collection vehicles from the point of collection to regional or municipal disposal sites. The waste is then processed to recover reusable or recyclable material or finally disposed of at locations such as landfills.

2.1.5 Municipal solid waste management in Ghana

In developing countries such as Ghana, waste is mainly collected at the point of generation or a temporary dumping site. The final waste disposal is usually done at open dump sites on the city's outskirts (Fredrick *et al.,* 2018). Unsuitable bin collection methods, an uncoordinated collection schedule, and a poor route impede effective waste management (Uddin and colleagues, 2021). According to Gumasing and Sasot (2019), private waste management companies now collect more than 60% of SW in Ghana's major cities, and the remaining 40% has been collected by private waste collectors. Zoomlion Ghana Limited is a leading private company in Ghana involved in solid waste management. The hazardous work of solid waste collectors is made more dangerous because some people dispose of their waste indiscriminately at street corners and in open drains, which are swept and collected by waste management company employees (Acquah *et al.*, 2021). Informal tricycle waste collectors provided spot-to-spot waste collection using improvised sirens to signal their arrival. The informal solid waste tricycle operators provided waste collection services to households in the study communities. Workers generally provided ‘spot-to-spot waste from households in the communities using improvised sirens to signal their arrival at respective spots(Asibey *et al.,* 2019).

2.1.6 Solid wastes generation in the Greater Kumasi area

Currently, solid waste generated by the city of Kumasi stands at 1,500 tons per day, of which 1000 tons are collected from domestic, commercial, and industrial, whilst 300 tons are from Asafo, Central, and Race Course Markets as significant generators. Meanwhile, the remaining 200 tonnes are not collected and left at communal sites, in gutters, or open spaces littered in the city. House-to-house and communal collection account for 20% and 80% respectively as the significant forms of waste collection in the study area (KMA,2011)**.**

2.1.7 Waste collection

There are three methods of waste collection. One is the door-to-door collection, where vehicles collect it from individual houses. Landlords pay for this. Secondly is the communal collection, where waste is collected at the transfer station (temporal place of gathering waste), and the heap collection or leftover collection. For every one (1) ton of waste collected by a contractor, he is paid GHS 15.00, and 1500 metric tons of waste are generated in the Kumasi Metropolis, but only 1200 metric tons are collected. The waste is deposited on an excavated ground after weighing. Bulldozer spreads the waste after the trucks have brought them from the collection stations. The compacting machine compresses waste into small bundles or volume treatment.

2.2 Occupational Health and Hazards Associated with Solid Waste Collection

Solid waste collectors are exposed to a wide range of occupational health hazards during their work. Solid waste collectors handle waste materials using physical effort, exposing themselves to hazards (Pecorini *et al.*, 2020). In the process of waste collection, waste collectors get direct contact with broken bottles, metals, containers with chemical, pesticide, and solvent residues, medical waste, devices containing heavy metals, and human faeces, which are hazards associated with waste collection (Pecorini *et al.*, 2020). Waste collectors must work in awkward positions and perform repetitive motions as part of their job. Most of the time, their work entails manual handling and solid hand exertions. Their jobs occasionally require them to work in the early morning hours. That exposes them to dim lighting as well as rain. These factors may contribute to ergonomic hazards and risks among SWCs (Stemn and Kumi-Boateng, 2019).

Solid waste workers in developing countries continue to face high-risk levels of occupational hazards due to poor working conditions and tools (Seshie *et al.,* 2020). Solid waste workers are persons with low socioeconomic statuses, such as poverty, poor housing conditions, poor nutrition, and earning little from their tasks (Jiang *et al.,* 2021). Such conditions as a lack of personal protection tools make them prone to hazardous substances and make it difficult for them to seek medical attention when injured (Jiang *et al.*, 2021). Medical conditions such as respiratory symptoms, skin, nose, eye irritation, fatigue, headaches, psychological problems, allergies, and musculoskeletal and dermal injuries are commonly experienced by municipal solid waste collectors (Bowan *et al.*, 2019).

2.3 Occupational Risk and Injuries among Solid Waste Collectors

Municipal solid waste collectors frequently contact hazardous waste components such as chemicals, sharp objects such as broken glass, and improperly disposed surgical blades. Sharp waste materials pose a high risk of injury to those who generate the waste and those who collect them (Deng *et al.*, 2020). Inexperience, low monthly income, a history of job-related stress, and sleeping disturbance were all significantly and positively associated with severe occupational injuries among solid waste collectors (Nyantakyi *et al.,* 2020). Wang *et al.* (2019) found a 43.7% overall prevalence of occupational injuries among SWCs in their study. They also reported that cuts were the most commonly sustained injury, followed by a fall, abrasion, fracture, strain, dislocation, burn, and others such as chemical splash and car and bicycle accidents. In a study conducted by Cheng *et al*. (2021), there was a report of 46.5% and 32.7% of accidents and needle stick injuries among SWC. In the same study, solid waste collectors who sustained cut wounds reported that the cuts were caused by sharp objects such as disposable razors, broken glass, pins, sharp can lids, thorns, or broken tree limbs. According to the workers, loose needles and other sharp objects frequently protrude from ruptured waste bags in the waste stream and puncture skin when they handle them during waste management activities (Cheng *et al.,* 2021).

2.4 Use of Personal Protection Equipment (PPE) among Solid Waste Collectors

Personal Protective Equipment (PPE) includes clothing, barrier products, or gadgets explicitly designed for workers to prevent injuries, workplace hazards, or diseases to which they may be exposed as part of their job. Personal protective equipment (PPE) is an essential fundamental component that aids in preventing or reducing the effects of occupational hazards (Mochache *et al.,* 2020). The use of personal protective equipment (PPE) is critical in the lives of workers. The American Occupational Safety and Health Administration (OSHA) agency, established in 1973, requires employers to protect employees from workplace hazards that can result in life-threatening injuries by providing PPE and health and safety training (Sarkar & Maiti, 2020). Workers are protected from occupational hazards when protective equipment is accessible and used appropriately. That is not always the case in low- and middle-income countries because PPE is always in short supply with little oversight of its use (Nyantakyi *et al.,* 2020). Solid waste collectors play an essential role in maintaining a healthy environment, so they must be protected from the many health hazards associated with their work. According to Ghana's Labour Law, "wherever workers are involved in any process involving exposure to any harmful or offensive substance or environment, effective protective equipment shall be provided and maintained by the employer for the use of the persons employed" (Sarkar & Maiti, 2020). Even though PPE is highly recommended, MSWWs use it at a meager rate (Berhan, 2020). Ravindra *et al.* (2016) reported 28% compliance and 72% noncompliance in a study to evaluate the use of PPE among workers of five refuse disposal companies in Port Harcourt, Nigeria. Non-compliance was caused by a lack of PPE and the discomfort associated with its use. (Dewi & Hidayat, 2020) also reported that most users complained that wearing PPE, such as gloves and boots, frequently resulted in dermatological problems due to the hot and humid conditions they encountered within them.

The correlation between waste collection and Hepatitis B infection primarily centers on the occupational exposure risks encountered by waste collection workers (Elkhateeb et al., 2019). These individuals face an elevated risk of being exposed to sharps (such as needles) and other hazardous waste that may be contaminated with blood or bodily fluids. Given that the Hepatitis B virus (HBV) can be transmitted through contact with infected blood and bodily fluids, improper handling or accidental injury from contaminated waste can present a substantial risk of Hepatitis B infection to waste collectors and those engaged in waste management (Kamarulzaman et al., 2016). This association underscores the significance of appropriate waste disposal, the utilization of personal protective equipment (PPE), and vaccination for individuals in the waste collection and management sectors.

The significance of waste collection and the prevalence of Hepatitis B infection are particularly notable among waste handlers who are exposed to various risks within their work environments. Research indicates that individuals involved in waste collection, such as municipal solid waste workers and medical waste handlers, exhibit a higher rate of Hepatitis B virus (HBV) infection due to their occupational exposure to contaminated materials.

The occupational hazards faced by these workers, including exposure to sharp objects, needle sticks, contaminated blood, and hazardous waste materials during the collection, transportation, and disposal processes, contribute to their heightened risk of HBV infection (Sawyerr et al., 2016). The nature of waste collection activities, which entail handling potentially infectious materials, establishes a route for the transmission of HBV among waste handlers. Factors such as inadequate utilization of personal protective equipment, history of needle stick injuries, absence of vaccination, and other high-risk behaviors all play a role in the elevated prevalence of HBV infection among waste collectors. These research outcomes highlight the critical need for the implementation of appropriate safety protocols, vaccination initiatives, and health education campaigns to reduce the risk of Hepatitis B infection among waste handlers (Coast, 2019).

2.5 Epidemiology of Hepatitis B

The global burden of HBV varies, as evidenced by prevalence rates of 1.5%, 2.3%, and 3.2% for the World Health Organization's (WHO) America, Europe, and Africa regions, respectively (Sadiea *et al.*, 2022). According to Pinchoff *et al.* (2016), the HBV prevalence in sub-Saharan Africa in 2002 was 3.0%, with a prevalence rate of 2.4% in the West African region where Ghana is located. Sadiea *et al.* (2022) recently estimated a slightly lower prevalence of 2.65% for sub-Saharan Africa. Conversely, there are concerns that the prevalence rates reported for sub-Saharan Africa may be significantly underestimated due to factors such as the region's limited availability of Hepatitis C virus (HCV) representative surveys (Liu *et al.,* 2019). The role of Hepatitis C viral infections in waste collection is significant, particularly for waste handlers who are at risk of exposure to blood, blood products, and body fluids during their work activities. Studies have shown that waste collectors, including municipal solid waste workers and medical waste handlers, face a risk of Hepatitis C virus (HCV) infection due to occupational exposure to contaminated materials, such as sharp objects, needle sticks, and other hazardous waste items (Tsovili et al., 2014).

The prevalence of Hepatitis C among waste handlers has been documented in various studies, highlighting the occupational hazards faced by these workers. Research has indicated that waste collectors who are exposed to needle-stick injuries or do not use proper personal protective equipment have a higher risk of HCV infection. While the prevalence of Hepatitis C may vary among waste handlers, the potential for occupational exposure to the virus underscores the importance of implementing safety measures, vaccination programs, routine health check-ups, and proper training for waste handlers to reduce the risk of infection (Brown et al., 2016).

Despite regional differences in HCV prevalence, patterns of HBV epidemiology vary greatly within countries. In the United States, people aged 30-49 have a high HBV prevalence, whereas in countries such as Italy and China, people over 50 accounts for the majority of infections (Dna, 2019). It is important to note that there are significant challenges in documenting an accurate HCV burden to determine the true incidence and prevalence in any country. Such challenges include the scarcity of essays that can distinguish between acute and chronic HCV infections, as the majority of acute HCV infections have no symptoms (Bonino *et al.*, 2022).

Globally where the impact of HCV has been thoroughly studied, the implications for national health systems have been discovered to be enormous (Trivedi *et al.*, 2015). According to Therapy, (2021), the lifetime cost of an HCV infection in the United States in 2011 was $64,490, but this could rise to $205,760 ($154,890-$486,890) when medical inflation is factored in. Maepa *et al.* (2022) also estimated a lifetime cost of $64,694 for Canadians with HBV infection in 2013, which could rise to $327,608 if liver transplantation is required. Viral hepatitis, including HCV, is thought to be a major cause of morbidity and mortality in Ghana and deserves more attention (Rybicka & Bielawski, 2020). However, extensive aggregate data on the prevalence of HCV in Ghana are currently lacking (Yang & Wei, 2022). Franzè et al., (2022) reported a national HBV prevalence rate of 1.7 % for Ghana in 2010 based on WHO's data. In a systematic review focusing on HBV seroprevalence in Africa (Buti et al., 2018), Shiffman, (2020) also reported an HCV prevalence rate for Ghana within the range of 0.2–9.4 %.

2.6 Routes of Transmission

The prevalence of HBV is higher in persons exposed to blood products, persons from lower socioeconomic statuses, and people of older age groups (Amarapurkar, 2018). Negligence during the use of sharp instruments may be a risk factor for blood-borne infections, causing serious health problems (Pandyarajan *et al.*, 2021). Razor sharing and shaving in barbering shops have been identified as key risk factors for HBV infection in Italy (Kumar *et al.*, 2018). It has also been identified as a risk factor for HCV among institutionalized patients (Pawłowska *et al.*, 2019). Studies in the United States have shown that the risk of acquiring HBV after being bruised with a sharp instrument from an HBV+ client ranged from 27% to 37%. In addition, the risk of acquiring HCV after being injured by a sharp object from an infected person ranged from 3 to 10% (Pandyarajan et al., 2021). For example, an accidental splash in the eye of as little as 10−8 ml of infected blood can transmit HBV to a susceptible host (Park *et al.*, 2022).

