SCHOOL OF PUBLIC HEALTH
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA

EVALUATION OF EXISTING SANITARY INFRASTRUCTURES WITHIN THE KPONE TOWNSHIP IN THE GREATER ACCRA REGION OF GHANA

BY

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A DISSERTATION SUBMITTED TO THE UNIVERSITY OF GHANA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PUBLIC HEALTH DEGREE

JULY, 2018

DECLARATION

I, Jacob Arnold Kwabla Sepenoo, do hereby declare that except for references from other peoples' work which have been duly acknowledged, this dissertation report is my own work carried out at University of Ghana, Legon under the supervision of Dr Uri Selorm Markakpo. This work has not been submitted in whole or in part for any degree in this or any other university.

…….……. ……..……..

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(Student)

…….……. ……

Dr Uri Selorm Markakpo Date

(Supervisor)

DEDICATION

I dedicate this work to the Almighty God for His steadfast love which saw me through my academic journey. I also dedicate this work to my family for their prayers and financial supports.

ACKNOWLEDGEMENTS

My greatest gratitude goes to the Almighty God who granted me the grace and strength to produce this work.

Much appreciation also goes to my supervisor for taking time out of his tight schedules to go through this work and whose useful advice and sound criticisms have made this work a success.

Thanks go to my family for their prayers and support throughout the course of my programme.

Finally, I appreciate the contributions made by my colleagues and research assistants towards the successful completion of the study.

ABSTRACT

Background: Kpone is one of the major industrial towns in Ghana and its industrialization has led to increase in population and other business activities. The rapid growth in population is accompanied by increase in volume of waste generated from industrial and domestic activities each day, which has not been properly managed, leading to sanitation problems.

Aims and objectives: This study was designed to assess sanitary infrastructures within Kpone Township. The specific objectives were to assess the availability of solid and liquid waste sanitary infrastructures in the study area and then ascertain the knowledge level and perceptions about sanitary infrastructure usage among the inhabitants.

Methods: A descriptive cross-sectional study which made use of structured questionnaire and focused group discussion to obtain information from 500 household heads and 30 waste collection service providers respectively. Descriptive statistics such as tables, frequency and percentages were used to describe demographic characteristics of the study participants and factors which influence sanitary infrastructure in the study area.

Results: All the respondents had fair knowledge and perception on good waste management practices; 56% lack waste bins at home; 57% resort to crude dumping or burning of refuse; 66% lack toilet facilities at home; 56% dispose of wastewater into open drains and 37% practice open defecation.

Conclusion: The inadequacy of sanitary infrastructure resulted to crude methods of waste disposal in the study area. Increasing the number of household toilets through the GAMA sanitation program, provision of standard drainage network, improving access to solid waste collection facilities and services and enforcement of sanitation laws would improve sanitary infrastructure and help achieve a sound environmental health at Kpone.

LIST OF ABBREVIATIONS

- GAMA : Greater Accra Metropolitan Area
- KVIP : Kumasi Ventilated Improved Latrine
- MMDAs : Metropolitan, Municipal and District Assemblies
- MLGRD : Ministry of Local Government and Rural Development

DEFINITION OF TERMS

- Sanitary infrastructure : household sanitary facilities (drains, toilets and waste bins)
- Liquid waste : feces, bathhouse and kitchen waste water
- Solid waste : household garbage

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CHAPTER ONE

1.1 Background

The management of waste is both an urban and rural problem. Everybody contributes to this problem (Gaurh & Pramanik, 2017). More often, the rate of waste generation is far higher than the capacity to manage it (Gabrielli, Amato, Balducci, Magi Galluzzi, & Beolchini, 2017; Kamaruddin et al., 2017; Ragossnig, 2017; Wan, Shen, & Choi, 2017). Waste has different origins which include domestic, commercial and industrial sources however, the onus of waste management does not depend on government or administrative authorities alone. There is growing consensus that waste generators such as residents (immediate stakeholders) need to team up with the appropriate authorities to resolve this problem that has far-reaching deleterious environmental and health implications. The urban population of Ghana is growing. This implies that waste management, supply of adequate amounts of safe water and maintenance of proper sanitation will need closer attention (Addo et al., 2017; Boateng, Amoako, Appiah, Poku, & Garsonu, 2016; Oduro-Appiah et al., 2017).

Particularly, waste volumes have increased in the streets of Accra due to factors such as increase in population size, number of industries, and lack of facilities for management of waste generated (Boateng et al., 2016). This situation has resulted in the inability of authorities to deal with the waste generated. The inability of individuals to see waste management as a shared responsibility may be a contributing factor to the waste management challenge in the country (Oduro-Appiah et al., 2017). Also, the waste management problems in the country could be due to the lack of co-ordination and collaboration among community members, the government and the private sectors involved in waste management (Addo et al., 2017).

1.2 Statement of the problem

Kpone is one of the major industrial towns in Ghana and industrialization of the town has led to geometric increase in population and other business activities over the last decades. The rapid growth in population is accompanied by increasing amount of waste produced from industrial and household activities each day. Kpone Township is 38 km from Accra, the capital city of Ghana and located in the eastern part of the Greater Accra Region. In spite of its proximity to Accra, and the large number of industries, the Kpone setting is largely rural and under developed.

Kpone is seen each day confronted by deteriorating conditions of its surroundings caused by refuse, which proves to be obstinate and threatens the health of humanity. A glance at various sites in the Township shows massive accumulation and indiscriminate dumping of refuse, choked drains, stinking gutters, over flow of sullage and effluents.

One of the foremost factors which improves sanitation is the availability of toilet facility at any place human beings dwell. The absence of toilet facility at homes, workplaces and market centers creates a conducive environment for open defecation which may prime the upsurge of fecal-oral diseases like cholera, typhoid fever, helminthiasis, dysentery, among others. Ghana is faced with perineal cholera cases in which lack of toilet facility was implicated as the major cause of the disease burden. In an attempt to curb down the menace in the Greater Accra Region of Ghana, World Bank sponsored GAMA project was introduced to make toilet facilities affordable and accessible to all. Unfortunately, Kpone-Katamanso Municipal Assembly was a district at the time and did not qualify for the sponsorship. It is therefore necessary to ascertain

how availability of toilet and other waste management facilities influence sanitary infrastructure at Kpone Township.

1.3 Justification

Notwithstanding the worries much of the time raised by concerned gatherings, organizations and people among the masses, the waste circumstance in the Kpone Township keeps on declining, in this way posturing genuine dangers to general wellbeing and the earth. Studies from the developed countries have shown that, the availability of adequate sanitary infrastructures with proper maintenance is key in proper waste management. Against this circumstance of mounting waste creation, safe sanitary infrastructures in good conditions are needed to arrange for waste generated to be properly collected and safely disposed of within the jurisdictions of Kpone. Evaluation of sanitary infrastructure at Kpone, therefore, would generate the evidence based data necessary for improvement of policy to support efforts towards addressing sanitation related issues at Kpone.

1.4 Conceptual framework

The diagram below is a conceptual framework that shows how availability of communal waste bins, domestic waste bins, toilet facility, drainage system, demographic characteristics, knowledge level and perceptions on sanitation affect sanitary infrastructure (outcome variable).

The availability, accessibility and conditions of both communal and domestic waste bins have been shown to affect sanitary infrastructure. For instance, if a community is not provided with communal waste bins, the community members practice indiscriminate waste disposal. In

addition, if communal waste bins are provided but residences lack the bins at homes for storage before disposal at the communal dumping site, they may be tempted to burn wastes within their premises, dump them into drains, dispose the wastes into nearby undeveloped plots or add it up at any nearby crude dumping site. Furthermore, if the communal bins provided are in bad conditions or have difficulty in accessibility, apathy in the usage of the bins develops.

Good drainage system promotes good sanitation. In Ghana, most drainage systems are the open drains type. Because the drains are open, they get easily clogged by wastes. Some residences even discharge the content of septic tanks, kitchen and bathhouse waste water into the drains. On the other hand, the unavailability of the drains encourages directing of waste water onto public roads or undeveloped plots. These insanitary waste water disposal practices do not only promote the breeding of malaria vectors and flooding but also, render the communities with stinking smells and reduces the aesthetic beauty of the communities thus, a threat to public health.

Finally, it is important to know how demographic characteristics and knowledge level influence sanitary infrastructure at the study area. For instance, some Ghanaians think domestic activities like sweeping and disposal of waste are feminine responsibilities, and as a result, gender could impact on sanitary infrastructure usage. Knowing about the health implications associated with waste management may also influence sanitary infrastructure usage among community members. For example, a person who is aware about the detrimental effects on crude dumping of waste is less likely to dump waste indiscriminately than its counterpart who knows nothing about the dangers associated with crude dumping of waste.

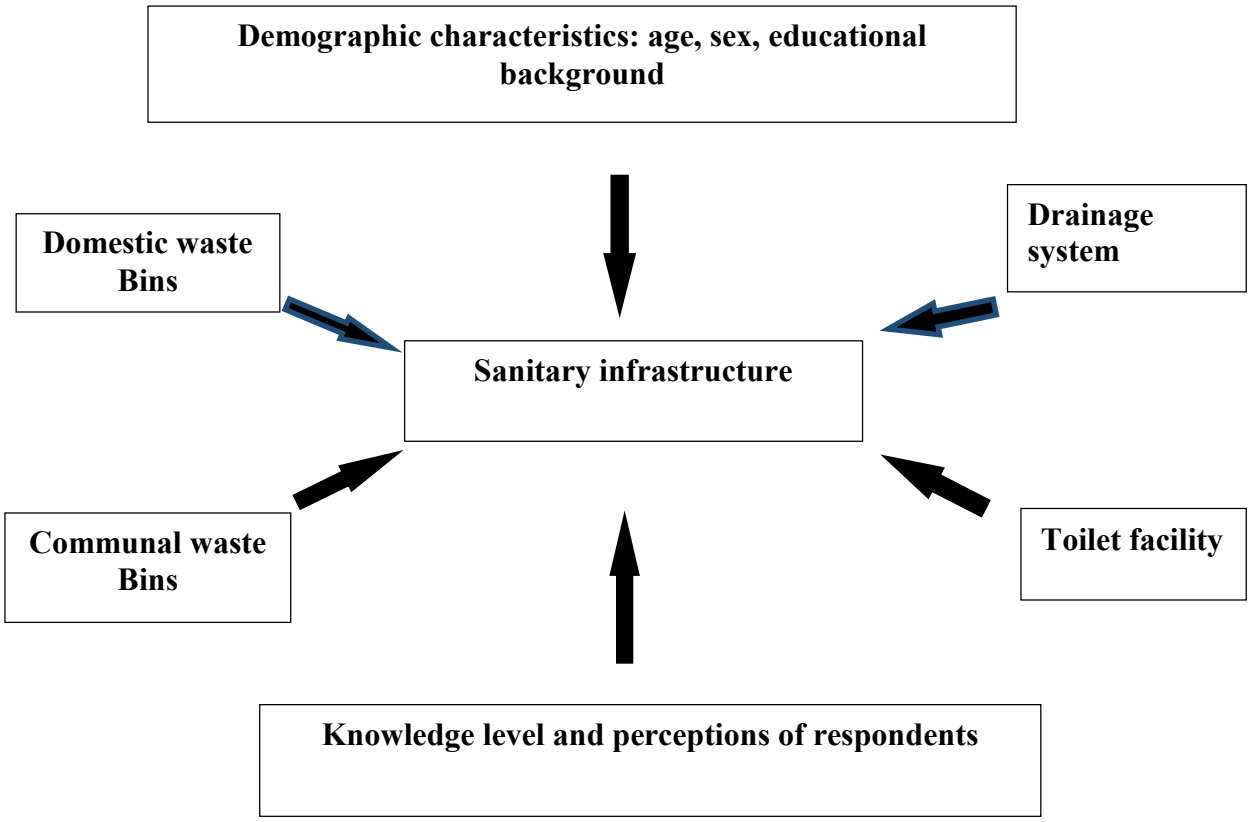

Figure 1.1: Conceptual framework

1.5 Research questions

The study seeks to provide answers to the following questions:

1. What are the solid and liquid waste management practices of people at Kpone?
2. What is the state of solid and liquid waste management facilities at Kpone?
3. What is the knowledge level and perceptions of people on sanitation at Kpone?

1.6 Objectives of the study

1.6.1 General objective

To evaluate the conditions of sanitary infrastructures within Kpone Township

1.6.2 Specific objectives

1. To assess the availability of solid and liquid waste sanitary infrastructures at the study area
2. To examine the conditions of waste and liquid waste sanitary infrastructures at the study area
3. To ascertain the knowledge level and perceptions of the populace on sanitary infrastructure usage at the study area

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter focuses on the various works by other people and agencies on sanitation. Endnote software was used to download over two hundred abstracts from manuscripts, books, thesis and journals on sanitation. Downloaded abstracts were further glanced through in order to select those that were relevant to the study. The ones relevant to the study were downloaded and read thoroughly in order to write up this literature review. Most of the literature reviewed were on current global issues on sanitation but majority were from Africa and for that matter, Ghana.

2.2 Sanitary infrastructure

Sanitation is all about the management of waste generated in order not to harm the environment and the availability of sanitary infrastructure and good attitude towards its usage defines sanitation in a region (Al-Khateeb, Al-Sari, Al-Khatib, & Anayah, 2017; Bonelli, Bosio, Cavallo, Gianolio, & Marengo, 2016; Braz et al., 2017; Ibanez-Fores, Bovea, Coutinho-Nobrega, de Medeiros-Garcia, & Barreto-Lins, 2018). The amount of waste produced by human activities is increasing in most parts of the world, accompanied by problems of disposal. In developed countries, good sanitary infrastructure are put in place to promote minimal disposal of waste but, substantial quantities are diverted for recycling (Abdelbasir, Hassan, Kamel, & El-Nasr, 2018; Bistulfi, 2013; Bonelli et al., 2016; Derakhshan et al., 2017; Zhao et al., 2018). Waste generation encompasses those activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal (Martinho et al.,

2017; Ragossnig, 2017). UNEP (2009), reported that in 2006, the total amount of municipal solid waste (MSW) generated globally reached 2.02 billion tones, and represented 7% annual increase since 2003, This amount of waste was further projected to increase to 37.3%, equivalent to approximately 8 per cent increase annually from 2007 and 2011 (UNEP, 2009). In addition, the WHO, also estimated that the total health-care waste per person per year in low income countries, was between 0.5 kg and 3 kg. Various authors, including those from Ghana therefore agreed that waste production is escalating at a faster rate globally (UNEP, 2009; rom Ghana (Addo et al., 2017; Boateng et al., 2016; Oduro-Appiah et al., 2017).

In order to achieve good sanitation in a locality, virtuous waste management infrastructure must be available during: waste generation, storage, collection, transfer and transport, processing and recovery and at final disposal site (Alavi Moghadam, Mokhtarani, & Mokhtarani, 2009; Aranda Uson, Ferreira, Zambrana Vasquez, Zabalza Bribian, & Llera Sastresa, 2013; Campo et al., 2018; "Leading on waste reduction," 2016). This means that in in accordance with standard waste management procedures in ensuring good sanitary behaviour, waste generated should be sorted into standard storage facilities, then collected by a compacter truck and transported finally for disposal at an approved disposal site. Waste disposal operations in the developed world are becoming increasingly sophisticated with specialist companies and facilities. The wastes generated are managed through landfills, incineration and composting. Disposal of solid wastes on land is by far the most common method. Incineration accounts for most of the remainder, whereas composting of solid wastes accounts for only an insignificant amount (Bayard, Benbelkacem, Gourdon, & Buffiere, 2018; Chow, Wong, Chan, & Chan, 2018; Chun, 2018; Clarke, 2018; "Report from the Fourteenth International Waste Management and Landfill

Symposium - Sardinia 2013," 2014). Selecting a disposal method depends almost entirely on costs, which in turn are likely to reflect local circumstances.

Waste collected can be transferred from small collection equipment like the tricycle to a transfer station for bigger truck collection to a final disposal. In the recent times, the availability of quality sanitary infrastructural systems makes it possible for wastes collected to be processed into energy, or recycled or recovered for materials to be reused (Algapani et al., 2018; S. S. Ali, Abomohra, & Sun, 2017; Anbazhagan & Palani, 2018; Anjum, Al-Talhi, Mohamed, Kumar, & Barakat, 2018; Antonetti et al., 2017).

Human activities unavoidably produce refuse. The better the substance turnover, and the extra complex and divers the substances produced, the tougher it is for waste management to reach standards for environmental safety. Burning of waste was one of the common practices of waste disposals at homes, restaurants and hospitals in the past. It was initially meant for the purposes of hygiene and reduction in the amount of waste produced, and with good sanitary standards, the system has gone through a long and intense progress in the recent times and it is used for disposing municipal wastes (Alam, Florea, Schollbach, & Brouwers, 2017; Aleluia & Ferrao, 2017; Andersson & Stage, 2018; Bian et al., 2018; Waste management and health, position paper of the Italian Association of Epidemiology 2008).

Converting waste to energy forms essential part of waste management. State-of-the-art equipment for doing this controls air pollution and facilitates safe emissions in the environment. Burning is essential to completely destroy poisonous organic materials in order to limit the

activities of disease causing microorganisms and viruses, and to concentrate traces of valuable and heavy metals in some of the waste. Owing to their benefits incinerators have turned into facilities for recycling of waste. Incinerators are inexpensive in supplying routine information on composition of chemical waste and can give information on the amounts of biogenic substances and other materials in in municipal wastes (Weidemann et al., 2016).

2.3 Waste storage, transfer and transport

Proper handling of waste before disposal is to store it in a skip container or dustbins but not indiscriminate dumping. Proper, storage of waste has tremendous aesthetic values (Azevedo, da Silva Araujo, Lagarinhos, Tenorio, & Espinosa, 2017; Hafner, Watanabe, Harter, Bergamaschi, & Parikh, 2017; Ho & Chen, 2017; Nwachukwu, Ronald, & Feng, 2017; Tabata, Wakabayashi, Tsai, & Saeki, 2017; Wakabayashi, Peii, Tabata, & Saeki, 2017). Proper collection of waste does not comprise gathering only, but also involve hauling after collection to the point where the collection truck is emptied (M. Ali, Wang, Chaudhry, & Geng, 2017).

In the United States of America (USA), “curb”, “setout-setback” and “backyard carry are among the most common type of residential collection services. Waste collection from household and commercial settings was carried out using concrete containers located at convenient sites for conveyance by trucks or tractors (Awodele, Adewoye, & Oparah, 2016; Chowdhury & Chakraborty, 2016; Fudala-Ksiazek, Pierpaoli, Kulbat, & Luczkiewicz, 2016; Tabata et al., 2017). Apart from these, separate waste containers were also placed by shops in certain places, which were evacuated directly into the trucks/tippers. This practice has an advantage of preventing people from indiscriminate refuse disposal (Becker, Yu, Stadler, &

Smith, 2017; Linzalone et al., 2017; Pardo, Moral, & Del Prado, 2017; Ribic, Voca, & Ilakovac, 2017; Wu, Yu, & Shen, 2017). Concrete refuse containers, however, may be very difficult to afford in Ghana, especially, in the Kpone Township. In most developing countries, wastes are collected from smaller collection points by vehicle to the final disposal sites (Abdelradi, 2018; A. Ali, 2010; Aliu, Adeyemi, & Adebayo, 2014).