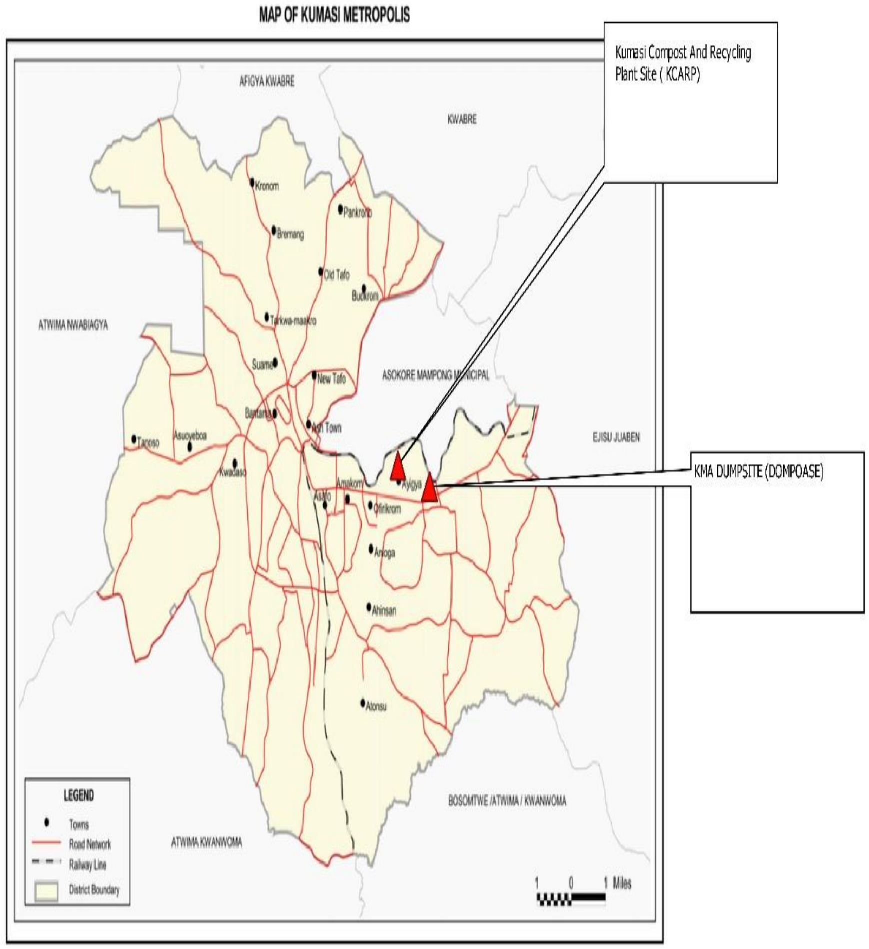
HBV is transmitted through skin or mucosal exposure to infectious body fluids, sexual contact, or perinatal transmission from infected mothers. HBV is up to 50 to 100 times more infectious than HIV, particularly in HBeAg-positive persons(Asare *et al.*, 2020). As a result, municipal waste collectors may be in danger of contracting HBV infection if they come into contact with contaminated sharp tools that have been inappropriately discarded (Paul *et al.*, 2019). That could also be the situation with Hepatitis C Virus (HCV) infection. In many countries, collecting solid waste materials is a common occupation among urban poor people (Uddin *et al.*, 2021). In Ghana, selected waste collection is done on an individual, informal, and personal basis or through structured recycling cooperatives or groups. Despite its importance in economics and the environment, this occupation is connected with hazardous and unpleasant working conditions. Furthermore, recyclable waste collectors live in a world marked by socioeconomic isolation and stigmatization(Gumasing & Sasot, 2019).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

Kumasi is Ghana’s second-largest city with an estimated present population of 5,440,463 (Department of Statistics Ghana, 2021). The population of Kumasi has been increasing speedily with an annual growth rate of 4.01% between 2020 and 2021(Department of Statistics Ghana, 2021). The rapid population growth, coupled with the cost of lands and residential rents, resulted in the proliferation of squatter settlements and unplanned development. These have created one of Kumasi's biggest informal settlements (Aboabo, Asawase, Tafo, etc.) (Adarkwa 2011). Kumasi is placed between latitude 6.35^0N– 6.40^0S and longitude 1.30^0 W– 1.35^0E and includes a total surface area of 254km^2 (KMA,2010).



Source: (Ghana Statistical Service, 2014)

Figure 3.1: Map including the study areas

3.1.1 Location

The metropolis is one of the thirty (30) districts in the Ashanti Region. It is located between Latitude 6.35^{o}N and 6.40^{o}S and Longitude 1.30^{o}W and 1.35^{o}E and is elevated 250 to 300 meters above sea level. The Metropolis shares boundaries with Kwabre East and Afigya Kwabre Districts to the north, Atwima Kwanwoma and Atwima Nwabiagya Districts to the west, Asokore Mampong and Ejisu-Juaben Municipality to the east, and Bosomtwe District to the south. It is approximately 270km north of the national capital, Accra. It has a surface area of approximately 214.3 square kilometers, about 0.9 percent of the region's land area. However, it accommodates about 36.2 per cent of the region's population.

3.1.2 Climate

The Metropolis falls within the wet sub-equatorial type. The average minimum and maximum temperatures are about 21.5^{O} C and 30.7^{O} C respectively. The mean humidity is around 84.16% at sunrise and 60.0% at sunset. The moderate temperature and humidity coupled with the double maxima rainfall periods (214.3mm in June and 165.2mm in September) directly affect population growth and the environment. The suitable climatic conditions have led to the influx of people from every part of the country and beyond its frontiers into the metropolis as a choice abode. Thus, Kumasi has become the most populous city in Ghana (1,730,249).

3.1.3 Vegetation

The Metropolis lies in the transitional forest zone, within the moist semi-deciduous South-East Ecological Zone. Predominant tree species are Ceiba, Triplochlon, Celtis, and other exotic species. The soil in this ecological zone is rich in nutrients for crop cultivation. This vegetative cover partly explains why Kumasi had the accolade of the "Garden City of West Africa". Although the city has lost a sizeable stretch of its vegetative cover to physical construction due to urbanization, specific segments of the Metropolis like KNUST, Kumasi

Zoological Gardens, Manhyia Gardens, and Nhyiaso still have green environments which need conscientious conversation plans.

3.1.4 Soil and Geology

The middle precambrian rock dominates the Kumasi Metropolitan area. The Metropolis's unique geological structure has positive and negative impacts on the local economy. The very existence of the precambrian rock has led to the development of the construction industry in the Metropolis. There are a few small-scale mining activities and stone quarrying and sand winning industries proliferation. Even though these have created employment opportunities, the uncontrolled extraction of these resources has resulted in environmental degradation.

3.2 Study Sites

3.2.1 Kumasi Compost and Recycling Plant, Ltd

Kumasi Compost and Recycling Plant (KCARP) is a mega-scale municipal solid waste treatment plant set up to receive and treat municipal solid waste from the Kumasi Metropolis and adjoining district assemblies. KCARP is located at Essereso-Adagya in the Bosomtwe District of the Ashanti region. KCARP project started in 2013 on a 150-acre piece of land at Adagya in the Bosomtwe District. It has an installed capacity to process about 1,200 tons of municipal solid waste. The facility is the most giant waste treatment plant in Africa, with the capacity to receive and treat municipal solid waste of 1200 tons per day, as shown in plate 3.2. This integrated composting and recycling plant, worth US$95 million, is cited in Kumasi to serve as the central point for processing waste generated in the Ashanti Region, specifically, Kumasi Metropolis and adjoining district assemblies. The facility comes in two phases; the first comprises a compost, sorting, recycling plant, weighing bridge, and a research laboratory, among others. The second consists of waste to energy, wastewater treatment plant, plastic waste leachate treatment workshop, and e-waste processing among others. Compost tunnels ensure that sorted organic matter is converted into compost under controlled moisture content, temperature, and air quality conditions. Compost samples are taken through rigorous laboratory analysis to ensure products are of high quality and meet end-users' needs. Matured compost is bagged on site. This compost is excellent organic fertilizer for agriculture and horticulture. KCARP can produce 3,000 bags of finished 50kg compost daily. The facility is aimed at using a step-by-step approach to achieve the zero-waste goal in communities to ensure a clean and green environment for all Ghanaians. KCARP, therefore, seeks to welcome public cooperation in achieving this dream of a better environment where Ghanaians will enjoy good health, good food, high yields in crop production, and a reduction of greenhouse gasses.

Plate 3.1: Overviewed of KCARP

3.2.2 Kumasi Waste Management Dumpsite (KWM)

The Dompoase Landfill is an engineered sanitary landfill belonging to the Kumasi Metropolitan Assembly (KMA), as illustrated in plate 3.7. It is a 100-acre facility about 10 kilometres from Kumasi's city on the Oti Stool Lands, close to the Dompoase community. It has a seepage treatment plant attached and is used for treating and disposing solid waste. The Landfill started operating in 2004 and receives household, commercial, institutional, and industrial waste without sorting. Its lifespan is predicted to be 15 years. It receives all forms of solid waste from various transfer stations in the metropolis. In 2009, the Dompoase Landfill received 72 per cent of the total volume of waste generated in the metropolis compared to the previous year's figure of 86 per cent (KMA-WMD, 2009). This drop reflects the inability of the sanitary landfill to handle the increasing volume of solid waste generated annually in the Kumasi Metropolis.

The site's solid waste is leveled off daily using a bulldozer, covered with sand, and then compacted by a compacting machine. People that search through the waste in search of scrap metal, plastic bottles, or anything else they may salvage to selled engage in informal recycling, as is the case in many underdeveloped nations. Between the waste and the environment, a vast liner system acts as a barrier. Dr leachate collecting pipes transport leachate to a treatment facility, where ten sedimentation ponds treat municipal septage. After treatment, the effluent is dumped into a neighboring river after being combined with landfill leachate and septate (Oda River).

Plate 3.2: Overview of Dompoase dumpsite.

3.3 Study Design

This study employed a cross-sectional design to examine the occupational hazards, health risk, and exposure among tricycle waste collectors in the Greater Kumasi Area (GKA) from July to November 2021. Tricycle waste collectors transporting solid waste to KMA and KCARP sites were assessed on occupational health risk, hazard, and exposure in their job. A cross-sectional design allows for data collection at a specific point in time, providing a snapshot of the occupational health hazards and risks tricycle waste collectors face. This design is beneficial for gaining insights into the prevalence and distribution of these hazards and their potential impact on the workers.

3.3.1 *Sampling procedure*

Tricycle waste collectors were sampled by convenience technique. Participants were recruited at the KMA and KCARP dumping sites, where the tricycle waste collectors emptied their loads.

3.3.2 *Study population*

The study population included all tricycle waste collectors in the Greater Kumasi area conveying wastes to the Kumasi Waste Management (KWM) and Kumasi Compost and Recycling Plant (KCARP) dumping sites.

3.3.3 *Inclusion criteria*

i. Individuals actively engaged in waste collection using tricycles within the Greater Kumasi area.
ii. Waste collectors plying their trade within the Greater Kumasi region.
iii. Waste collectors who voluntarily agree to participate in the study and provide informed consent.

3.3.4 *Exclusion criteria*

i. Waste collectors who do not use tricycles for waste collection, such as those using other types of vehicles or manual methods.
ii. Waste collectors plying their trade outside the defined geographical scope of the study.

iii. Waste collectors who refused provide informed consent and not willing to participate in the study.

3.3.5 Sample Size Estimation

A sample size of 315 tricycle waste collectors was estimated for this study based on 5% of the study population. Using Slovin's scientific method of sample determination.

n = $\frac{\boldsymbol{N}}{\mathbf{1+N\alpha^2}}$

=Where **n**=sample size,

N=sample frame **(1500),** and

α represented the margin of error which is **0.05** with a confidence level of **95%.**

n = $\frac{\boldsymbol{N}}{\mathbf{1+N\alpha^2}}$ With a design error of 5%.

The population of tricycle waste collectors in Greater Kumasi was estimated to be 1500.

N = Sample frame =1500,

α = error term = 5%,

n = $\frac{1500}{1+500(0.05)^2}$ = 315

Sample size =**315**

Hence, a total sample size of 315 was estimated for this study. However, two study sites were used for this study. Hence proportion to population size was employed to estimate sample size per each study site (Table 3.1). That was to ensure that the sampled mean was closer to the population mean and minimize errors.

Table 3.1: The Estimated Samples Size for each Dump Site

Name of Dumpsite	Population/Estimates	Sample size
Kumasi Compost and Recycling Plant (KCARP)	1000	210
KMA waste management dumpsite	500	105
Sum	Total =1500	Total = **315**

(Source: Field Data, 2021).

$$KCARP = \frac{1000}{1500} \times 315 = 210$$

$$KMA = \frac{500}{1500} \times 315 = 105$$

315 respondents were recruited from two study sites (KCARP=210 and KMA=105).

3.4 Data Collection and Study Instruments

The study instruments below were employed to collect data to achieve the stated objectives of the study. Semi-structured questionnaire, Face-to-Face interview and Observational checklist

***Survey*-Objective 1:** Determine the current practices of tricycle waste collectors on waste management and economic gains from their trade. A semi-structured questionnaire was used to discover the knowledge, attitude, and perceptions captured on the current practices. Questions on waste management and knowledge of waste collection training were included to achieve the study's objective.

Objective 2: To assess the hazards and risks associated with waste collection among tricycle waste collectors on waste. A semi-structured questionnaire was designed to capture physical, chemical, and biological hazards in waste management. In addition, PPE usage and the associated risk from the exposed hazards was assessed using the same instrument.

Objective 3: Assess the health status and diseases suffered by tricycle waste collectors. A health assessment survey semi-structured questionnaire together with laboratory screening were used to achieve this objective. The laboratory works purposely captured the prevalence of HBV among waste collectors in KMA site. The questionnaire captured health-related problems connected to waste collection and diseases suffered during waste collection activity.

3.4.1 Data collection procedures

Primary data were obtained using semi- structured questionnaires, personal observations, and face-to-face interviewed from the tricycle waste collectors in Greater Kumasi.

3.4.2 Semi-structured questionnaire administration

At each dumpsite, tricycle waste collectors, upon verbal consent, were provided with a structured questionnaire to solicit information on occupational health risks and exposures in their trade.

3.4.3 Face-to-face interviews

Face-to-face interview was used to solicit information on solid waste management practices from the research assistant at KCARP and the officer at KMA in charge of waste management. These officers' information determined the solid waste management practices at these sites in Greater Kumasi.

3.4.4 Personal observation

Personal observations were adopted to gather information on the waste pickers' practices and related hazards exposed. Photographs of some solid waste management practices on the site were taken and documented. Observation of the use of personal protective equipment [PPE] by the waste collectors was assessed.

3.4.5 Blood sample collection

Blood samples from 100 tricycle waste collectors at KMA were taken through venipuncture into a dry plastic tube. Each blood sample taken was stored under ice and transported to the Asante Mampong Municipal Government Hospital laboratory for further processing analysis. In the laboratory, each sample was centrifuged, and the serum separated and subsequently used to test for Viral Hepatitis B surface antigen (HBsAg) using the ELISA method (Plate 3.10).

Plate 3.3: Blood Sample Collection

3.4.6 Procedures for hepatitis b surface antigen (hbsag) test

- Serum samples stored at -20°C and ELISA kits stored at 40°C were removed and allowed to thaw at room temperature for at least 30 minutes.
- 100 µL of positive and 100 µL of negative control were dispensed in duplicates into the respective wells.
- One well was set blank as a background control.
- 100µL of the thawed serum was added to each well.
- The microtiter plates were placed into a humidified box and incubated at 37°C for 60 minutes.
- 50µLof enzyme conjugate was added to each well except the blank well.
- The microtiter plates were swirled gently for one minute to facilitate mixing.