2.4 Waste Management in Ghana

Waste management in Ghana has become a Herculean task for the metropolitan, municipal and district assemblies (MMDAs). Because the waste management facilities in communities are inadequate, people practice indiscriminate disposal of wastes. This situation makes it difficult for Metropolitan Assemblies to deal with large quantities of waste. The ultimate result is that waste is either found in heaps or littering the environment in prodigious quantities (Oduro-Appiah et al., 2017). Waste from domestic sources included food waste, garden waste, sweepings, ash, packaging materials, textiles and electric and electronic waste with organic waste being the major component (Boateng et al., 2016).

Waste is collected in three ways in Accra. The first is conducted outside each house directly by Waste Management Department (WMD) using trucks. The second is from communal containers by WMD using collection trucks. These are restricted to low-income areas like Nima, where people could not afford to pay the house-to-house collection service fees. The third and the final mode of refuse collection is the door-to-door service in middle-income areas like Labadi using a container that is hauled by a motorbike (Addo et al., 2017).

2.5 Problems Associated with the Current Waste Management System

Urbanization is a mind boggling wonder that gives openings and advantages to nations yet additionally connected with the procedure which are issues of social, financial and ecological nature. In nations around the globe, one noteworthy ecological issue that stands up to city specialists is strong waste transfer. Most city governments are defied by mounting issues with respect to the gathering and transfer of strong waste. In high-wage nations, the issues normally fixate on the troubles and staggering expense of discarding the vast volume of waste produced by family units and organizations. In bring down salary nations, the primary issues are identified with accumulation, with between 33% and one-portion of all waste created in Third World urban communities staying uncollected (Ndounga Diakou, Ntoumi, Ravaud, & Boutron, 2018). The effectiveness of waste collection and disposal is influenced by the management processes available, which again, is limited by the available revenue for obtainment and provision of equipment required for waste collection and disposal (Rogoff, 2014; Saidan, Drais, & Al-Manaseer, 2017; "Waste Disposal Session Q&A," 2016).

The landfill appears to have an uncommon fascination for metropolitan waste chiefs since it offers a modest and helpful alternative for squander transfer contrasted and different techniques, for example, reuse, reusing and vitality recuperation ("Report from the Fourteenth International Waste Management and Landfill Symposium - Sardinia 2013," 2014). In Ghana, sorting of waste is not a common practice and most of the wastes collected are dumped at the land fill site in jumbles. However, there are fewer land fill sites than the volume of waste generated. This scenario leads to burning and dumping with less recycling or composting at the land fill sites (Freeman, 2010; Ghanadzadeh, Akhavan Malayeri, Bollhasani, Eshrati, & Shamsi, 2014;

Oduro-Appiah et al., 2017). As it was understood that, the safe disposal method was land filling with wastes, the associated problem with increased land filling, has led to a decrease in the available land space, and so the amount of waste collected and dumped at the final disposal sites has also reduced in Ghana over the last decades. The reduction in waste collected and dumped at the final disposal sites has subsequently led to a flow-back of waste into the environment and the need for the construction of a new landfill (Asase, Yanful, Mensah, Stanford, & Amponsah, 2009; Freeman, 2010; Yoada, Chirawurah, & Adongo, 2014). It is important to note here that the waste management system makes no provision for income generation to support its activities. The waste management is therefore limited by the revenue from the Municipal Assembly's budgetary allocation. Today, city waste collection and exchange are particularly hazardous in unindustrialized countries, however numerous western urban areas have likewise thought about this issue previously (and some presumably still do) (Arbulu, Lozano, & Rey-Maquieira, 2016; Bing et al., 2016). For these reasons, new methods of waste management that involve effective handling, collection, treatment and disposal, use land space judiciously, minimize environmental emissions and generate revenue for maintenance of infrastructure as well as remuneration for service providers need to be introduced in order improve sanitation and health.

2.6 Knowledge, perception and practice of sanitation

Toilet facilities in developing countries are not considered to be important. There are three types of latrines Ghana. The first is the conventional pit latrine, in which the superstructure is placed directly on the pit. These types of latrines are provisional, because they are abandoned as soon as they are full. Albeit they are cheap to construct they are hard to keep spotless and free from

flies. Observation of the space around the squat hole reveals a stuffy and damp environment that will encourage the spread of hookworm and breeding of houseflies. Improved traditional pit latrines on the other hand, have concrete platforms that encircle the squat hole. They are therefore easier to clean nevertheless, for a higher fee. The third type of latrine in Ghana is the ventilated improved pit (VIP) or Kumasi ventilated improved pit latrine (KVIP) which has a concrete floor, and a vent conveying links to the air above the roof. The upper end the vent is secured with a fly screen. Awful stenches are driven far from the pit into the air. Flies which are led into the pit from the environment by light are pulled in by the screen and killed by the warmth and gases in the vent. VIPs or KVIPs in this way have minimum scents, and the chunk could be re-utilized or the pit can be purged by a cesspit emptier. They are anyway, more costly to build than the pit latrines. The water closet (WC) is the third type of toilet facility and the most hygienic and expensive type of facility. It makes use of water to flush the excreta from a bowl or pot into a septic tank (Amoah, Gbenatey Nartey, & Schrecongost, 2016). Separate urinals are important because they are easier to build and use. In addition, they prevent excessive use and accumulation of urine in the latrines (Amoah et al., 2016).

The provision of potable water, good sanitation and learning of cleanliness conduct are among the most important interventions of public health (Fasora, 2001). According to research on water treatment after collection, keeping and utilization, poor sanitation and inadequate hygiene has led to progressive contamination of water from the source of supply to the point of consumption. Current information on access to water supply is either not available or inconsistent in most developing countries. The Ugandan environmental report, for instance, indicates that even though the has been a 10% improvement in household access to water supply

in the last ten years access to sanitation, particularly, infrastructure for excreta disposal diminished by 2% margin, as population increased (Komakech et al., 2014).

Billions of individuals will not have access to good sanitation worldwide, if waste is not properly collected and safely disposed of. Human excreta constitutes a great hazard to health, especially, in respect of the transmission of infectious disease. However, basic sanitation through the provision of latrines for instance, would safeguard health. Additionally, waste can be made valuable by reuse. For instance, human excreta and waste water are reused in numerous nations in farming (Kumar, Kumar, & Nanda, 2018; Owamah, Dahunsi, Oranusi, & Alfa, 2014; Schouw, Bregnhoj, Mosbaek, & Tjell, 2003).

Despite continued effort to promote sanitation, 40% of the world's population is still without basic sanitation. This number does not tell the whole story. Sanitation coverage is often much lower in rural than in urban areas. For example, in Africa, 84% of urban, but only 45% of rural residents have access to basic sanitation. The number is similar in Asia where 78% of urban and 31% of rural residents has access to basic sanitation (Gu et al., 2017).

Africa is one of the most exceedingly terrible performing mainlands in sanitation and is certain to miss focus by wide edges except a radical move is made to turn things around quickly (Joined Countries' Worldwide sanitation scope). It additionally expresses that, sanitation scope in Sub-Sahara Africa is just 35% and that sanitation scope in Sub-Sahara is a challenge around the world. In Africa today, in excess of 66% (2/3) of the populace need sterile methods for excreta transfer which additionally expresses that absence of access to safe drinking water and poor

sanitation is one of the significant reasons for mortality, particularly, among kids and ladies who endure most because of poor living conditions (Yeasmin et al., 2017). Studies have also shown that sanitation conditions in rural developing countries, the outbreak of infectious diseases like cholera and dysentery was ascribed to inaccessibility of safe water and inadequate facilities for disposal human excreta (Addo et al., 2017; Nau, 2010).

In Africa, improper disposal of human excreta leading to contamination of drinking a limitation of access to potable water is a major cause of spread of diarrhoeal disease and a major contributor to the ten percent disease burden in developing countries (Ncube, Ncube, & Voyi, 2017). Studies from Ghana have indicated that limitation of waste management facilities coupled with poor hygiene behaviour, inadequate supply of safe water and unsafe transfer of local waste water and non-liquid waste prompts significant sanitation issues (Abor, 2013; Cazabon, Fobil, Essegbey, & Basu, 2017; Freeman, 2010; Ghanadzadeh et al., 2014). Studies have shown that 1 gram of feces can contain ten million virus, one million bacteria, one thousand parasite cysts and a hundred worm eggs. These factors make the safe transfer of excrement a most critical of all general wellbeing needs (Steyer et al., 2015). Still today, the larger part of ailments on the planet is caused by the way that fecal issue enters the human body in view of absence of safe sanitation and cleanliness. To keep this enormous weight of ailment down, safe water and sanitation are just 50% of the appropriate response. The other half is motivating individuals to utilize them carefully and well. A great many individuals have still not been enough educated about the connection amongst dung and sicknesses (Al-Khatib, Kontogianni, Abu Nabaa, Alshami, & Al-Sari, 2015), which needs to be corrected in order to improve sanitation and hygiene necessary for promotion and maintenance of good health.

In Ghana, maintenance of sanitation is a major problem as people continue to practice indiscriminate dumping of refuse or burn it anyhow and anywhere (Freeman, 2010). Insofar as the procedure evacuates waste, it is regarded as appropriate. However, the consequent adverse effects on sources of drinking water, soil, atmosphere, and the esthetics of the environment are relegated to the background. In spite of the fact that sanitary facilities are necessary for maintenance of sanitation, use of latrine is a practice that is way beyond the mere provision of structures. Using a latrine, hand washing after visiting the toilet and keeping the latrine clean, are practices which are more related to attitude and habit than availability of structures. For instance, studies have shown that, the supply of safe water and sanitation logistics in schools is an initial move towards a sound physical learning condition profiting both learning and wellbeing. In any case, the availability of logistics alone, does not make them practical or create the coveted effect. It is the utilization of these logistics and the related cleanliness practices of individuals that is advantageous to health (Aatamila et al., 2011; Abdelradi, 2018; Al-Khatib, Abu Hammad, Sharkas, & Sato, 2015).

In schools, cleanliness instruction intends to advance those practices that will help avert water and sanitation-related illnesses and also yield healthy conduct later on in the life of grown-ups. Studies from developing countries have shown that, majority of people living around lake shores and water banks do understand the significance of water throughout everyday life, yet, don't guarantee its quality before utilize. This has incredibly yielded poor sanitation in numerous districts particularly landing destinations (Chakraborty & Konar, 2002; Zhang, Zheng, & Yu, 2016). Safe water unavailability and inadequate sanitation and hygiene have also

been linked to the spread of water related tropical diseases including malaria, yellow fever and schistosomiasis which are ranked among the most important public health and socio-economic challenges confronting people in developing countries (Auler, Nakashima, & Cuman, 2014; Baker, Greenland, Mendlein, & Harmon, 1988).

CHAPTER THREE

METHODOLOGY

3.1 Type of Study

The study design was cross sectional which made use of quantitative and qualitative techniques to address the specific objectives.

3.2 Study Location/Area

Kpone Township is situated in the Eastern part of Greater Accra Region. The topography of the town is flat and forms part of the coastal plains ranging from 0m (South) to 35m (North) above sea level with a total population of 13,798 (GSS, 2010). Kpone is one of the major industrial cities in Ghana and the industrialization of the town has led to geometric increase in population and other business activities over the last decades.

3.3 Variables

3.3.1 Outcome variable

Sanitary Infrastructure (Waste management system, services and practices of people in the community) was the major dependent variable of the study.

3.3.2 Independent variables

Demographic characteristics (Age, sex and educational background), Knowledge level and perceptions of respondents, drainage systems, communal waste bins, household waste bins and toilet facilities were the independent variables investigated.

3.4 Study population

The study population targeted household heads/landlords/ caretakers and waste management contractors within the Kpone Township.

3.4.1 Inclusion criteria

Landlords or care takers or household heads who were above 18 years and have lived at Kpone for more than 5 years and consented for the study.

3.4.2 Exclusion criteria

Persons below the age of 18 years and have lived at Kpone for less than 5 years were not selected for the study.

3.5 Sampling

3.5.1 Sample sizeExclusion criteria

In all, 500 participants were enrolled from 500 households to participate in this study. The sample size was estimated using the Yamane's formula with a confidence interval of 95%. According to this formula, sample size,

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size,

N is the population size,

e is the level of precision.

Using the above formula, sample size is calculated as:

Sample Size = 13,798 / [1+ 13,798 x $(0.05)^2$] = 395 respondents.

Adding a 10% rate of attrition of respondents, will give a:

Sample size = 395 + [395 x 10/100] = [395+40] = 435 individuals in 435 households

In addition, thirty-two (32) waste contractors in the municipality were recruited into the study giving a total sample size of five hundred and thirty-two (532).

3.5.2 Sampling method

The entire Kpone Township was divided into four strata. One hundred and twenty-five (125) houses were selected from each stratum using systematic random sampling with a sampling interval of two. A household head, caretaker, tenant, or a landlord of the sampled house who was expected to be 18 years or above during the sampling was consented and enrolled. Structured questionnaires were then administered to the participants and later retrieved for processing. With the waste management contractors, a focused group discussion at the rate of eight (8) contractors per section was used to obtain information on waste management infrastructure. Recording gadgets were used to record all issues discussed.

3.6 Data collection technique/ methods and tools

Face-to-face interview using a structured questionnaire, observation checklist and photography were used to assess the situations of sanitary infrastructure at the study area. For the waste management contractors, focus group discussions were used to collect all needed information.

3.7 Quality control

Proper quality assurance procedures and precautions were used to ensure the reliability and validity of the data. Two (2) research assistants with public health background were recruited and given adequate training. The content of the training involved; the purpose and objectives of the study, data collection techniques and tools to be used, translation of questionnaires into various local languages, data collection ethical guidelines. The principal investigator was part of the research team during the interviews to ensure that relevant information in line with the objectives of the study were collected. The questionnaires were checked for mistakes and completeness before final entry into appropriate software for statistical analysis. Errors and omissions detected were discussed with the respective assistants and were guided to make the necessary corrections. The reliability of the questionnaires was tested using Cronchbac's alpha and a value more than 0.7 was accepted as good.

3.8 Data processing and analysis

Initial data collected were cleaned and entered into Microsoft excel spreadsheet version 2016 and finally imported into STATA software version 15 for statistical analysis. Descriptive statistics such, cross-tabulations, tables, frequency and percentages were used to describe demographic characteristics of the study population and other variables that influence waste management.

3.9 Ethical considerations

Ethical clearance was obtained from the Ghana Health Service Ethical Review Committee (GHS-ERC). Also, permission was acquired from the Kpone-Katamanso Municipal Assembly. Finally, informed consent was obtained from the participants before the study was carried out.

3.9.1 Access to and approval of study area

The principal investigator visited the study area personally to notify the management of the Municipal Assembly about the intention to conduct the study. Permission was then obtained from the Municipal Coordinating Director before the commencement of the study.

3.9.2 Privacy and confidentiality

In order to ensure privacy and confidentiality, the questionnaires were coded and names of respondents were not required in completing them. The interview was held in an isolated area with one participant at a time to ensure privacy. Additionally, participants' names were not mentioned as part of the report, and information gathered from participants were kept strictly confidential between the principal investigator and the study participants.

3.9.3 Compensation

Study participants did not receive any compensation for participating in the study and this condition was made known to the participants before they chose to take part in the study. However, participants were given refreshment or snacks after administering the questionnaires.

3.9.4 Risks and benefits

Apart from the time that was lost by study subjects in answering the questionnaires, and question regarding their privacy, such as age and marital status which might cause them to become a bit uncomfortable, and recruitment into the study did not attract any fee. Participants did not, received any direct benefits. Nonetheless, it was normal that the aftereffects of the investigation will contribute to proper waste management that will be beneficial to both the study participants and the investigator**.**

3.9.5 Voluntary withdrawal

Participation in the study was entirely voluntary and participants were at liberty to ignore any questions that they did not want to answer. Participants could also choose to withdraw from the survey anytime they desired without any cause to them. However, participants were entreated to fully participate to ensure that findings from the study will be a true reflection of the factors being investigated in the study area. In the event of any withdrawal by a participant, all data gathered on the participant were deleted and destroyed.

3.9.6 Informed consent and consenting process

Informed consent was obtained from each participant before commencement of the study. Respondents in the study were met one-on-one to clarify the purpose of the research to them and their informed consent obtained. The decision to be included in the survey was absolutely voluntary and refusal to take part did not affect the relationship between the participant(s) and the researcher. In addition, respondents were requested to endorse a written informed consent

form after clarification of the purpose of the study to them before they participated they were recruited

3.9.7 Data storage and usage

Data gathered in this study was strictly for research purposes. The data was accessible to only the principal investigator and research assistants. Secrecy was ensured in dissemination of findings from this study since participants were not identified by their names.

3.9.8 Conflict of interest

There was no conflict of interest in this study.

3.9.9 Funding of the study

This research was solely funded the principal investigator.

3.9.10 Pretesting of questionnaire

The questionnaire was pre-tested at Oyibi Zonal Council within the Kpone-Katamanso Municipality with similar characteristics to ensure validity of questions, before conduct of the actual study. Errors and omissions detected were discussed with the research assistants and necessary corrections effected before commencement of actual data collection.

CHAPTER FOUR

RESULTS

4.1 Gender distribution

Figure 4.1 below, summarizes the distribution of study participants with respect to gender. Majority (275) of the study participants were males against their minority (225) female counterparts.

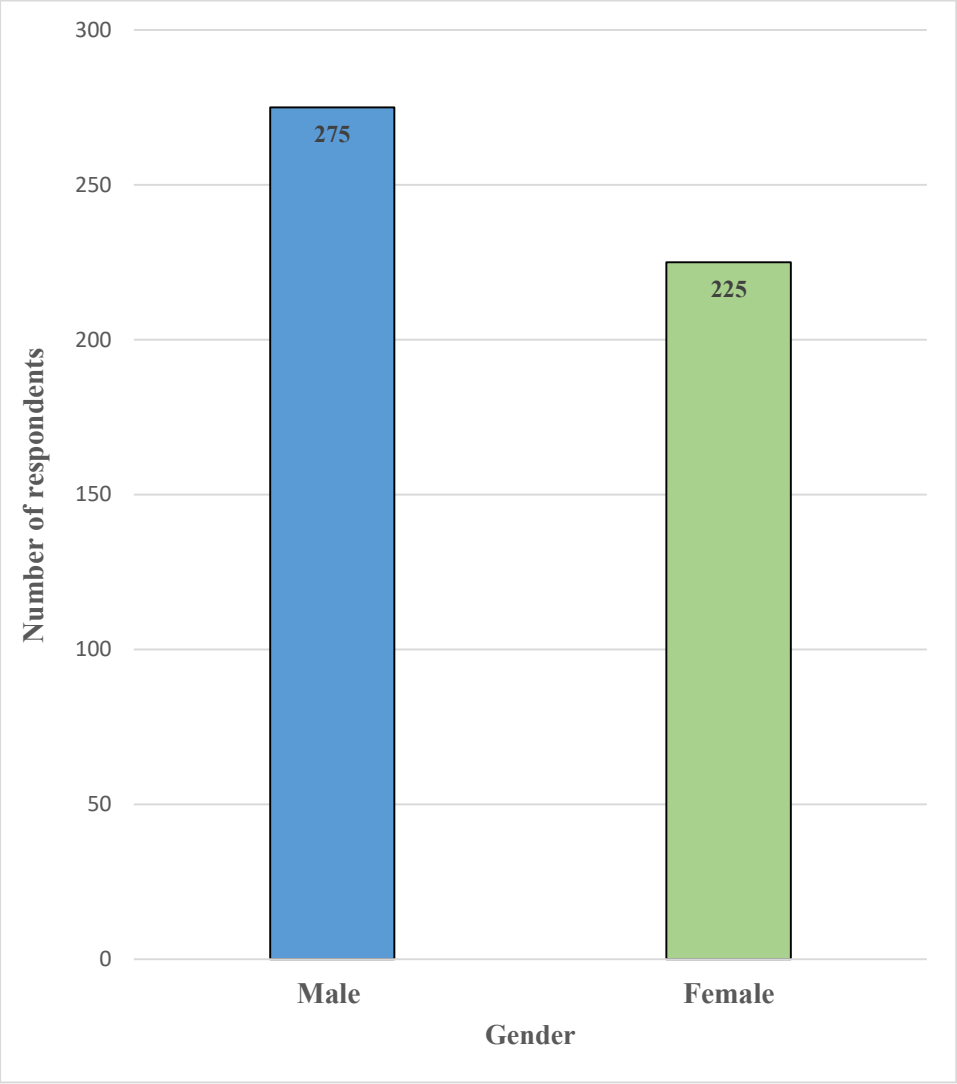

Figure 4.1: Bar chart showing gender distribution among study participants.