- These microtiter plates were placed again into the humidified box and incubated at 37oC for 30 minutes.
- Each well was washed five times after the incubation period.
- 50µL of substrate A(HRP-substrate) and 50µL of substrate B(TMB) were added to each well respectively.
- Mixing was done gently by swirling, and the microtiter plates were incubated at 37oC for 30 minutes.
- 50µL of stop solution was added to each well to stop the colour reaction. The optical density OD value for each plate was read at 450nm.

Plate 3.4: Laboratory analyses of blood samples

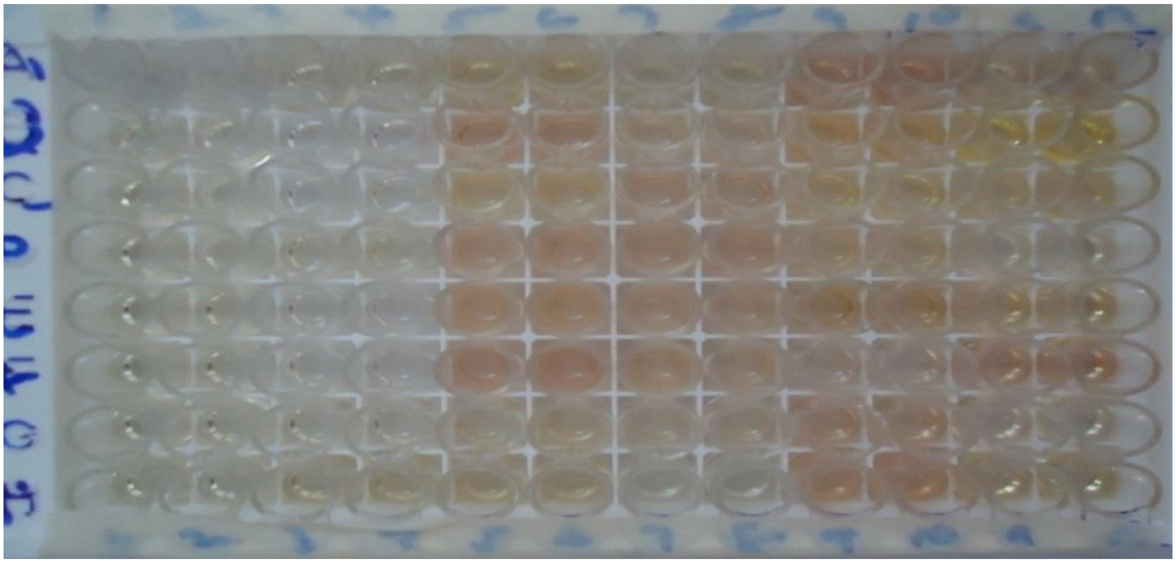


Plate 3.5: ELISA microtitre plate after controls, standards, and samples have been added

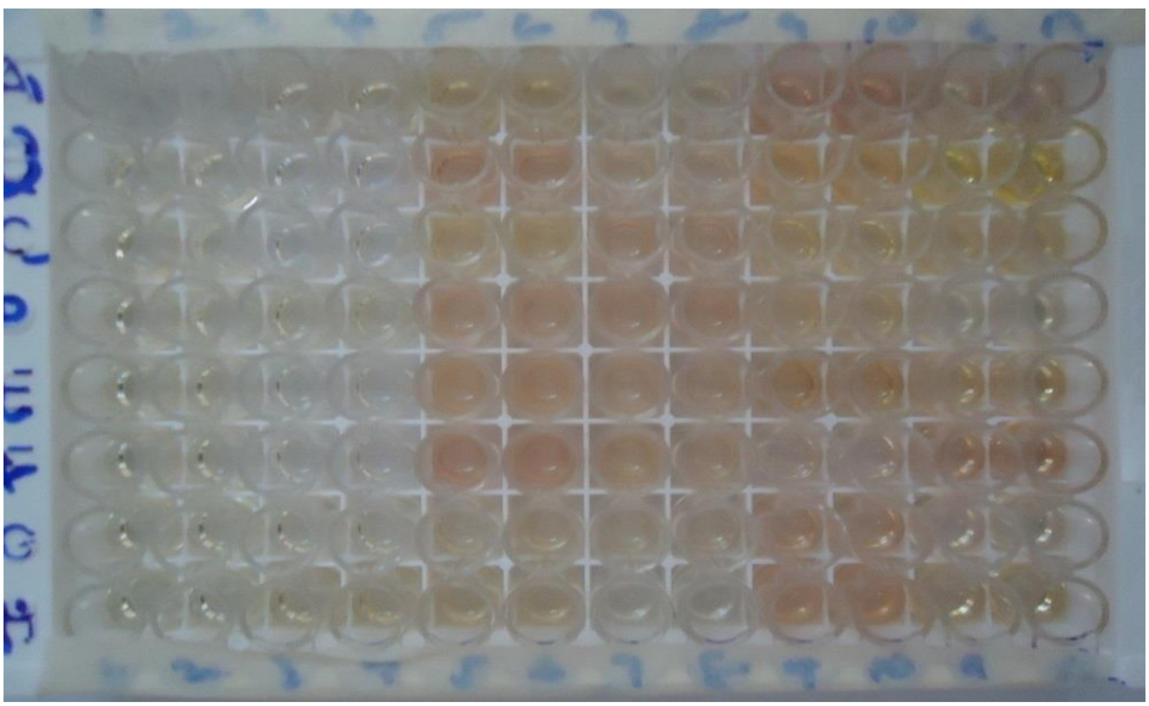


Plate 3.6: ELISA microtiter plate after anti-HBs. Peroxidase has been added.

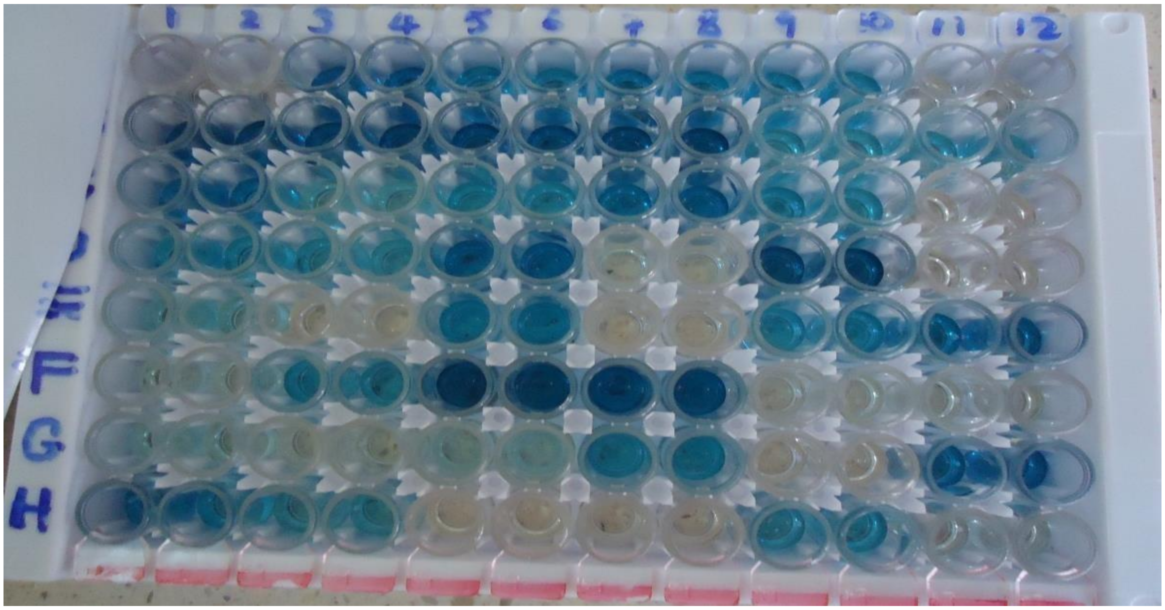


Plate 3.7: ELISA microtiter plate after substrate A and B TMB solutions have been added

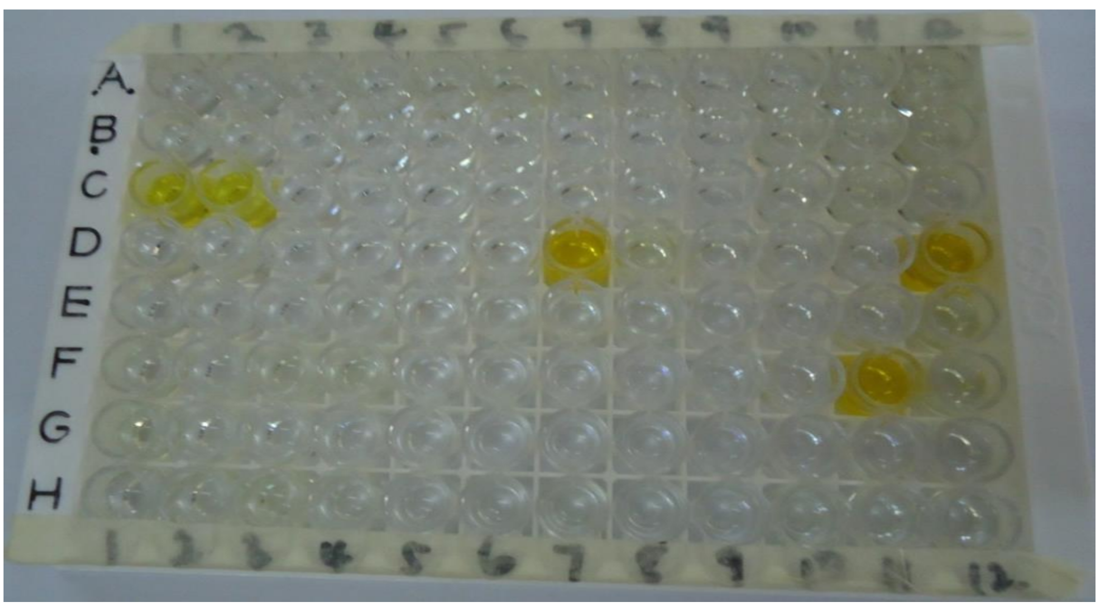


Plate 3.8: ELISA for HBsAg just after the stop solution has been added

3.5 Quality Control

Internal and external quality control techniques were implemented to ensure accurate results. To ensured blood sample integrity, whole blood samples were carried on ice in EDTA-coated tubes to the laboratory for analysis. Positive and negative controls were used during the test procedures to ensure the reagents were valid. All test protocols were adhered to, to ensure the validity and reliability of the test results.

3.6 Pilot Study

The questionnaires developed based on the research objectives, suggestions, and criticisms were welcomed by my supervisors and colleagues for the necessary corrections. Before the main study, the questionnaires were pilot-tested using respondents from Asante Mampong Municipal to ensure the validity of the items. Responses to the questions proved positive, allowing the research to take off.

3.7 Ethical Considerations

Ethical clearance for the study was obtained from the Committee for Human Research Publications and Ethics at the School of Medical Sciences, Kwame Nkrumah University of Science and Technology. In addition, clearance and permission were obtained from the Directors of KMA and KCARP. Permission from the respective Heads of the dumpsite was also sought. Verbal consent was obtained from each participant before enrolment.

3.8 Quantitative Data Management and Analysis

All administered questionnaire was checked for completeness, accuracy, and consistency of the responses, and data were entered into SPSS version 25 statistical software. The data was cleaned and subsequently analyzed using descriptive and inferential statistics. The descriptive statistics included mean, mode, standard deviation, and range. For inferential statistics, the chi-square test was used to test the associations between categorical data, and a P-value of < 0.05 was considered significant.

CHAPTER FOUR

RESULTS

4.1 Biodata

Table 4.1: Demographics characteristics of the respondent

Variable	Frequency(n=315)	Percentage (%)	X^2 (P-value)
Age Group (Years)			
≤19	64	20.32	
20-29	184	58.41	
30-39	51	16.19	415.8(0.0000)
40-49	9	2.86	
≥50	7	2.22	
Sex			
Male	307	97.46	283.81(0.0000)
Female	8	2.54	
Educational Status			
None	87	27.62	
SHS/Level	24	7.62	333.4(0.0000)
JHS/Middle form	91	28.89	
Primary	106	33.65	
Tertiary	7	2.22	
Marital status			
Married	126	40.00	12.6(0.0003)
Single	189	60.00	
Religion			
Islam	224	71.11	
Christianity	87	27.62	366.8(0.0003)
Buddhism	2	0.63	
Traditionalism	2	0.63	
Working experience (years)			
≤5	224	71.11	
≥6	91	28.89	56.16(0.000)
Daily working duration			
≤4	31	9.84	250.04(0.000)
5≤8	249	79.05	
>8	35	11.11	

(Source: Field Data, 2021).