4.2 Age distribution among respondents

Figure 4.2 below, summarizes the distribution of age among the 500 respondents recruited for the study. As shown, individuals of age between 36-40 and 31-35 years, represented the majority (37%) and (34%) respectively of the participants. Participants of age group 18-25 were the minority (3%), and none of them was 56 years old or above.

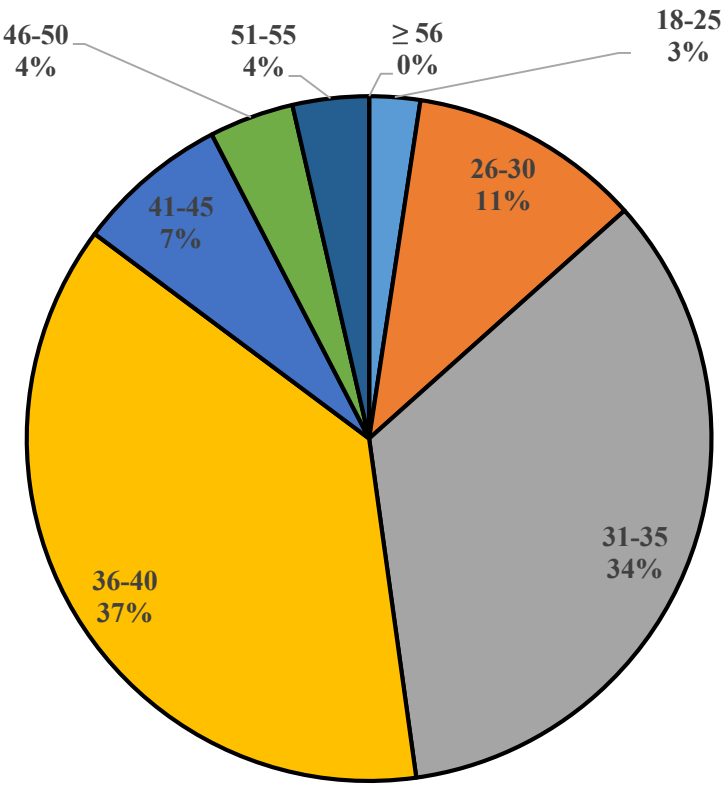

Figure 4. 2: Distribution of age among the 500 study participants

4.3 Educational background of respondents

Figure 4.3 below, summarizes the educational background of the respondents of the study. As shown, the educational background of the 500 participants revealed that majority (56.2%) comprising 281 individuals had secondary education as their highest level of education and was followed by tertiary education which comprised 142 (28.4%) individuals. According to the results, only 2 (0.4%) of the participants, did not receive any formal education at all.

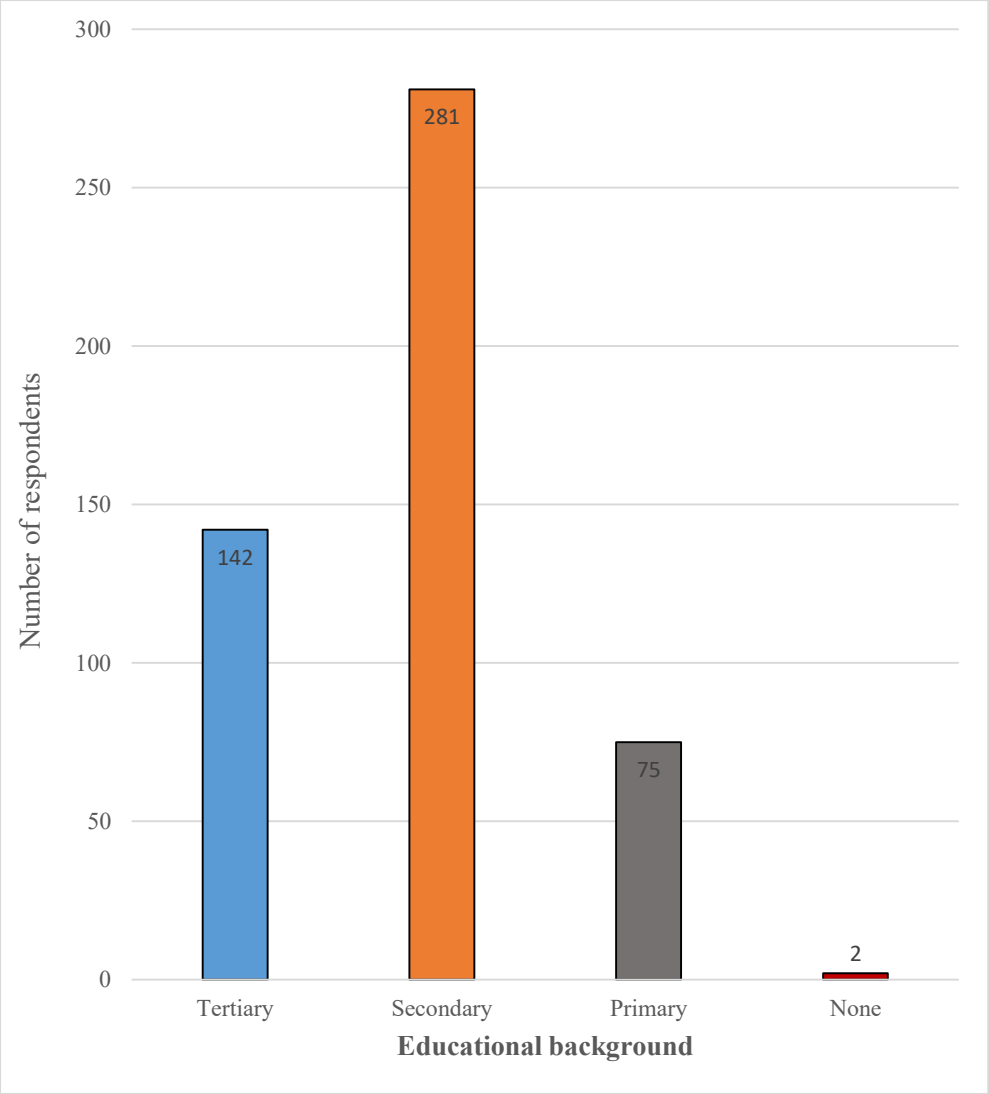

Figure 4.3: Educational background of study participants.

4.4 Household size of respondents

Figure 4.4 below, summarizes the data on household sizes of the 500 household heads/ caretakers who participated in the study. As shown, household size of 7 to 9 individuals was the largest (40%) among all the households surveyed. This was followed by household size of ten individuals and above (**≥ 10**) which formed 34% of all the households surveyed. Lastly, a household size of 1 to 3 individuals were the minority and comprised 6% of all the households surveyed.

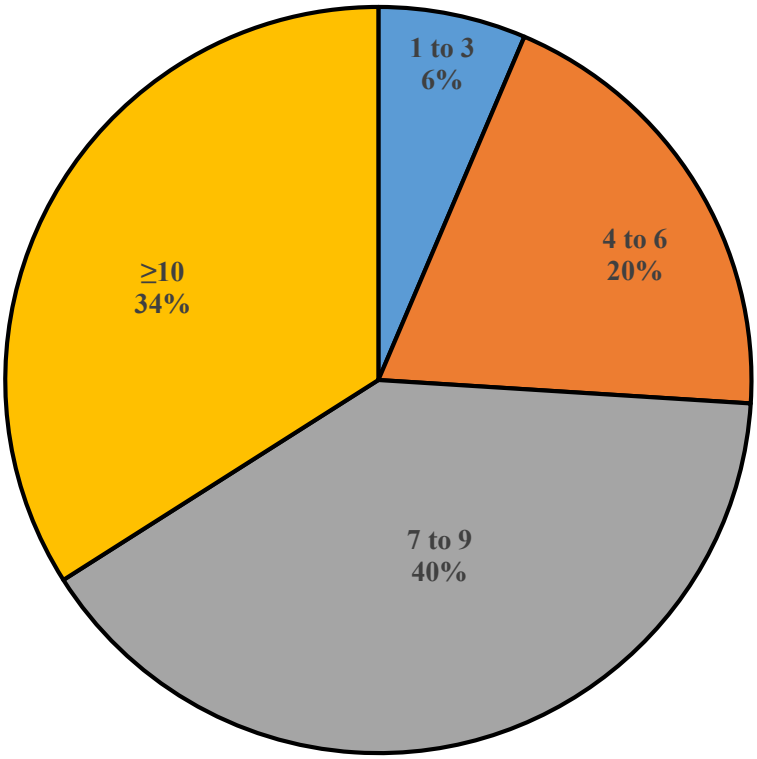

Figure 4.4: Distribution of household sizes among the 500 study participants

4.5 Availability of refuse storage facility in houses

Study participants were asked to state whether they had refuse storage facilities at home or not. Of the 500 participants, minority (220/500) representing 44% had refuse storage facilities at homes whiles the majority (280/500) representing 56% were not having refuse storage facilities at home (Table 4.1).

4.6 Type of refuse storage facilities in house

Among the 220 participants who had refuse storage facilities at homes, as many as 215 were storing refuse in sacks which represents 97%. Four respondents which represents 2% said they were storing wastes in standard bins and 1 respondent which represents 1% said, household wastes generated were stored in cartons (Table 4.1).

4.7 Refuse disposal practices adopted by respondents without storage facilities

Among the 280 participants who lacked refuse storage facilities at homes, they were asked to state the disposal methods they were practicing. Majority (161/280, 57%) were practicing burning and crude dumping followed by crude dumping practices only (92/280, 33%). The minority, (27/280, 10%) were practicing burning only as means of disposing off their household wastes (Table 4.1).

4.8 Refuse disposal practices adopted by respondents with storage facilities

The waste disposal practices of the 220 respondents with refuse storage facilities at home revealed that, majority (201/220, 91%) were using communal dumping sites, with only 2 (1%) admitting that they were practicing indiscriminate dumping into the environment (Table 4.1).

Table 4.1: Assessment of household solid waste management

Variable	Frequency	Percentage [%]
Availability of storage facility at home		
Yes	220	44
No	280	56
Total	**500**	**100**
Storage facility type used by respondents who have storage facility at home		
Carton	1	1
Sack	215	97
Standard bins	4	2
Total	**220**	**100**
Disposal method practiced by respondents who do not have storage facilities at home		
Burning only	27	10
Crude dumping only	92	33
Burning and crude dumping	161	57
Total	**280**	**100**
Disposal method practiced by respondents who have storage facilities at home		
At communal dumping site	201	91
Door–to–door disposal	17	8
Crude dumping	2	1
Total	**220**	**100**

4.9 Availability of toilet facility in houses

In this study, the 500 respondents who were sampled from 500 houses were asked to state the availability of toilets facility in their homes. Responses revealed that, majority (332/500, 66%) lacked toilet facilities in their homes and the rest (168/500, 34%) have toilets in their homes (Table 4.2).

4.10 Type of toilet facilities used in houses that have them

Of the 500 respondents only 168 have household toilet facilities. The 168 respondents were subsequently asked to state the type of toilet facilities they were having at homes. The most prevalent toilet facility was used pit latrine (83/168, 50%) followed by KVIP (56/168, 33%) and WC (29/168, 17%) as shown in Table 4.2 below.

4.11 Toilet disposal practices adopted by respondents without toilet facilities

Out of the 332 respondents who lacked toilet facilities at home, majority (220/332, 66%) used both public toilets and open defecation practices and the rest (112/332, 34%) practiced open defecation only as means of human excreta disposal at the study area as shown in Table 4.2 blow.

4.12 Waste water disposal practices adopted by respondents

The most practiced waste water disposal method at the study area was disposal into public drains (279/500, 56%) followed by disposal into open space (186/500, 37%), disposal into soak away pits (32/500, 6%) and disposal into septic tanks (3/500, 1%) as displayed in Table 4.2 below.

Table 4.2: Assessment of household liquid waste management

Variable	Frequency	Percentage [%]
Availability of storage facility at home		
Yes	220	44
No	280	56
Total	**500**	**100**
Toilet facility type used by respondents who have toilets at home		
KVIP	56	33
Pit latrines	83	50
WC	29	17
KVIP	56	33
Total	**168**	**100**
Disposal method practiced by respondents who do not have storage facilities at home		
Open defecation only	112	34
Public toilet only	0	0
Both open defecation and public toilet	220	66
Total	**332**	**100**
Disposal method practiced by respondents who have storage facilities at home		
Open space	186	37
Public drains	279	56
Soak away pit	32	6
Septic tanks	3	1
Total	**500**	**100**

4.13 Need for keeping the environment clean

In the assessment of respondents' understanding on environmental hygiene and sanitation, they were asked to state whether it was good or not to keep their environment clean. All the respondents (500/500, 100%) stated that, it was good to keep the environment clean as shown in Table 4.3 below.

4.14 Reasons for keeping the environment clean

Respondents were consequently asked to give a reason for keeping their environment clean. Once again, all the respondents (500/500, 100%) stated that, keeping the environment clean is key in promoting good health (Table 4.3).

4.15 Need for toilet facility in every house

In the assessment of respondents' understanding on sanitation, they were asked to state whether it was good or not to have toilet facilities at homes. All the respondents (500/500, 100%) stated that, it was good to have toilet facilities at home (Table 4.3).

4.16 Reasons for having toilet facilities in houses

Of the 500 respondents who stated that it was good to have toilet facility at homes, when they were subsequently asked to give a reason for their choice of answer, majority (367/500, 73%) said having toilet at home promotes health and sanitation and the rest (133/500, 27%) said it makes the house attractive for renting (Table 4.3).

4.17 Need for waste bins in every house

The 500 respondents selected from 500 households to participate in this study were asked to state whether it was necessary to have waste bins at home for refuse storage. All the respondents (500/500, 100%) stated that, it was good to have waste bins at home for refuse storage (Table 4.3).

4.18 Reasons for having waste bins in houses

The participants were further asked to state one reason why keeping waste bins at home was good. All the participants (500/500, 100%) stated that, keeping waste bins at home promotes health and sanitation (Table 4.3).

4.19 State of sanitation at Kpone

In table 4. 3 below, participants were asked to describe the state of sanitation at Kpone and all of them (500/500, 100%) rated the current state of sanitation at Kpone Township to be very bad.

Table 4.3: Assessment of knowledge and perception of respondents about sanitation

Variable	Frequency	Percentage [%]
Necessity of keeping the environment clean		
Yes	500	100
No	0	0
Total	**500**	**100**
Reasons for keeping the environment clean		
The Assembly generates more revenue	0	0
It provides jobs for people	0	0
It promotes health	500	100
Total	**500**	**100**
Reasons for keeping the environment clean		
The Assembly generates more revenue	0	0
It provides jobs for people	0	0
It promotes health	500	100
Total	**500**	**100**
Necessity of toilet facility in every house		
Yes	500	100
No	0	0
Total	**500**	**100**

Variable	Frequency	Percentage [%]
Necessity of waste bins in every house		
Yes	500	100
No	0	0
Total	**500**	**100**
Reasons for having waste bins at home		
It makes the house attractive for renting	0	0
It brings peace in the house	0	0
It promotes health and sanitation	500	100
Total	**500**	**100**
State of sanitation at Kpone		
Good	0	0
Very good	0	0
Bad	0	0
Very bad	500	100
How to improve sanitation at Kpone		
Enforcement of sanitation laws	85	17
Employment of more sanitary workers	0	0
Regular organizing of clean-up exercises	0	0
Provision of better sanitation services	415	83
Total	**500**	**100**

4.21 Type of waste collection services at Kpone

At the study area, there were 30 waste management service providers. They were all invited for a group discussion to help assess sanitary infrastructure at the study area. All the service providers were rendering door – to – door waste collection services at the study area (Table 4.4).

4.22 Waste contractors' suggestions on how to improve sanitation at Kpone

Waste collection contractors were further asked to suggest the best solution in improving sanitation at Kpone. Majority (21/30, 70%) said enforcement of the sanitation laws should be the best solution in curbing the peril of sanitation at the study area. The rest (9/30, 30%) said the land filled site receives waste from almost all part of the greater Accra and easing the pressure on the land filled site would be the best solution to facilitate quick collection and final disposal of wastes at the study area (Table 4.4).

4.23 Waste contractors' assessment of sanitation at Kpone

The recruited 30 waste contractors who were rendering waste collection services also rated the sanitation at the study area to be very bad as shown in Table 4.4 below.

Table 4.4: Focused group discussion with waste contractors on sanitation

Variable	Frequency	Percentage [%]
Type of waste collection services at Kpone		
Communal bin collector	0	0
Door-to-door collector	30	100
Total	**500**	**100**
Suggestions on how sanitation at Kpone can improve		
Enforcement of sanitation laws	21	70
Easing the pressure on the land-filled site	9	30
Regular organizing of clean-up exercises	0	100
Total	**500**	**100**
Assessment of sanitation at Kpone		
Good	0	0
Very good	0	0
Bad	0	0
Very bad	500	100
Total	**500**	**100**

CHAPTER FIVE

DISCUSSION

5.1 Introduction

Kpone is one of the towns along the coast in the greater Accra region of Ghana and the locations of heavy industries like the Tema oil refinery, Aluworks Ghana limited, ASKA Energy, Sentou steel factory, Sentou ceramics factory, Sunon Asogli Power company Ghana limited, Olam Ghana limited, Kpone Thermal Plant, Bel-Aqua company limited, Kpone land filled site, among others make the town a major industrial settlement in Ghana. The industrialization of the town and other commercial activities and even the presence of an engineered land filled site should provide good sanitary infrastructure at Kpone however, the town is seen each day with burdened deteriorating sanitation problems which prove to threaten the health of the inhabitants. In the midst of the sanitation challenges, a written informed consent was solicited from study participants at Kpone to help assess the sanitary infrastructure at the study area.