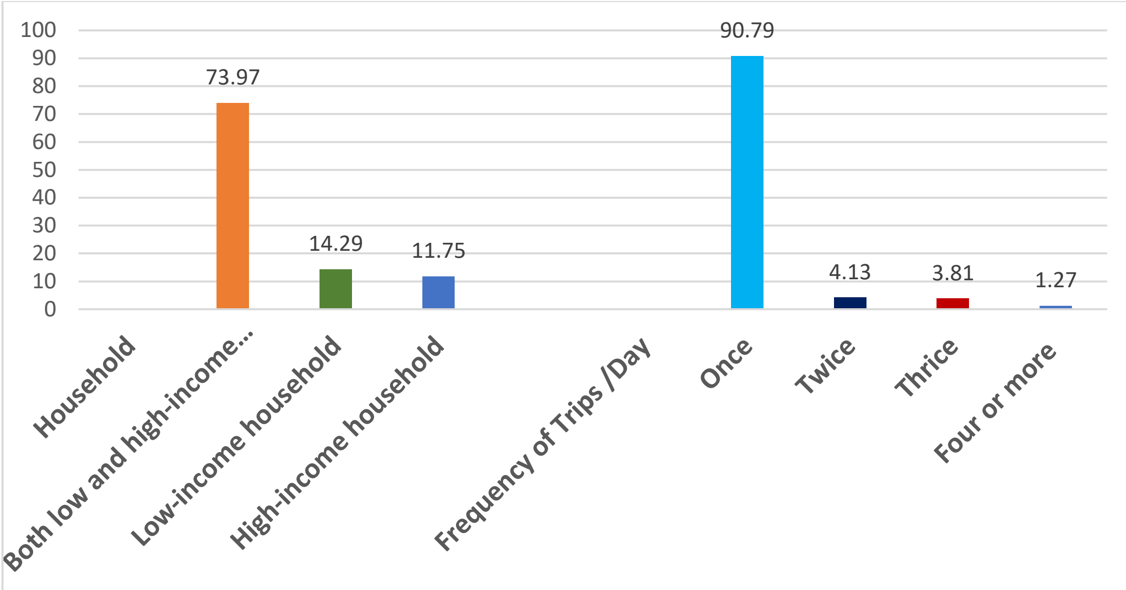
Table 4.1 shows that, 58.41%, 32%, and 2.22% of respondents aged between 20-29 years, ≤19 years, ≥50 years respectively. The mean age of the participants was 25.4 (±5.87) years, with a modal age group of 20–29 (with ages ranging from 16 to 55 years). Most (97.46%) of respondents were males. Table 4.1 shows that, 33.65%, 28.89%, and 27.62% had primary, JHS/Middle, and no formal education, respectively, whereas 7.62% and 2.22% had SHS/O'level and tertiary level education. The majority (60.0) % of the respondents were single, 71.11% Muslims, whereas 27.62% were Christians. More than two-thirds (71.11%) of the respondents had worked for five years, whereas 28.89% had worked for between six to ten years. Many respondents (45.08%), worked for six hours daily, and 11.11% for eight hours. There were statistically significant ($p > 0.00$) differences between the various socio-demographic characteristics of the respondents (Table 4.1).

4.2 Knowledge, Attitude, and Perception of Tricycle Waste Collectors on Waste Management

4.2.1 waste collection sites and the number of trips collected and transported per day.

Figure 3.16 shows that most (73.97%) respondents collect solid waste from low and high-income households, whereas 14.29% and 11.75% collected solid waste only from low and high-income households, respectively. Most respondents (90.79%) convey the solid waste with their tricycle to the dumpsite site once a day, whereas 4.13%, 3.81%, and 0.63% twice, thrice, or more trips per day, respectively ($p > 0.00$).

Figure 4.1: Sites for Waste Collection and Frequency of Trips per Day



(Source: Field Data, 2021).

4.2.3 Waste management activities and **economic gains from the trade**

Table 4.2 reveals that 43.0% were engaged mainly in waste collection, 34% in disposal, and 23% in conveying the waste to final disposal site. More than 37% of the respondents earned over 90 cedis per day, whereas 22.86%, 12.70%, 10.79%, and 10.48% earned between 80-89, 30-39, 40-49 and 60-69 cedis respectively. The monthly income distribution among the respondents showed significant variation (p value > 0.0004). Specifically, 50.48% of the respondents earned more than 400 cedis. In descending order of prevalence, 16.51% earned between 100 and 150 cedis, 11.75% earned between 250 and 300 cedis, 6.67% earned between 150 and 200 cedis, 6.35% earned between 250 and 400 cedis, 5.08% earned between 50 and 100 cedis, and 3.17% earned between 200 and 250 cedis.

Table 4.2: ***Waste Management Activities and*** **Economic gains from the trade**

Variable	Frequency	Percentage (%)	X^2 (P-value)
Waste management practices			
Collection	190	43.0	17.80(0.0002)
Transportation	100	23.0	
Disposal	150	34.0	
Daily profit (GH¢)			
20-29	13	4.13	105.04(0.0002)
30-39	40	12.70	
40-49	34	10.79	
50-59	6	1.90	
60-69	33	10.48	
80-89	72	22.86	
>90	117	37.14	
Current monthly incozme(GH¢			
50-100	16	5.08	141.90(0.0004)
150-200	52	16.51	
250-300	21	6.67	
350-400	10	3.17	
450-500	37	11.75	
550-600	20	6.35	
>650	159	50.48	

(Source: Field Data, 2021).

4.2.4 Knowledge of waste management practices and perception of tricycle waste collectors

4.2.4.1 Training on waste collection and transportation

In Table 4.4, 29.84% had prior waste collection and transportation training. Among these, 17.46% were trained by KMA, 3.17% by friends, 2.54% by educational institutions, 1.59% via television, 1.27% from radio, and 0.95% by a colleague. 66.67% lacked waste management education, while 41.27% got it from KMA, 40% from KCARP, and 3.49% from educational institutions, showing significant differences ($p > 0.000$).

Table 4.3: Waste Collection and Transport Training

Variable	Frequency (n=315)	Percentage (%)	X^2 (P-value)
Training			
No	221	70.16	51.20(0.000)
Yes	94	29.84	
Training Source			
Family& colleagues	17	5.39	121.13(0.000)
Personal	5	15.80	
KMA	55	17.46	
Media	9	2.86	
Educational institution	8	2.54	
Waste Management Training			
No	210	66.67	35.00(0.000)
Yes	105	33.33	
Management training Source			
Relatives	35	11.11	119.3(0.000)
KCARP	126	40.00	
KMA	130	41.27	
Educational institution	11	3.49	
Radio and television	13	4.13	

(Source: Field Data, 2021).

4.2.4.2 Knowledge of Waste Composition and Collection

In Table 4.5, waste collection types include household waste (67%), industrial waste (14%), market waste (9%), and school waste (2%). Composition of waste collected were food waste (38%), sharp objects (16%), plastics (19 %), electronic waste (13 %), boxes (6%), and animal body parts (8%). The bulk of the waste, were collected: 64.76% on weekends, 20.32% on weekdays, and 14.92% on both weekdays and weekends (p value> 0.000).

Table 4.4: Waste Collection and Composition

Variable	Response	Frequency (n=315)	Percentage	X^2 (P-value)
Type of waste	Household waste	210	67	460.19(0.000)
	Industrial waste	45	14	
	Market waste	30	9	
	Hospital waste	25	8	
	School waste	5	2	
Composition of waste	animal body parts	25	8	461.82(0.000)
	sharp objects	50	16	
	electronic waste	40	13	
	Boxes	20	6	
	plastic containers/sachet rubbers	60	19	
	food waste	120	38	
Days of collection of bulky waste	Weekdays	64	20.32	146.76(0.000)
	Weekends	204	64.76	
	Both	47	14.92	

(Source: KCARP, 2021).

4.2.4.3 Waste segregated for disposal at the point of collection

Table 4.6 shows that most wastes (86.35%) were not sorted, whereas 13.65% of the respondent's indicated wastes were sorted. Wates collected were dumped at KCARP 72.38%, KMA site 25.71%, and communal container 1.90% ($p > 0.000$).

Table 4.5: Waste Segregation and Disposal

Variable	Response	Frequency	Percentage	X^2 (P-value)
Sorting of waste	No	272	86.35	166.47(0.000)
	Yes	43	13.65	
The final waste disposal site	KCARP	228	72.38	
	KMA site	81	25.71	214.4(0.000)
	Communal container	6	1.90	

(Source: Field Data, 2021).

4.2.5 Awareness of personal health and environmental issues related to waste collection.

Table 4.7 shows 82.54% of the respondents experienced occupational injuries while on duty; Among 260 injured, 42% had one instance, while 33% had twice, and 25% more. The study identified common injuries as follows: cuts or punctures (45%), dislocations (41%), and fractures (14%). It also examined which body parts were most often injured, finding legs (46.04%) and heads (41.27%) were the most affected. Other injuries occurred to hands (6.35%), fingers (4.44%), and toes (1.9%). Regarding the causes of these injuries, falls (46.78%) and sharp objects (41.9%) were the leading sources. Additional causes included collisions, falling objects, the use of hand tools, and heavy lifting. Treatments were mainly, self-medicated (46.98%), 40% used health facility, 3.75% herbalist. The majority of the respondents, 66.67%, had not been vaccinated for tetanus, and 87.63% had never been vaccinated for Viral Hepatitis B ($p > 0.000$).

Plate 4.1: Leg injuries without proper treatment

Table 4.6: Risk and Hazard Issues Related to Waste Collection

Variable	Frequency	Percentage(%)	X^2 (P-value)
Occupational Injury			
Yes	260	82.54	113.41(0.000)
No	55	17.46	
Rate of injury			
Once	132	42.00	61.76(0.000)
Two or more times	105	33.00	
All days	78	25.00	
Causes of injury			
Cut/puncture	141	45.00	88.32(0.000)
dislocation	130	41.00	
fracture	44	14.00	
Body Part injured			
Leg	145	46.04	407.72(0.000)
Hand	20	6.35	
Finger	14	4.44	
Head	130	41.27	
Toe	6	1.9	
Source of Injury			
Falls	147	46.67	
Sharp object	132	41.9	
Collision	22	6.98	
Hit by a fallen object	10	3.18	
Lifting heavy object	3	0.95	
Snakebite	1	0.32	
Place of Injury treatment			101.53(0.000)
Home	148	46.98	
Health facility	126	40.00	
Drug store	31	9.84	
Herbalist	10	3.18	
Tetanus vaccination			35(0.000)
Yes	105	33.33	
No	210	66.67	
Hepatitis B vaccination			154.05(0.000)
Yes	65	20.63	
No	250	79.37	

(Source: Field Data, 2021).

4.2.6 Perception of PPE usage

In Table 4.8, perceptions of PPE usage were assessed. A majority, 53.33%, agreed that PPEs are crucial for protection. Of these, 40.32% strongly agreed, while 1.59% disagreed and 4.76% strongly disagreed about the necessity of PPEs for protection. Regarding comfort, 11.75% agreed that wearing PPEs made them uncomfortable, with 31.11% strongly agreeing. Conversely, 26.98% disagreed, and 30.16% strongly disagreed about PPE-related discomfort.

Table 4.7: Perception of PPE Usage

Variable	A (n/%)	SA	D	SDS	Mean	SD	Skewness
PPEs are very needed for protections	168 (53%)	127 (40%)	5 (2%)	15 (5%)	1.58	0.750	1.552
Wearing PPEs makes me uncomfortable	37 (12%)	98 (31%)	85 (27%)	95 (30%)	2.76	1.013	-0.179

SDS: strongly disagree, D: disagree, N: neutral, SA: strongly agree, A: agree SD: standard deviation (Source: Field Data, 2021)

4.2.6.1 Perception of safety practices carried out by waste collectors

Table 4.9 the result of the study shows that 73.02% of the respondents use PPE; 46% use safety boots, 36% gloves, facemasks 10%, and 8% overall coats. Nearly 70% of the respondents use PPE whilst working, whereas 30.79% do not because they are uncomfortable, 17.46% use PPE, 12.06% were unaware, and 1.27% could not afford to purchase it. Nearly half of the respondents, 49%, wash their PPEs, 43% change their PPEs, whereas 8% wear the same PPE all the time ($p > 0.000$).

Table 4.8: Safety Practices Carried Out by Waste Collectors

Variable	Responses	Frequency	Percentage (%)
Use PPE for waste collection	Yes	230	73.02
	No	85	26.98
Types of PPEs	safety boots	195	46
	gloves	150	36
	mask	40	10
	protective cloth	35	8
Use PPE whiles working	yes	218	69.21
	no	97	30.79
If not, why?	not aware	38	12.06
	uncomfortable	55	17.46
	don't know where to purchase	4	1.27
Maintain health and safety in your work environment.			
	Change PPE	152	43
	Wash PPE	171	49
	wear the same PPE all the time	28	8

(Source: Field Data, 2021).

4.2.6.2 Use of Personal Protective Equipment (PPE)

In Figure 4.2, safety boot usage was predominant among the respondents at 78%, while the least used was the overall coat at 8%. Additional safety equipment's included facemasks (10%), helmets (32%), gloves (36%), and goggles (30%).

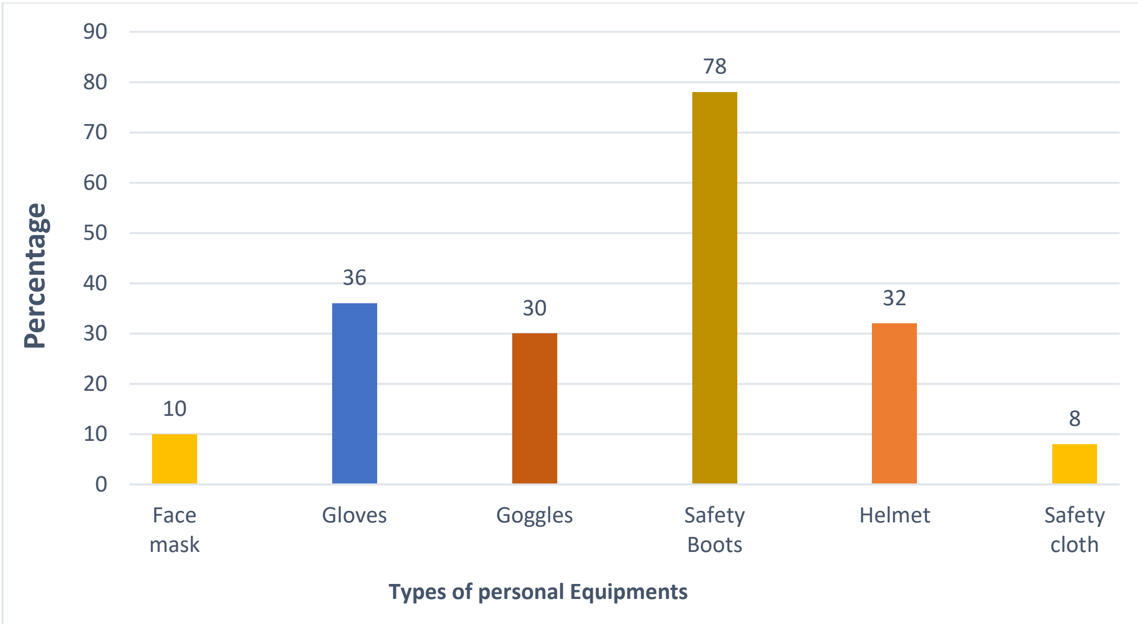


Figure 4.2: Use of PPEs among the Participants

(Source: Field Data, 2021).

4.3 Hazards Associated with Waste Collection

4.3.1 Physical hazards exposure in solid waste

Figure 4.3 shows that respondents were exposed to razor blades 55%, cutlets 17%, broken glass 15%, and metal pieces 13%. Risks encountered among respondents were injuries from falling from a height 62%, falling from a tricycle 9%, heat 15%, 4%, burn 2%, and fracture 8%. Parts of the respondent's body affected include the head injury 51%, fingers 20%, leg 14%, knee 12%, and toe 3%.

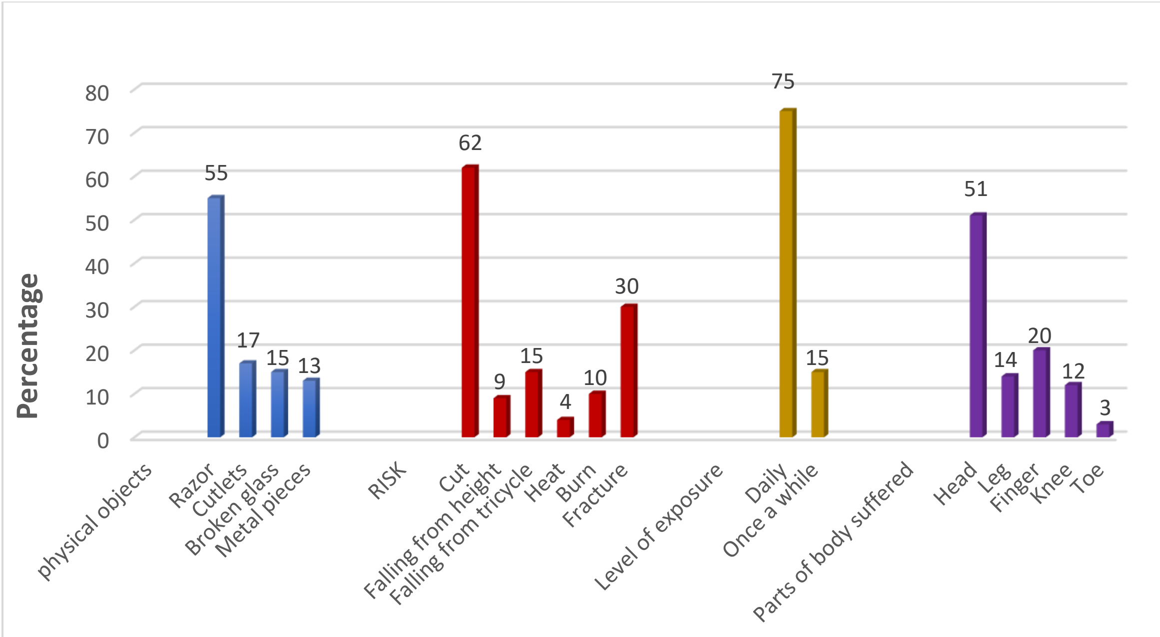


Figure 4.3: Physical objects in solid waste

(Source: Field Data, 2021).

4.3.2 Biological Hazards Exposure

Figure 4.4 shows that 27% of the respondents were exposed to food waste, poultry litter 23%, used nose masks 21%, faeces 17%, and animal carcasses 12%. Most 76% of the respondent were daily exposed to biological waste. Skin disorders suffered were 51%, eye irritation 20%, diarrhea 14%, headache 12%, and nausea 3%. The body parts most affected were the skin, eye, and finger.

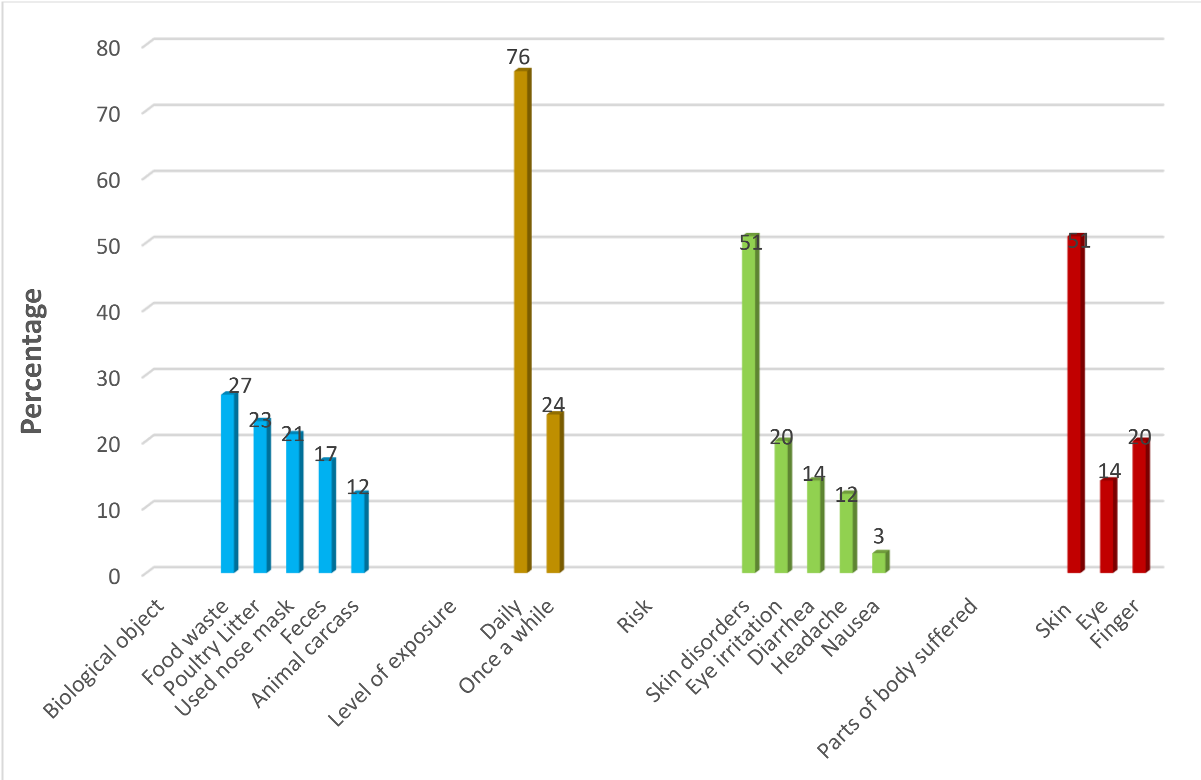


Figure 4.4: Biological object exposure

(Source: Field Data, 2021)

4.3.3 Chemical hazard

Figure 4.5 the result shows that respondents were exposed to oil containers at 30%, chemical containers at 23%, batteries at 19%, hair products at 18%, pesticides at 10%, gasoline products at 31%, and Paints at 24%. The risks included Skin irritation 48%, eye irritation 24%, and nausea 28%. Diseases suffered were skin at 63.49% and eye infection at 36.5%, respectively.

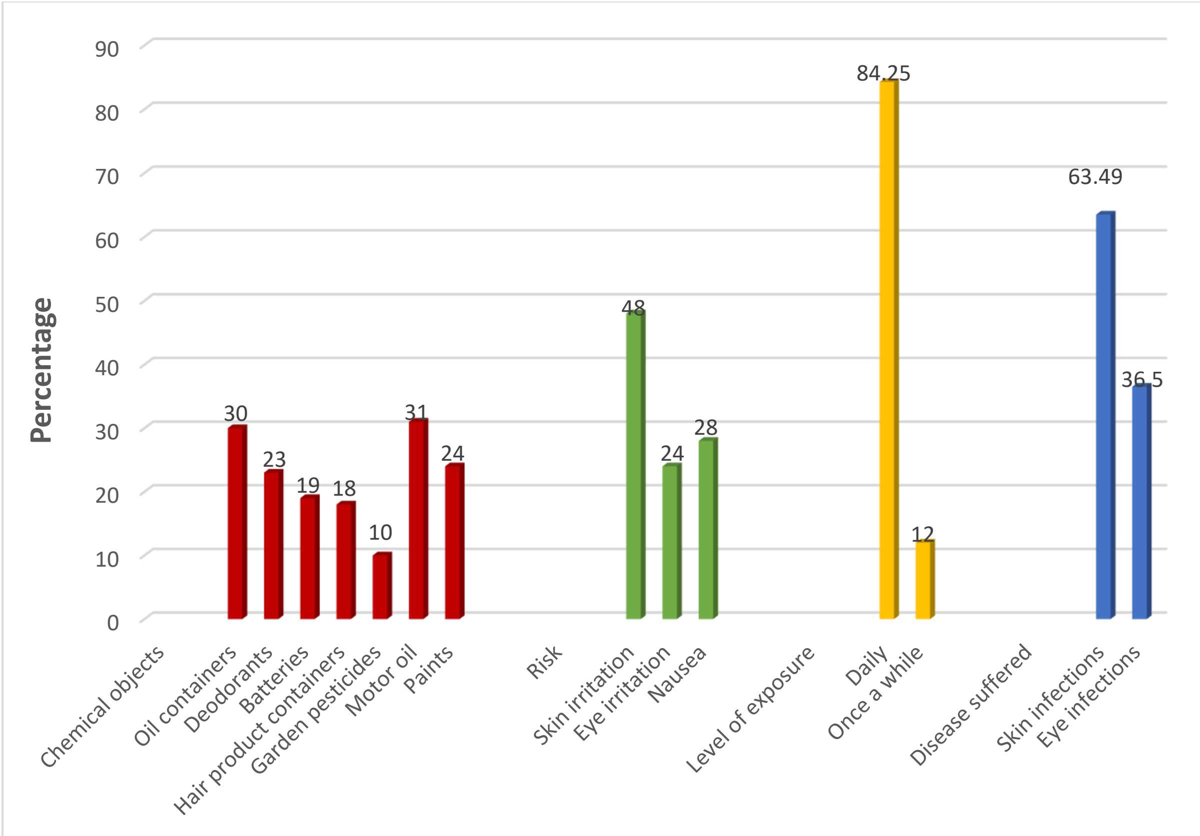


Figure 4.5: Chemical object in solid waste

(Source: Field Data, 2021)

4.4 Health Status and Other Diseases Suffered by Waste Collectors

Table 4.10 the study shows that 66.98% of the respondents had a health problem, whereas 33.02% did not. Health conditions reported by many respondents were back pain 33.97%, abdominal pain 32.06%, chest discomfort 31.43%, and difficulty using the arms 31.11% [($p > 0.000$)).

Table 4.9: Health Status and Other Diseases Suffered by Waste Collectors

Variable	Frequency	Percentage %)	X^2 (P-value)
Have health problems			
Yes	211	66.98	36.34(0.000)
No	104	33.02	
Pain in the chest area			
Yes	99	31.43	43.45(0.000)
No	216	68.57	
Difficulty in breathing			
Yes	76	24.13	84.34(0.000)
No	239	75.87	
Abdominal pain			
Yes	101	32.06	40.53(0.000)
No	214	67.94	
Back pain			
Yes	107	33.97	32.38(0.000)
No	208	66.03	
Difficulties using arms			
Yes	98	31.11	44.96(0.000)
No	217	68.89	
Difficulties in walking			
Yes	78	24.76	80.26(0.000)
No	237	75.24	
Malaria			
Yes	56	17.78	130.82(0.000)
No	259	82.22	

(Source: Field Data 2021).

4.4.1 Reported health conditions among waste collectors

The prevalence of other health conditions reported among participants is presented in Table 4.11 below. Generally, the prevalence of reported diseases was low among participants. The most-reported health condition was diarrhea disease, which about 27.30% of participants reported having. From Table 4.11, there was statistically significant ($p > 0.000$) in all the Reported health conditions among waste collectors.

Table 4.10: Other Health Conditions Reported among Waste Collectors

Variable	Frequency	Percentage	X^2 (P-value)
Problems with vision			
Have problem	49	15.56	149.49(0.000)
No problem	266	84.44	
Problems with hearing			
Have problem	24	7.62	226.31(0.000)
No problem	291	92.38	
Headache or migraine			
Have headache	41	13.02	172.34(0.000)
No headache	274	86.98	
Skin disease			
Have skin infection	49	15.56	149.49(0.000)
No skin infection	266	84.44	
Diarrhoea			
Have diarrhoea	86	27.30	64.92(0.000)
No diarrhoea	229	72.70	
Heart disease			
Have heart disease	53	16.83	138.67(0.000)
No heart disease	262	83.17	
Ulcer disease			
Have **Ulcer**	42	13.33	169.4(0.000)
Don’t have Ulcer	273	86.67	
Tuberculosis			
Have tuberculosis	23	7.30	229.72(0.000)
No tuberculosis	292	92.70	

4.5 Prevalence of Hepatitis B among Waste Collectors

In Table 4.12, Viral Hepatitis B Surface Antigen (HBsAg) testing was conducted among 100 respondents, resulting in 12% testing positive and 88% testing negative. The table also demonstrated a significant association between viral hepatitis B infection and the educational background as well as the monthly earnings of tricycle solid waste collectors ($\chi^2 = 29.7$, $p < 0.005$). Notably, the age group between 20-29 years had the highest infection rate at 75.0%. Among the infected participants, 91.7% (11) were males, 75.0% (10) had primary education, and 75.0% (9) earned less than GHC 00 per month. Additionally, 75.0% (9) were single.