5.2 Socio-demographic characteristics of participants

In all, 530 study participants were engaged to contribute to the assessment of sanitary infrastructure at Kpone. They consisted of 500 landlords/landladies, household heads or caretakers and 30 waste collection contractors. Studies conducted in the past from Ghana have shown that, skewness in demographic characteristics such as gender, age, educational background and household size were significant factors which affect waste management practices. In such studies, Female respondents and age group below 18 were less likely to practice proper waste management. Participants with low educational background had little

knowledge on waste management and service delivery and household size associated with volume of household waste generation (Addo et al., 2017; Boateng et al., 2016). In this study however, about one-half of the study participants were males and the other one-half were females. Age distribution also revealed that, 73% of the respondents were between 31-40 years of age. Individuals of age 31 to 40 years represents young adults who were expected to be passionate on developmental issues at the study area as well as dealing with waste management challenges. However, the gravity of the sanitation related problems in the area depicts otherwise. In addition, of the 530 recruited participants, as many as 528 (96%) had received formal education. Since majority of the respondents had received some form of formal education, the findings from this study is not expected to be influenced by lack of formal education. This study also revealed that, 74% of the participants have household size ranging from 7 and above, Large household size correlates with volume of household waste generation (Addo et al., 2017; Afon & Okewole, 2007; Afroz, Hanaki, & Tudin, 2011; Bandara, Hettiaratchi, Wirasinghe, & Pilapiiya, 2007; Beigl, Lebersorger, & Salhofer, 2008) hence, there was huge waste generation at the study area.

5.3 Availability and condition of sanitary infrastructures

Waste especially human excreta, is very dangerous to health and our surroundings when it is not properly managed. One major unavoidable need of humanity is the removal of waste material such as urine and feces from the body regardless of the availability of safe disposal facilities. In Ghana, an individual who lives in a house which does not have domestic toilet facility is assumed to resort to open defecation practices since public toilets are not existing everywhere and the existing ones are neither accessible at all times. In this study, all the

respondent (100%) admitted that, it was good to have toilet facilities at homes however, majority (66%) of them lacked toilet facilities and were using public toilets and open space for disposing their excreta. One of the dangers of open defecation is the outbreak of diarrheal diseases. In the year 2014, between the months of June and August, the greater Accra region of Ghana reported 6,179 cholera cases with 51 deaths and lack of household toilet facility was the risk factor for the cholera epidemic. This had led to the introduction of the Greater Accra Metropolitan Area (GAMA) sanitation project to provide domestic toilet facilities to improve sanitation in the region. The project was a world bank sponsored program which started in 2016 and is expected to end in 2020 (MLGRD-GAMA, 2017). One major limitation to the program is the exclusion of district assemblies in the region. Kpone falls within the jurisdiction of Kpone-Katamanso municipality which was a district at the time the GAMA sanitation program commenced and is therefore, not part of the program, and consequently, did not benefit from the provision of toilet facilities. There is therefore an urgent need for supporting the inhabitants within Kpone with domestic toilets as enshrined in the GAMA sanitation project to promote sanitation in the study area.

The regard of refuse as a valueless material that has detrimental effect on the environment and health has greatly influence the attitudes of people about how to dispose of waste. This study investigated how households disposed of their waste water and the findings revealed that, the most practiced waste water disposal method at the study area was disposal into public drains which also corresponds with some other findings from Ghana (Addo et al., 2017; Yoada et al., 2014). In Ghana, most of the drainage systems are open drains which do not slope to allow easy flow and truncate at short intervals. Moreover, drains which are meant to receive only liquid

wastes end up receiving polythene bags, food debris, feces, refuse and other solid materials which deny the drains easy flow and thus, promotes breeding of malaria vectors and flooding. Good waste water disposal practices at the study area can improve if the assembly provides standard drainage network system at the study area.

5.4 Knowledge and perceptions of the populace on sanitary infrastructure usage

Even though all the 500 respondents have good perception on waste management and knew that keeping the environment clean is good to maintain sanitation, majority were not having refuse storage facilities at home. Studies in the past have shown that, lack of domestic waste storage facilities promote the crude methods of solid waste management practices (Nowakowski, 2016; Seng, Kaneko, Hirayama, & Katayama-Hirayama, 2011; Sumithra, Sunitha, & Nagaraju, 2014) which is in agreement with the findings from this study. In this study, respondents without storage facilities were burning wastes generated on their premises or dumping them on nearby undeveloped lands.

All the 500 respondents have fair knowledge on sanitation problems at the study area and ranked sanitation at the area to be very bad. Majority of them (83%) were of the view that, the assembly was not doing enough to improve sanitation and entreated the assembly to improve sanitation service delivery at Kpone Township whiles the remaining 17% also suggested that, enforcement of sanitation laws would help to improve sanitation at the study area.

At Kpone, there were 30 waste collection service providers which were rendering waste collection services to the inhabitants on daily bases. All of them were invited for a group discussion to help assess sanitary infrastructure at the study area. The type of collection service

they were rendering was door-to-door waste collection services. During the discussion they mentioned that, majority of households practice crude methods of waste disposal. They further stated that, houses which even engaged their services were not storing waste properly. They stored their waste in open containers and plastic bags associated with foul smell that attracted houseflies, especially, into houses without toilets. In suggesting ways of improving sanitation at the study area, majority (70%) were of the view that, enforcement of sanitation laws would help deter people from bad waste storage and disposal practices since they assumed people were aware that, poor handling and disposal of waste are major causes of environmental pollution, and creation of favourable breeding grounds for pathogenic organisms, and the spread of infectious diseases yet handle waste poorly. They also lamented on the long hours they spend in disposing refuse at the land fill site due to long queues at the disposal site. The long hours they spend in disposing wastes collected at the land fill site sometimes encourage crude dumping of waste by some refuse collectors at unauthorized places. All the 30 waste collectors rated sanitation at the study area to be very poor and subsequently suggested that, authorities should create more disposal sites to reduce the pressure on the Kpone land fill site and enforce laws to deter everyone including themselves from poor waste storage, collection, transport and disposal methods.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Majority of the respondents had fair knowledge and perception on good waste management practices but, the inadequacy of sanitary infrastructure resulted to crude methods of waste disposal at the study area. Increasing the number of household toilets through the GAMA sanitation program, provision of standard drainage network, improving access to solid waste collection facilities and services and enforcement of sanitation laws will help achieve sound environmental health at Kpone.

6.2 Recommendations

1. Greater part of the respondents showed that requirement of sanitation laws is important to enhance sanitation at Kpone. In perspective of this, it is prescribed that the Metropolitan, Municipal and District Assemblies (MMDAs) together with the sanitation division of the Ministry of Local Government and Rural Development (MLGRD) enforce the sanitation laws to forestall aimless dumping of waste and open defecation by certain individuals at Kpone.
2. Likewise, the respective experts should include Kpone in the WHO program for provision of subsidized latrines to family units as a method of keeping down the act of open defecation in the territory.
3. Finally, the inhabitants of Kpone need the connection between sanitation, wellbeing and financial empowerment so that they would value the need to keep their surroundings free from filth.

REFERENCES

Aatamila, M., Verkasalo, P. K., Korhonen, M. J., Suominen, A. L., Hirvonen, M. R., Viluksela, M. K., & Nevalainen, A. (2011). Odour annoyance and physical symptoms among residents living near waste treatment centres. *Environ Res, 111*(1), 164-170. doi:10.1016/j.envres.2010.11.008

Abdelbasir, S. M., Hassan, S. S. M., Kamel, A. H., & El-Nasr, R. S. (2018). Status of electronic waste recycling techniques: a review. *Environ Sci Pollut Res Int*. doi:10.1007/s11356-018-2136-6

Abdelradi, F. (2018). Food waste behaviour at the household level: A conceptual framework. *Waste Manag, 71*, 485-493. doi:10.1016/j.wasman.2017.10.001

Abor, P. A. (2013). Managing healthcare waste in Ghana: a comparative study of public and private hospitals. *Int J Health Care Qual Assur, 26*(4), 375-386. doi:10.1108/09526861311319591

Addo, H. O., Dun-Dery, E. J., Afoakwa, E., Elizabeth, A., Ellen, A., & Rebecca, M. (2017). Correlates of domestic waste management and related health outcomes in Sunyani, Ghana: a protocol towards enhancing policy. *BMC Public Health, 17*(1), 615. doi:10.1186/s12889-017-4537-8

Afon, A. O., & Okewole, A. (2007). Estimating the quantity of solid waste generation in Oyo, Nigeria. *Waste Manag Res, 25*(4), 371-379. doi:10.1177/0734242X07078286

Afroz, R., Hanaki, K., & Tudin, R. (2011). Factors affecting waste generation: a study in a waste management program in Dhaka City, Bangladesh. *Environ Monit Assess, 179*(1-4), 509-519. doi:10.1007/s10661-010-1753-4

Al-Khateeb, A. J., Al-Sari, M. I., Al-Khatib, I. A., & Anayah, F. (2017). Factors affecting the sustainability of solid waste management system-the case of Palestine. *Environ Monit Assess, 189*(2), 93. doi:10.1007/s10661-017-5810-0

Al-Khatib, I. A., Abu Hammad, A., Sharkas, O. A., & Sato, C. (2015). Public concerns about and perceptions of solid waste dump sites and selection of sanitary landfill sites in the West Bank, Palestinian territory. *Environ Monit Assess, 187*(4), 186. doi:10.1007/s10661-015-4401-1

Al-Khatib, I. A., Kontogianni, S., Abu Nabaa, H., Alshami, N., & Al-Sari, M. I. (2015). Public perception of hazardousness caused by current trends of municipal solid waste management. *Waste Manag, 36*, 323-330. doi:10.1016/j.wasman.2014.10.026

Alam, Q., Florea, M. V. A., Schollbach, K., & Brouwers, H. J. H. (2017). A two-stage treatment for Municipal Solid Waste Incineration (MSWI) bottom ash to remove agglomerated fine particles and leachable contaminants. *Waste Manag, 67*, 181-192. doi:10.1016/j.wasman.2017.05.029

Alavi Moghadam, M. R., Mokhtarani, N., & Mokhtarani, B. (2009). Municipal solid waste management in Rasht City, Iran. *Waste Manag, 29*(1), 485-489. doi:10.1016/j.wasman.2008.02.029

Aleluia, J., & Ferrao, P. (2017). Assessing the costs of municipal solid waste treatment technologies in developing Asian countries. *Waste Manag, 69*, 592-608. doi:10.1016/j.wasman.2017.08.047