Table 4.11: Relationship between Hepatitis B and Waste Collectors Demographic characteristics

Study variable	Hepatitis B Status		χ² (P-value)
	Negative [n (%)]	Positive [n (%)]	
Age (Years)			
<20	17 (19.3)	2 (16.7)	
20-29	48 (54.5)	9 (75.0)	3.83 (0.429)
30-39	18 (20.5)	1 (8.3)	
40-49	2 (2.3)	0 (0.0)	
≥50	3 (3.4)	0 (0.0)	
Sex			
Male	81 (94.2)	11 (91.7)	
Female	5 (5.8)	1 (8.3)	0.116 (0.733)
Education			
No formal Education	49 (55.7)	9 (75.0)	
Primary Education	30 (34.1)	2 (16.7)	11 (0.011*)
Secondary Education	8 (9.1)	1 (8.3)	
Tertiary level	1 (1.1)	0 (0.0)	
Marital status			
Married	42 (47.7)	3 (25.0)	1.82 (0.177)
Single	46 (52.3)	9 (75.0)	
Religion			
Christianity	26 (29.5)	2 (16.7)	0.95 (0.33)
Islam	62 (70.5)	10 (83.3)	
Monthly income			
< GHC 500	60 (68.2)	9 (75.0)	
GHC 500-1000	20 (22.7)	2 (16.7)	29.7 (0.00*)
> GHC 1000	8 (9.1)	1 (8.3)	

(Source: Field Data, 2021)

CHAPTER FIVE

DISCUSSION

5.1 Socio -Demographic Characteristics

In this present study, nearly 80% of the waste collectors were under 30 years and were predominantly males, consistent with the finding of a similar study conducted in Ghana on solid waste collectors, who showed that this trade involved mostly young men. Similar finding has been reported by Hirpe & Yeom, (2021). A recent study conducted by Batta & Kwon, (2020) revealed that more than 97% of the study participants were males in agreement with this present study. This trend of male dominance in this sector could be attributed to the fact that waste collection entails a lot of lifting bulky waste and transporting same to dumpsites The result agrees with a study conducted by (Ziad et al., 2021). The study showed 58.41% of respondents were between 20-29 years and that majority of them were not married consistent with the finding of a similar study conducted by Sadiea et al., (2022). In this study, more than 62% of the respondents had basic education, in agreement with the finding from previous research conducted by Acquah *et al.* (2021) in Agbogbloshie, which found that individuals involved in solid waste collection had a shallow level of formal education. This finding could be attributed to the fact that the majority of the participants either dropped out of school or had a low educational status and could not get well-paid jobs in the other sectors of the economy and thus resorted to waste collection to make ends meet as a result agrees with a study conducted by (Akmal & Jamil, 2021). Most of the respondents were Muslims, and the majority of them were not married. That could be argued that most of these Tricycle Waste Collectors were migrant young men from the Northern part of Ghana who had come down to the south for greener pastures and, in the absence of such jobs, resorted to waste collection for a living.

5.2 Knowledge, Attitudes, and Perception of Solid Waste Handling

In this study, waste collectors perceived waste picking as part of the overall waste management intended for the environment and sanitation. Waste management, however, requires good knowledge, attitudes, and risk perception. The majority of respondents in this study were involved in collecting domestic waste, although most had low training and qualification in waste management. Very few of them had received waste management training, primarily from KMA. This finding could be attributed to the fact that most participants had no prior training in waste collection and transportation. Deng *et al.* (2020) support this assertion that waste collectors with high literacy levels have a low level of knowledge and awareness of waste management, risks, and impacts of waste. Seshie *et al.* (2020), demonstrated that awareness campaigns were critical for changing the social aspects of waste collectors including safety training and positive reinforcement of safety rules.

5.3 Economic Gains in Waste Collection

In this study, participants viewed waste collection as a source of economic gain and livelihood and were thus self-employed. Income earned from waste pickers becomes the primary source of household income used to pay medical bills (Wassie *et al.*, 2022). Most respondents earned daily and monthly wages of more than 100 cedis and 500 cedis, respectively. Waste picking and collection in Ghana create opportunities for unemployed groups, sometimes taking them off the streets. Informal waste workers also improve the quality of life in the communities in which they work. Though the usage of economic gains from the waste collection was not assessed, Dias (2016) in Durban indicated that some waste pickers use the income to buy other goods to sell, generating more income for their families.

5.5 Waste Composition and Management Activities

Most households did not sort their waste. However, the types of waste collected were mainly household waste consisting of the carcass, leftover foods, sharp objects, plastics, etc. supporting the study by Dzah *et al.* (2022) which grouped waste into two major types; organic and inorganic materials although organic content of solid waste in Ghana is usually more than 60% (Ojo, 2018). In this study, waste collectors collect, transport, and dispose of waste at designated treatment sites, mostly KCARP, with KMA playing a pivotal role in a city without an efficient waste management system (Zaky, 2018). Waste pickers and collectors protect the environment by allowing materials to be reused or reprocessed while providing valuable materials for recycling industries (Dias, 2016). In Ghana, waste is mainly collected at the point of generation or a temporary dumping site and finally disposed of at open dump sites on the city's outskirts (Fredrick *et al.*, 2018).

5.6 Safety Practices

In this study, PPEs were used by a more significant proportion of respondents during waste collection and transportation. Safety boots were the main PPE used, and almost half of those polled washed their PPE to ensure health and safety, contrary to Berhan (2020) studies that reported meager rates of compliance with PPE use among workers (Berhan, 2020; Ravindra *et al.,* 2016). The health risks waste pickers and collectors face are critical (Soogreem *et al.,* 2012), and Ghana in particular. The International Labor Organization (2019) regards health safety in the workplace as the promotion and maintenance of the highest degree of physical, mental, and social well-being. Informal waste collectors are at a higher risk of physical injury (Acquah *et al.*, 2021).

5.7 Hazards and Risk Exposure

Solid waste collectors are exposed to occupational health-related problems from waste materials and their physical effort in waste handling (Bogale *et al.,* 2014).

5.7.1 Physical hazards within the working surroundings of waste collectors

The findings of this study revealed exposure to razors, Glass cutlets, broken glass, and metal pieces as the major physical hazards to waste collectors. Risks of these physical hazards include falling from a height, falling from a tricycle, injuries, heat, burn, and fracture. The finding of this study concord with a study by (Ncube *et al.*, 2021) that showed waste pickers were much more susceptible to the risk of getting cut, and scratched, often without protection through mixed waste.

5.7.2 Chemical hazards within the working environments of waste collectors

This study revealed that oil containers, chemical containers, batteries, hair products, and pesticides where the chemical hazards waste collectors were exposed to. Associated diseases were skin irritation, eye irritation, and nausea as reported previously Kretchy *et* *al.* (2015). This further collaborated well with similar studies (Sharma & Jain, 2019) and (Aparcana, 2017) pointed out that opening tins and buckets contained hazardous substances.

5.7.3 Biological hazards commonly found in novel group waste collectors within the Kumasi metropolis

The biological hazards waste collectors were exposed to, were waste feed, poultry litter, used nose masks, feces, and carcasses of animals. The resulting diseases associated were skin diseases, diarrhea, eye irritation, nausea, and headache following (Fatimah *et al.*, 2020).

5.8 Factors Associated with Occupational Injuries

In this study, occupational injuries were significantly associated with the work category; collection and transportation of solid waste. That could be attributed to the fact that workers were involved in repeated physical activities such as lifting and carrying waste into trucks and tricycles and transporting same to landfill sites exposing them to injuries (Bogale *et al.*, 2014). On the other hand, findings from other studies showed that occupational injuries were associated with work experience and work-related stress (Rakib *et al.,* 2014) including the use of PEEs in the workplace (Zaky, 2018). Workers without PEEs were two times more likely to report occupational injury than workers with PPEs (Adeleke *et al.*, 2021).

5.9 Health Status of Waste Collectors

Waste collectors are exposed to various physical, chemical, biological, and psychosocial hazards that can impact their health. These hazards include manual handling of heavy loads, exposure to hazardous substances and contaminants, risk of injuries, infectious diseases, and mental health challenges as compare to a study by(Batta & Kwon, 2020) . One of the primary physical health effects experienced by waste collectors is musculoskeletal disorders. The manual handling of heavy waste bins or bags and repetitive movements can lead to back pain, joint problems, and musculoskeletal injuries. These conditions can significantly impact their quality of life and ability to perform their work effectively supporting the study by(Kretchy et al., 2015) . Chemical hazards also pose risks to waste collectors. They may come into contact with toxic substances, such as household chemicals, industrial waste, and medical waste, which can lead to respiratory issues, skin problems, and long-term health complications if proper protective measures are not in place. Infectious diseases are a significant concern for waste collectors due to their exposure to potentially contaminated materials. Waste collectors may face a higher risk of contracting diseases such as hepatitis B, gastrointestinal infections, and skin infections, as confirmed by a study from (Ncube et al., 2021). Lack of proper personal protective equipment (PPE) and inadequate waste handling practices increase the likelihood of disease transmission. Psychosocial hazards, including stress, fatigue, and mental health challenges, are prevalent among waste collectors supporting a study by(Acquah et al., 2021). The nature of their work, such as working long hours, dealing with unpleasant odours and sights, and facing social stigma, can harm their mental well-being. These factors may contribute to increased stress levels, anxiety, depression, and burnout among waste collector etc. similar to claims previous studies that reported risk of respiratory diseases among waste(Weghmann & Niekerk, 2018); Gebremedhin, 2016).

5.10 Prevalence of Hepatitis B among Tricycle Caste Collectors

Hepatitis B virus (HBV) infection is a global issue, affecting two billion people in the world, with 360 million chronic carriers of hepatitis B surface antigen (HBsAg.The findings of this study revealed several factors contribute to the increased risk of hepatitis B transmission among waste collectors. Firstly, waste collectors often come into contact with potentially infectious materials, including discarded needles, syringes, and other medical waste that may carry the hepatitis B virus. Additionally, poor sanitation practices, improper handling of waste, and limited access to personal protective equipment (PPE) further contribute to the risk of contracting the disease. Quite similar to the findings of Acheampong (2011), which advanced that 70% of waste collectors interviewed in Accra were exposed to physical hazards like blades and razors that were the potential transmission of HBV. A study revealed that 10.4% out of the 231 respondents were aware of the existence of the HBV vaccine. That rightly shows that tricycle waste collectors care less about the need to get vaccinated against HBV. The prevalence of HBV among tricycles was fairly low at 12%. The reported value in this study was lower than that reported by Dna, (2019) in Dakar at 14.5 % and 16.5%. The study conducted among tricycle waste collectors found that 12% of the participants tested positive for hepatitis B. This finding highlights a noteworthy disease prevalence rate within this specific occupational group. The relatively high prevalence is concerning and calls for attention to the health and well-being of tricycle waste collectors.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The results indicate that the majority of tricycle waste collectors are young males between the ages of 20-29, with primary education and primarily from Muslim backgrounds. Most of them have been working in waste collection for up to five years and work for about six hours daily. They mainly collect solid waste from both low and high-income communities and transport one trip of waste per day. The study also reveals that waste collectors engage in various waste management activities, including collection, transportation, and disposal. Economic gains from the trade varied, with a significant number earning over 90 cedis per day, and some earning above 400 cedis monthly.

The study identifies several occupational health hazards faced by tricycle waste collectors. Physical hazards include exposure to sharp objects, broken glass, and metal pieces, which can lead to injuries such as cuts, dislocations, and fractures. Biological hazards arise from exposure to food waste, poultry litter, and used nose masks, leading to skin disorders, eye irritation, and diarrhea. Chemical hazards stem from exposure to oil containers, chemical containers, and batteries, resulting in skin and eye irritation, and in some cases, nausea. Additionally, the risk of falling from heights was also a significant concern among waste collectors. These findings underscore the importance of implementing proper occupational health and safety measures, including the use of personal protective equipment, to mitigate the identified hazards and risks.

The study reveals that waste collectors commonly suffer from various health issues, such as back pain, abdominal pain, chest discomfort, and difficulties using their arms and walking. Diarrhea and headache were the most reported health conditions among the participants. Moreover, a notable finding is the prevalence of 12% of tricycle waste collectors testing positive for hepatitis B, this indicates a significant health concern and emphasizes the importance of regular health screenings, immunizations, and proper healthcare access for waste collectors. The prevalence of other health issues and diseases beyond hepatitis B was not explored in the study, and further research is required to comprehensively assess the overall health status of tricycle waste collectors. This study showed the prevalence of HBV among tricycle solid waste collectors in the Greater Kumasi Metropolis.

6.2 Recommendations

Based on the essential findings and recommendations drawn from the study, the following recommendations were made by the researcher:

6.2.1 KCARP and KMA

1. Regular Monitoring and Evaluation:

Continuing monitoring and evaluation of occupational health and safety practices should be conducted to ensure compliance and effectiveness. That can involve periodic inspections, audits, and feedback mechanisms to identify areas for improvement and address any emerging issues promptly. Bring all tricycle waste collectors under its umbrella and screen and license them while ensuring frequent training and workshops to improve their knowledge and skills in waste collection and transportation. Random but frequent supervision of waste collectors to keep them on their toes and help eliminate certain unhygienic practices among them, which could lead to infecting themselves, is of a higher recommendation.

2. Regular Health Screenings

Waste collectors should have access to regular health screenings and medical check-ups. That can help detect and manage any occupational health issues at an early stage. Particular attention should be given to screening for infectious diseases, such as hepatitis B, and providing appropriate vaccination and treatment as necessary.

3. Training and Education

Waste collectors should receive comprehensive training on occupational health and safety practices. That should cover waste handling techniques, proper lifting and carrying methods, and safe disposal of hazardous waste. Training programs should also address the importance of personal hygiene and infection prevention measures to reduce the risk of contracting infectious diseases.

4. Establish a Reporting and Incident Management System

Waste management companies should develop a robust reporting system that allows waste collectors to report incidents, hazards, and near misses. This system should ensure anonymity and provide clear guidelines on reporting procedures. Timely investigation of reported incidents should be conducted, and corrective actions should be implemented to prevent similar incidents from occurring in the future. Provide training programs at the onset of hiring and on an ongoing basis to educate all waste collectors, trash vehicle drivers, and managers about hazards, injuries, and their reduction and prevention.

5. Collaboration with Stakeholders

Waste management companies should collaborate with relevant stakeholders such as local authorities, healthcare providers, and occupational health and safety agencies. This collaboration can facilitate the exchange of information, resources, and expertise to improve waste collectors' occupational health and safety. Joint efforts can also lead to the development of comprehensive waste management strategies that prioritize the well-being of waste collectors.

6.2.2 Waste collector

1. Use Personal Protective Equipment (PPE) Properly

Waste collectors should use the provided PPE, such as safety boots, gloves, face masks, and helmets, correctly and consistently during their work. They should receive training on how to wear, maintain, and dispose of PPE properly to minimize exposure to occupational hazards.

2. Attend Occupational Health and Safety Training

Waste collectors should actively participate in training programs focusing on occupational health and safety. These sessions should cover waste handling techniques, proper lifting and carrying methods, identification of hazardous waste, and infection prevention measures. Waste collectors can better protect themselves from workplace hazards by acquiring the necessary knowledge and skills.

3. Practice Safe Lifting and Carrying Techniques:

Waste collectors should be trained on ergonomic lifting and carrying techniques to minimize the risk of musculoskeletal injuries. That includes using proper body mechanics, avoiding heavy loads whenever possible, and seeking assistance. Regular exercise and stretching routines can also help improve strength and flexibility, reducing the likelihood of strains and injuries.

4. Promote Hygiene and Sanitation Practices:

Waste collectors should prioritize personal hygiene to reduce the risk of infections and illnesses. They should wash their hands thoroughly with soap and clean water before and after waste collection activities. Waste collectors should also have access to clean water and appropriate sanitation facilities during work shifts.

5. Take Breaks and Rest Periods:

Waste collectors should be encouraged to take regular breaks and rest during their work shifts. That allows for physical and mental recovery, reducing the risk of fatigue-related accidents and injuries. Employers should establish work schedules that incorporate adequate rest periods and promote a healthy work-life balance.

6. Report Hazards and Incidents:

Waste collectors should proactively report any hazards, incidents, or near-miss events to their supervisors or relevant authorities. By promptly reporting such incidents, appropriate measures can be taken to address the hazards and prevent similar incidents. An open and supportive reporting system should ensure waste collectors feel comfortable and confident in reporting.

7. Seek Medical Attention and Regular Health Check-ups:

Waste collectors should prioritize their health and seek medical attention when necessary. They should be encouraged to undergo regular health check-ups to detect and address occupational health issues early on. Waste collectors should also ensure they are up-to-date with vaccinations, such as hepatitis B, to protect themselves from infectious diseases.

8. Engage in Advocacy and Collective Action:

Waste collectors can advocate for their rights, occupational health, and safety by joining or forming worker associations or unions. Collective action can help raise awareness about the challenges faced by waste collectors and exert pressure on relevant stakeholders to improve working conditions. Waste collectors should actively participate in discussions and negotiations regarding their occupational health and safety.

Areas for Further Studies

1. Expand the scope of the research to include waste collectors from other regions or even on a national level to identify regional variations and common trends in occupational health hazards and practices.
2. Conduct more extensive studies on the prevalence of specific diseases among waste collectors, expanding beyond hepatitis B to include other infectious and non-communicable diseases.
3. Evaluate the effectiveness of safety interventions, such as the use of personal protective equipment (PPE) like safety boots, through randomized controlled trials or comparative studies to assess their impact on reducing occupational health risks

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APPENDICES

Appendix One: Questionnaire

Survey questionnaire on occupational health risk and exposure among a tricycle waste collector in the Greater Kumasi.

I Joseph Appiah a student of University of Education, Winneba, undertaking a study on occupational health risk and exposure among a tricycle waste collector in the Greater Kumasi. I therefore seek your support by participating in a survey as a respondent and any information you provide will be treated with anonymity and your answers will remain confidential.

Informed **CONSENT**: Agreed [ ]   **Sub Metro:**………………………..

Biodata/profile			
No	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	**SKIP**
1.	Date of interview:		
2.	Age of respondent	Below 20years [ ] ………………...1 20 – 29 years [ ] …………………..2 30 – 39 years [ ] …………………….3 40-49 years [ ] …………………….4 50 and above[ ] …………………...5	
3.	Sex of respondent:	Male [ ] ……………………….….1 Female [ ] ………………………....2	
4.	Highest educational level:	Primary [ ] ……………...………...1 JHS/Middle form [ ] ………..……2	

		SHS/O'level[ ] ……………………....3 Tertiary [ ] ……………………..……4 Other (specify)……………………..5	
5.	Marital status	Married [ ] …………………….......1 Single [ ] ………………..……......2 Divorced [ ] ……………………....3 Separated [ ] ……………………....4 Living together…………………......5	
6.	Ethnic group	Akan [ ] ……………..…………......1 Ga [ ] …………………………........2 Ewe [ ] …………...…...……….......3 Dagomba [ ] ……...…………..…....4 Other (specify……………………......5	
7.	Religion	Christianity [ ] ……..……………......1 Islam[ ] ………………………….…..2 Buddist [ ] ………..……………........3 Traditional [ ] …….……………….....4 Other (specify………………..…......5	
8.	Hometown		
9.	District		
10.	Home region	Ashanti [ ] …….………………..........1 Accra [ ] …………………………2	

		Eastern [ ] ………….……….......3 Central [ ] ………………………..4 Northern region [ ] ……………….5 Upper East [ ] ……………………6 Upper West [ ] …………………....7 Other (specify………………….……8	
11.	Current residence		
12.	Residential status	Rented room [ ] ……..………….....1 Rented kiosk [ ] ……….………...2 Rented uncompleted house [ ] …...3 Resented apartment [ ] …………...4 Self-made kiosk [ ]……………..…5 Other (specify……………………...6	
13.	Previous employment	Farming [ ] ….…………………....1 Trading [ ] …………….……….....2 Labourer [ ] ………….……..…....3 Other (specify……………….….…4	
14.	Current employment	Waste Collector [ ] …….……..…..1 Farming [ ] ……….……………....2 Trading [ ] …………….……….…...3 Labourer [ ] ……………….….......4 Other (specify…………………......5	

15.	Main employment	Waste Collector [ ] ……….……........1 Farming[ ] …….……………………2 Trading [ ] …………….……........3 Labourer [ ] ……….…….……........4 Other (specify………………….......5	
16.	How long have you been doing this work?	Under 5 years [ ] ……….………..….1 6-10 years [ ] …….………………….….2 11-15 years[ ] …………………...…3 16-20 years [ ] ……….…..….........4 Other (specify…………………........5	
17.	How did you first get into this work?	Through friend [ ] ………………...1 Unemployed [ ] …………………...2 Relative [ ] ……………………...…3 Other [ ] ………………………...…4	
18.	Which suburb of Kumasi do you usually collect your waste from?	Tafo [ ] …………………………...1 Asawase [ ] ………………………2 Asokwa [ ] …………...………...3 Kwadaso [ ] ………………………4 Suame [ ] …………………….......5 Manhyia [ ] …………………..……6 Bantama [ ] …………………......7 Subin [ ] ……………………...…8	

		Oforikrom [ ] ……………………..9 Other [ ] ……………….………..10	
19.	Which type of area do you collect their waste?	High income places [ ] …………....1 Low-income places [ ]…………….2 Both [ ]…………………………….3 Other(specify)…………………...…4	
20.	How many trips on the average do you do per day?		
21.	How many hours do you work in a day	0-4hrs [ ]…………………………..1 4- 5 hrs [ ] ………………………...2 5-6 hrs [ ] ……………………….....3 6-7 hrs [ ] ………………..……..4 7-8hrs [ ]…………………………..5 Other [ ] …………………………..…6	
22.	How much do you make per day?	20-30 cedis [ ] ………………….....1 30-40 cedis [ ] …………………….2 50-60 cedis [ ]………………..…...4 60-70 cedis [ ] …………………….5 70-80 cedis [ ] …………………….6 80-90 cedis [ ]…...………………...7 Other [ ]…………………………..8	

23.	What is your current monthly income	50-100 cedis [ ] …………………..1 100-150 cedis [ ] ………………...2 150-200 cedis [ ] ………………...3 200-250 cedis [ ] …………………4 250-300 cedis [ ] ………………...5 350-400 cedis…………………..……..6 0ther [ ] ……………………..….7	
24.	Which of the following activities do you engage?	Collection [ ] ……………………1 Disposal [ ]………………………2 Transport [ ]……………………..3 Other(specify)……… …………...4	
Knowledge, attitude, and perception of solid waste handling			
25.	Have you been trained on how to collect and transport waste?	Yes [ ]……………………………1 No [ ]……………………………2	→ **Q27**
26.	Where did you received your training on waste collection?	Educational institution [ ] ………..1 Television [ ]……………………..2 Radio [ ]…………………………3 KMA[ ]…………………………..4 Other (specify)………………..…..5	
27.	Do you have any training on management of waste?	Yes [ ]……………………………1 No [ ]……………………………..2	→ **Q29**
28.	If yes, where did you acquire it?	Educational institution [ ]………...1	

		Television [ ]…………..………..2 Radio [ ]…………………………3 KMA[ ]…………………………..4 Other (specify)………………..…..5	
29.	Are you aware of the consequences of poor solid waste handling to your health?	Yes [ ]………………………….....1 No [ ]……………………………..2	→ **Q33**
30.	If yes, what are some of the consequences of poor waste handling on your health?	Disease contraction [ ]…………..…1 Cut [ ]……………………….…..…..2 Burns [ ]…………………………...3 Injuries [ ]………………………....4 Others(specify) ………………..….5	
31.	What are some of the environmental pollutions caused by poor solid waste management in Kumasi?	Litter on the compound [ ]……….1 Choked of gutters [ ]……………..2 Flooding…………………………3 Others……………………………4	
32.	What are some of the diseases you can contract from solid waste collection?	Malaria [ ]………………..……..1 Cholera [ ]…………………….…...2 Diarrhoea [ ]………………………3 HBV [ ]……………………………4 Titanus [ ]……………………..….5 Others……………………………..6	

33.	PPEs are very needed for protection?	Agree [ ]…………………………..1 Strongly agree [ ]…………………2 Disagree [ ]………………………..3 Strongly disagree……………..…..4	
34.	Wearing PPEs makes me uncomfortable?	Agree [ ]…………………………..1 Strongly agree [ ]…………………2 Disagree [ ]………………………..3 Strongly disagree……………..…...4	
Waste generation, segregation and disposal			
35.	What type of waste do you often collect?	Household waste [ ]………………1 Industrial waste [ ]………………...2 Market waste [ ]…………………...3 Hospital waste [ ]…………………4 Others……………….……………4	
36.	What is the general composition of the waste you collect? (multiple option)	Animal body parts [ ]……………..1 Sharps objects [ ]…………………2 Electronic waste [ ]………………..3 Boxes [ ]…………………………4 Plastic containers/sachet rubbers[ ].5 Food waste [ ]……………………..6 Other (specify)………………........7	

37.	Which of the days do you collect high and heavy waste?	Weekdays [ ]……………………..…..1 Weekends [ ]………………………2 All days [ ]……………………..….3	
38.	Is sorting done by residents from whom you collect waste?	Yes [ ]………………………….....1 No [ ]……………………………..2	→ Q39
39.	If yes was waste separated into different containers?	Yes [ ]………………………….....1 No [ ]……………………………2	→ Q39
40.	Where do you transport the collected waste for final disposal?	Kumasi Compost & recycle plant [ ]…………………………………1 KMA waste management site [ ]…..2 Communal container [ ]………….....3 Other (specify)……………………..4	
Health and Safety issues associated in waste collection			
41.	Do you use PPE often during waste collection and transportation?	Yes [ ]…………….…………......1 No [ ]……………………………..2	→ Q42
42.	What health and safety tools do you use in your work?	Safety boot [ ]……………………..1 Gloves [ ]……………………......2 Mask [ ]…………………………...3 Protective cloth [ ]………………...4 Other (specify)……………………..5	

43.	Do you use PPE whiles working?	Yes [ ]…………………………......1 No [ ]……………………………...2	
44.	If no, why?	Not aware [ ]……………………....1 Uncomfortable [ ]………………....2 Don't know where to purchase [ ]...3 Other (specify)……………………..4	
45.	Which health and safety tools do you use all the time during waste collections? (multiple option)	Wallington boot [ ]……………..……1 Gloves [ ]…………………..…………2 Mask [ ]……………….…………….3 Other (specify)…..…………………4	
46.	How do you maintain health and safety in your work environment?	Change PPE [ ]…………….………...1 Wash PPE [ ]……………………...2 Wear same PPE all the time [ ]…....3 Other (specify)………….……..........4	
47.	What types of physical hazard are you expose to during working time? (multiple option)	Razor blades [ ]…………….…….1 Glass cutlets [ ]…………….…….2 Metal pieces [ ]…………………....3 Broken glasses [ ]………………....4 Other (specify)……..………………5	

48.	What type of PPE do you use whiles handling the above waste?	Wallington boot [ ]…………..……1 Gloves [ ]………………..……..2 Mask [ ]…………….…………..3 Helmet [ ]……………..…………..4 None [ ]……………..……………..5 Other (specify)…………..………6	
49.	Have ever experience any physical hazard in the course of your work?	Injuries [ ]…………………………1 Falling from height [ ]…………....2 Falling from tricycle [ ]…………..3 Heat [ ]……………………...…..4 Burn [ ]………………..………..5 Fracture [ ]……………………..…6 Other (specify)……………..………7	
50.	Which of the following injuries are you affected	Cut/puncture [ ]…………………...1 Dislocation [ ]……………………..2 Eye injury [ ]……………………....3 Other (specify)………..…………4	
51.	Which part(s) of the body is/was the injury?	Head [ ]…………………………....1 Leg [ ]……………………………..2 Finger [ ]…………………….…3 Toe [ ]……………………………..4 Knee [ ]……………………………5	

		Other (specify)……………………..…..6	
52.	What was the source of the injury?	Sharp object [ ]……………………1 Lighting heavy object [ ]…………2 Vehicle used in collecting waste [ ]..3 Other (specify)………………….…4	
53	Did you seek for medical care for that injury?	Yes [ ] …………………………....1 No [ ] …………………………..…2	
54	What types of biological hazard have you seen during work?	Faeces [ ]……………….…….…..1 Carcass of animals [ ]……….……2 waste feed……. [ ]…………......…3 poultry litter……[ ]……………….4 Used nose mask [ ] ……………….5 Other (specify)………….............6	
55	How often are you exposed to the above waste?	Daily [ ]…………………………...1 Once a while [ ]…………………...2 Other (specify)…………….………3	
56	Which of these food wastes are you exposed to?	Rotten [ ]…………………………..1 Peels/husk of plants [ ]…………....2 Expired food [ ]…………………..3 Plants [ ]……………………...……4 Other (specify)…………..............5	

57	Which of the following disorder do you experience?	Skin disease [ ]……………………1 Diarrhoea [ ]………………………2 Eye irritation [ ]………….………3 Nausea [ ]…………………….………4 Headache [ ]……………….,……5 Other (specify)………….…………6	
58	What type of PPE do you use whiles handling the above waste?	Wallington boot [ ]………………..1 Gloves [ ]…………………………2 Mask [ ]…………………….....…3 Protective cloth [ ]………………...4 Helmet [ ]…………………………5 Other (specify)…………………..…6	
59	Which of the following plastics containers are you exposed to?	Oil containers [ ]………………......1 Chemical containers [ ]……………2 Batteries [ ]………………………..3 Hair products containers [ ]……....4 Pesticides [ ]…………………...…..5 Other (specify)……………………..6	
60	What are the electronic waste products are you exposed to? (multiple options)	Cell phones [ ] ……………..……1 Computers [ ]……………..………2 television [ ]……………..…..……3	

		radio [ ]……………………..…..…4 fluorescent tubes [ ]………………5 batteries ..[ ]……………………..…6 Other (specify)…………..……...7	
61	What type of PPE do you use whiles handling the above waste	Safety boot [ ]……………….……1 Gloves [ ]………………..……...2 Mask [ ]…………………….……..3 Protective cloth [ ]…………..….4 Other (specify)………..…………4	
62	Which of the following do you experience	Skin irritation [ ]…………………..1 Eye irritation [ ]…………………...2 Nausea [ ]………………………….3 Headache [ ]……………………..…4 Other (specify)………..…………5	
63	Do you have or experience health problems now	Yes [ ]………..……………...…....1 No[ ]…………...…………………2	

Health problems	**Q 64** . Do you have of the following health problems?	**Q 65** For how long have you had …………..?	**Q 66.** Do you currently take any medicine for ………..?	**Q 67** How does this health problem affect your work/ other daily activities?

a) Pain or other unpleasant feeling in the chest area	Yes .....1 No ......2→**b**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
b) Difficulty in breathing	Yes .....1 No ......2→**c**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
c) Abdominal pain	Yes .....1 No 2→**d**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
d) Back pain	Yes .....1 No 2→**e**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
e) Restrictions in using your arms	Yes .....1 No 2→**f**	days |__|__| months|__|__| years|__|__|	Yes .....1 No 2	|__|__|
f) Restrictions in walking	Yes .....1 No 2→**g**	days |__|__| months|__|__| years|__|__|	Yes .....1 No 2	|__|__|
g) Problems with vision	Yes .....1 No 2→**h**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|

h) Problems with hearing	Yes .....1 No ......2→**i**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
i) Problems speaking	Yes .....1 No 2→**j**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
j) Psychological problems	Yes .....1 No 2→**k**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
k) Headache or migraine	Yes .....1 No 2→**l**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
l) Toothache	Yes .....1 No..........2→**m**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
m) Sexual dysfunction	Yes .....1 No 2→**n**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|
n) Skin problems	Yes .....1 No ......2→	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2	|__|__|

CODES FOR Q67 & Q 73: 1=Everything is normal; 2=It sometimes affects my ability to work/carry out everyday activities; 3=It often affects my ability to work/carry out everyday activities; 4=Not able to work/carry out everyday activities.		
Q68	Did you see a health provider about any of these problems?	Yes..1 No ....2 Don't remember......................................88

Diseases	**Q69**. Have you ever been told by a doctor that you have ………	**Q70.** How long ago did you develop the first disease symptoms? RECORD "00" IF NO SYMPTOMS	**Q71.** Do you currently suffer from?	**Q72.** Do you currently take any medicine for …..?	**Q73.** How does this health problem affect your work and other daily activities?
a) Hypertension (high blood pressure)	Yes .... 1 No 2→**b**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2→**b**	Yes .....1 No 2	|__|__|
b) Heart disease	Yes .... 1 No 2→**c**	days |__|__| months |__|__| years |__|__|	Yes .....1 No 2→**c**	Yes .....1 No 2	|__|__|

c) Chronic pulmonary disease	Yes .... 1 No 2→**d**	days |__|__| months |__|__| years |__|__|	Yes .....1 No 2→**d**	Yes .....1 No 2	|__|__|
d) Ulcer disease	Yes .... 1 No 2→**e**	days |__|__| months |__|__| years |__|__|	Yes .....1 No 2→**e**	Yes .....1 No 2	|__|__|
e) Liver disease	Yes .... 1 No 2→**f**	days |__|__| months|__|__| years |__|__|	Yes .....1 No 2→**f**	Yes .....1 No 2	|__|__|
f) Kidney/urinary disease	Yes .... 1 No 2→**g**	days |__|__| months |__|__| years |__|__|	Yes .....1 No 2→**g**	Yes .....1 No 2	|__|__|
g) Diabetes	Yes .... 1 No 2→**g**	days |__|__| months |__|__| years |__|__|	Yes .....1 No 2→**h**	Yes .....1 No 2	|__|__|
h) Arthritis	Yes .... 1 No 2→**h**	days |__|__| months|__|__| years|__|__|	Yes .....1 No 2→**i**	Yes .....1 No 2	|__|__|
i) Malaria	Yes .... 1 No 2→**i**	days |__|__| months |__|__| years |__|__|	Yes .....1 No.......2→**j**	Yes .....1 No 2	|__|__|
j) Tuberculosis	Yes 1	days |__|__|	Yes 1	Yes 1	

	No 2→**j**	months |__|__| years |__|__|	No.......2→	No 2	|__|__|

Physical risk

S/N	Hazards	1	2	3	4
1	PPEs are worn by all workers				
2	Ridding for long hours				
3	Pushing or pulling loads (over 5 Kg)				
4	Employees are exposed to dusty conditions at the working place.				
5	Working with your hands above shoulder height				
6	Employees work for long hours				
7	Slipping or falling during transport of loads				

Please Tick Appropriately **Key: Never =1; Sometimes=2; Often=3; Always=4**

Biological hazard

S/N	Hazards				
1	Presence of insects/flies in/on waste				
3	Workers stand in dirty water whiles working				
4	Presence of stingy insects				
5	Are there any “sharp” materials in the waste gathered?				

Please Tick Appropriately **Key: Never =1; Sometimes=2; Often=3; Always=4**

Chemical hazards

S/N	Hazards				
1	Are you exposed to substance that can be inhaled, ingested or absorbed into the body?				
2	When dealing with chemicals wear PPEs				
3	Chemical containers are part of daily waste collected?				
4	Chemicals exposed to are poisonous and corrosive				

Please Tick Appropriately **Key: Never =1; Sometimes=2; Often=3; Always=4**

Have you been vaccinated? Yes [ ]…………………….1

No [ ]…………………….2

Appendix Two: Consent Form

STUDY TITLE: **OCCUPATIONAL HEALTH RISK OF TRICYCLE WASTE COLLECTORS IN GREATER KUMASI OF ASHANTI REGION, GHANA**

PARTICIPANTS' STATEMENT

I acknowledge that I have read or have had the purpose and contents of the Participants' Information Sheet read and satisfactorily explained to me in a language I understand (Twi/Ga/Hausa/English/Other). I finally understand the contents and any potential implications as well as my right to change my mind (ie withdraw from the research) even after I have signed this form**.**

I voluntarily agree to be part of this research.

Name or Initials of Participant……………………. ID

Code……………………………

Participants' Signature……OR Thumb Print……OR Mark (Please specify)………

Date: ……………………………..

INVESTIGATOR'S STATEMENT AND SIGNATURE

I, the undersigned, certify that the participant has been given ample time to read and learn about the study, its procedures, risks and benefits. All questions and clarifications raised by the participant have been duly addressed and the participant has freely agreed to participate in the study.

Researchers' name…………………………………………………………….

Signature……………………………………………………………………….

Date……………………………………………………………………………..

AAM-USTED
AKENTEN APPIAH-MENKA
UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT
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FACULTY OF ENVIRONMENT AND HEALTH EDUCATION

The Chairman
Committee on Human Research, Publications and Ethics
School of Medical Sciences
KNUST
Kumasi

27th JANUARY, 2022

Dear Sir,

LETTER OF INSTITUTIONAL SUPPORT: OCCUPATIONAL HEALTH RISK AMONG TRICYCLE WASTE COLLECTORS IN THE GREATER KUMASI OF ASHANTI REGION, GHANA.

I write in support of the application titled: "**Occupational Health Risk among Tricycle Waste Collectors in the Greater Kumasi of Ashanti Region, Ghana**". As part of the requirements for the award of a Master Degree in Environmental and Occupational Health Education, Mr. Appiah Joseph is undertaking a research study on the above title.

The Faculty of Environment and Health Education of AAM-USTED supports this proposed study that seeks to assess occupational health risk among tricycle waste collectors in the Greater Kumasi of Ashanti Region, Ghana. Tricycle Waste Collectors have become an integral part of municipal waste collection and management. However, they are exposed to various health risks and hazards that can be detrimental to their health. The levels of occupational health risk and hazards among them is a public health problem worth investigating and needs urgent attention and hence the relevance of this study.

The team of researchers are students from the faculty under the supervision of Dr. Denis Dekugmen Yar, an experienced Biomedical Scientist with requisite skills to support the study. The Faculty would therefore be grateful if you could grant an approval for the conduct of this study.

The outcome from this study would provide empirical data on occupational health risk and hazards associated with the use of tricycle for waste collection in Greater Kumasi. The outcome would also inform policy makers to take critical decision on formulating safety protocols for waste collectors.

I express my fullest support for this proposal and its execution.

Yours sincerely,

DR. RICHARD AMANKWAH KUFFOUR
DEAN

DEAN
FACULTY OF ENVIRONMENT & HEALTH EDUCATION
AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING & ENTREPRENEURIAL DEV'T
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+233 209777318 / (0)20 204

The Chairman 20th January, 2022

Committee on Human Research, Publications and Ethics

School of Medical Sciences

KNUST

Kumasi

Dear Sir,

CONSENT FOR RESEARCH: OCCUPATIONAL HEALTH RISK OF TRICYCLE WASTE COLLECTORS IN GREATER KUMASI OF ASHANTI REGION, GHANA.

Mr. Appiah Joseph (index number; 200029115), is our MPhil Environmental and Occupational Health student at the Department of Public Health Education, Faculty of Health and Environment Education, College of Agriculture Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) of the erstwhile University of Education Winneba.

Mr. Appiah, as part of his academic requirements for the award of Master of Philosophy Degree in Environmental and Occupational Health Education, is to undertake a project dissertation on "***Occupational health risk of tricycle waste collectors in greater Kumasi of Ashanti region, Ghana***". He will employ a cross-sectional study to assess the prevalence and causes of occupational injuries and health risks among **tricycle waste collectors in greater Kumasi of Ashanti region, Ghana**. The study would provide empirical data on occupational injuries and their causes among tricycle waste collectors with relevant recommendations to the stakeholders for policy consideration formulation to reduce injuries and health risks among tricycle waste collectors in the metropolis.

Your kind approval is therefore required for the conduct of this study to fulfil this academic obligation.

Yours faithfully,

(Academic Supervisor)

Denis Dekugmen Yar (PhD)

KUMASI COMPOST AND RECYCLING PLANT LTD.

June 15, 2021

Our Ref: KC/HCAM/EAE001/2021

Your Ref:

Dr. Bismark Dwumfour-Asare
Department of Public Health Education
University of Skills Training and Entrepreneurial Development
Ashanti Mampong
Ghana.

Dear Dr. Dwumfour-Asare,

RE: CONSENT FOR RESEARCH

We acknowledge receipt of your letter dated April 16, 2021 on the above subject matter and the content well noted.

We are pleased to inform you that your request has been approved to enable **Mr. Joseph Appiah** use our facility to conduct Occupational Risk Among Tricycle Waste Collectors in *Greater Kumasi* for a period of four weeks (4) starting from **Monday, 28th June to Friday, 23rd July 2021** with the exception of Wednesdays.

He is however required to submit a copy of the research outcome to us.

We are glad to have him at Kumasi Compost and Recycling Plant Ltd (KCARP) and hope that we are able to help him achieve his academic goals.

Yours sincerely,

....
Solace V. Obour (Mrs.)
Human Resource & Admin. Manager

KUMASI COMPOST AND RECYCLING PLANT LIMITED
22/06/2021
HUMAN CAPITAL AND ADMINISTRATION MANAGER

P. O. Box UP1512 KNUST, Kumasi - Ghana | info@kcarpltd.com | www.kcarpltd.com | +233 32 249 5112 +233 32 249 5115 | Essereso-Adagya, Kumasi - Ghana

Kwame Nkrumah
University of Science
and Technology, Kumasi

College of Health Sciences
SCHOOL OF MEDICINE AND DENTISTRY

COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS

Our Ref: CHRPE/AP/044/22

9th February 2022

Mr. Appiah Joseph
Department of Public Health Education
Akenten Appiah-Menka University of Skills
Training and Entrepreneurial Development
MAMPONG.

Dear Sir,

LETTER OF APPROVAL

Protocol Title: ***"Occupational Health Risk of Tricycle Waste Collectors in Greater Kumasi of Ashanti Region, Ghana"***

Proposed Site: ***Kumasi Compost and Recycling Plant.***

Sponsor: ***Principal Investigator.***

Your submission to the Committee on Human Research, Publications, and Ethics on the above-named protocol refer.

The Committee reviewed the following documents:

- A notification letter of 15th June 2021 from the Kumasi Compost and Recycling Plant Ltd (study site) indicating approval for the conduct of the study at the Recycling Plant.
- A Completed CHRPE Application Form.
- Participant Information Leaflet and Consent Form.
- Research Protocol.
- Questionnaire.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for a fixed period of one year, beginning **9th February 2022** to **8th February 2023** renewable thereafter. The Committee may, however, suspend or withdraw ethical approval at any time if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study, annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you for your application.

Yours faithfully,

Rev. Prof. John Appiah-Poku.
Honorary Secretary
FOR: CHAIRMAN

Room 7, Block L, School of Medicine and Dentistry, KNUST, University Post Office, Kumasi, Ghana
Tel: +233 (0) 3220 63248 **Mobile:** +233 (0) 20 5453785 **Email:** chrpe.knust.kath@gmail.com/chrpe@knust.edu.gh

Appendix Three: Study Pictures

Sorting A, where tricycle empty the load.

Eating while on duty, Chewed fried meat without proper handwash

Risk for tricycle waste collectors when on duty , eating without proper handwash

Parking Park for tricycles before empty the cart

Parking Park for tricycles before empty the cart

Woman selling food to the waste collectors without proper handwashing

Research assistance engaging the target population

Researcher engaging the tricycle waste collectors