Algapani, D. E., Qiao, W., di Pumpo, F., Bianchi, D., Wandera, S. M., Adani, F., & Dong, R. (2018). Long-term bio-H2 and bio-CH4 production from food waste in a continuous

two-stage system: Energy efficiency and conversion pathways. *Bioresour Technol, 248*(Pt A), 204-213. doi:10.1016/j.biortech.2017.05.164

Ali, A. (2010). Wasting time on solid waste in developing countries. *Waste Manag, 30*(8-9), 1437-1438. doi:10.1016/j.wasman.2010.04.025

Ali, M., Wang, W., Chaudhry, N., & Geng, Y. (2017). Hospital waste management in developing countries: A mini review. *Waste Manag Res, 35*(6), 581-592. doi:10.1177/0734242X17691344

Ali, S. S., Abomohra, A. E., & Sun, J. (2017). Effective bio-pretreatment of sawdust waste with a novel microbial consortium for enhanced biomethanation. *Bioresour Technol, 238*, 425-432. doi:10.1016/j.biortech.2017.03.187

Aliu, I. R., Adeyemi, O. E., & Adebayo, A. (2014). Municipal household solid waste collection strategies in an African megacity: analysis of public private partnership performance in Lagos. *Waste Manag Res, 32*(9 Suppl), 67-78. doi:10.1177/0734242X14544354

Amoah, P., Gbenatey Nartey, E., & Schrecongost, A. (2016). Performance evaluation of biofil toilet waste digester technologies in Ghana: the efficacy of effluent treatment options. *Environ Technol, 37*(23), 3002-3013. doi:10.1080/09593330.2016.1173116

Anbazhagan, S., & Palani, S. (2018). Extraction of consortium of hydrolytic enzymes from waste activated sludge using ultrasonication and stirring with surfactants. *Ultrason Sonochem, 40*(Pt A), 874-880. doi:10.1016/j.ultsonch.2017.08.034

Andersson, C., & Stage, J. (2018). Direct and indirect effects of waste management policies on household waste behaviour: The case of Sweden. *Waste Manag, 76*, 19-27. doi:10.1016/j.wasman.2018.03.038

Anjum, M., Al-Talhi, H. A., Mohamed, S. A., Kumar, R., & Barakat, M. A. (2018). Visible light photocatalytic disintegration of waste activated sludge for enhancing biogas production. *J Environ Manage, 216*, 120-127. doi:10.1016/j.jenvman.2017.07.064

Antonetti, E., Iaquaniello, G., Salladini, A., Spadaccini, L., Perathoner, S., & Centi, G. (2017). Waste-to-Chemicals for a Circular Economy: The Case of Urea Production (Waste-to-Urea). *ChemSusChem, 10*(5), 912-920. doi:10.1002/cssc.201601555

Aranda Uson, A., Ferreira, G., Zambrana Vasquez, D., Zabalza Bribian, I., & Llera Sastresa, E. (2013). Environmental-benefit analysis of two urban waste collection systems. *Sci Total Environ, 463-464*, 72-77. doi:10.1016/j.scitotenv.2013.05.053

Arbulu, I., Lozano, J., & Rey-Maquieira, J. (2016). The challenges of municipal solid waste management systems provided by public-private partnerships in mature tourist destinations: The case of Mallorca. *Waste Manag, 51*, 252-258. doi:10.1016/j.wasman.2016.03.007

Asase, M., Yanful, E. K., Mensah, M., Stanford, J., & Amponsah, S. (2009). Comparison of municipal solid waste management systems in Canada and Ghana: a case study of the cities of London, Ontario, and Kumasi, Ghana. *Waste Manag, 29*(10), 2779-2786. doi:10.1016/j.wasman.2009.06.019

Auler, F., Nakashima, A. T., & Cuman, R. K. (2014). Health conditions of recyclable waste pickers. *J Community Health, 39*(1), 17-22. doi:10.1007/s10900-013-9734-5

Awodele, O., Adewoye, A. A., & Oparah, A. C. (2016). Assessment of medical waste management in seven hospitals in Lagos, Nigeria. *BMC Public Health, 16*, 269. doi:10.1186/s12889-016-2916-1

Azevedo, L. P., da Silva Araujo, F. G., Lagarinhos, C. A. F., Tenorio, J. A. S., & Espinosa, D. C. R. (2017). E-waste management and sustainability: a case study in Brazil. *Environ Sci Pollut Res Int, 24*(32), 25221-25232. doi:10.1007/s11356-017-0099-7

Baker, D. B., Greenland, S., Mendlein, J., & Harmon, P. (1988). A health study of two communities near the Stringfellow Waste Disposal site. *Arch Environ Health, 43*(5), 325-334. doi:10.1080/00039896.1988.9934943

Bandara, N. J., Hettiaratchi, J. P., Wirasinghe, S. C., & Pilapiiya, S. (2007). Relation of waste generation and composition to socio-economic factors: a case study. *Environ Monit Assess, 135*(1-3), 31-39. doi:10.1007/s10661-007-9705-3

Bayard, R., Benbelkacem, H., Gourdon, R., & Buffiere, P. (2018). Characterization of selected municipal solid waste components to estimate their biodegradability. *J Environ Manage, 216*, 4-12. doi:10.1016/j.jenvman.2017.04.087

Becker, A. M., Jr., Yu, K., Stadler, L. B., & Smith, A. L. (2017). Co-management of domestic wastewater and food waste: A life cycle comparison of alternative food waste diversion strategies. *Bioresour Technol, 223*, 131-140. doi:10.1016/j.biortech.2016.10.031

Beigl, P., Lebersorger, S., & Salhofer, S. (2008). Modelling municipal solid waste generation: a review. *Waste Manag, 28*(1), 200-214. doi:10.1016/j.wasman.2006.12.011

Bian, B., Zhang, L., Zhang, Q., Zhang, S., Yang, Z., & Yang, W. (2018). Coupled heating/acidification pretreatment of chemical sludge for dewatering by using waste sulfuric acid at low temperature. *Chemosphere, 205*, 260-266. doi:10.1016/j.chemosphere.2018.04.120

Bing, X., Bloemhof, J. M., Ramos, T. R. P., Barbosa-Povoa, A. P., Wong, C. Y., & van der Vorst, J. (2016). Research challenges in municipal solid waste logistics management. *Waste Manag, 48*, 584-592. doi:10.1016/j.wasman.2015.11.025

Bistulfi, G. (2013). Sustainability: Reduce, reuse and recycle lab waste. *Nature, 502*(7470), 170. doi:10.1038/502170a

Boateng, S., Amoako, P., Appiah, D. O., Poku, A. A., & Garsonu, E. K. (2016). Comparative Analysis of Households Solid Waste Management in Rural and Urban Ghana. *J Environ Public Health, 2016*, 5780258. doi:10.1155/2016/5780258

Bonelli, M., Bosio, L., Cavallo, R., Gianolio, U., & Marengo, P. (2016). Waste prevention impacts on small municipalities: Three experiences from northern Italy. *Waste Manag Res, 34*(10), 1014-1025. doi:10.1177/0734242X16661054

Braz, L. G., Braz, J. R. C., Cavalcante, G. A. S., Souza, K. M., Lucio, L. M. C., & Braz, M. G. (2017). [Comparison of waste anesthetic gases in operating rooms with or without an scavenging system in a Brazilian University Hospital]. *Rev Bras Anestesiol, 67*(5), 516-520. doi:10.1016/j.bjan.2017.02.001

Campo, G., Cerutti, A., Zanetti, M., Scibilia, G., Lorenzi, E., & Ruffino, B. (2018). Enhancement of waste activated sludge (WAS) anaerobic digestion by means of pre- and intermediate treatments. Technical and economic analysis at a full-scale WWTP. *J Environ Manage, 216*, 372-382. doi:10.1016/j.jenvman.2017.05.025

Cazabon, D., Fobil, J. N., Essegbey, G., & Basu, N. (2017). Structured identification of response options to address environmental health risks at the Agbogbloshie electronic waste site. *Integr Environ Assess Manag, 13*(6), 980-991. doi:10.1002/ieam.1964

Chakraborty, D., & Konar, S. K. (2002). Ecological study on the status of pollution by steel plant waste on river Damodar at Barnpur, West Bengal. *Indian J Environ Health, 44*(1), 50-57.

Chow, C. F., Wong, W. L., Chan, C. W., & Chan, C. S. (2018). Converting inert plastic waste into energetic materials: A study on the light-accelerated decomposition of plastic waste with the Fenton reaction. *Waste Manag, 75*, 174-180. doi:10.1016/j.wasman.2018.01.034

Chowdhury, R. B., & Chakraborty, P. (2016). Magnitude of anthropogenic phosphorus storage in the agricultural production and the waste management systems at the regional and country scales. *Environ Sci Pollut Res Int, 23*(16), 15929-15940. doi:10.1007/s11356-016-6930-8

Chun, S. K. (2018). Mass balance analysis on the behavior of major elements disposed at a waste landfill site. *Waste Manag, 71*, 233-243. doi:10.1016/j.wasman.2017.10.050

Clarke, W. P. (2018). The uptake of anaerobic digestion for the organic fraction of municipal solid waste - Push versus pull factors. *Bioresour Technol, 249*, 1040-1043. doi:10.1016/j.biortech.2017.10.086

Derakhshan, Z., Ghaneian, M. T., Mahvi, A. H., Oliveri Conti, G., Faramarzian, M., Dehghani, M., & Ferrante, M. (2017). A new recycling technique for the waste tires reuse. *Environ Res, 158*, 462-469. doi:10.1016/j.envres.2017.07.003

Fasora, L. (2001). [The problem of drinking water supply and waste disposal in Brno as an example of an integral function of the townships in the Brno area, 1881-1913]. *Sb Pr Filos Fak Brnenske Univ Rada Hist, 50*(48), 157-169.

Freeman, F. (2010). Ghana: the waste land. *World Policy J, 27*(2), 47-53.

Fudala-Ksiazek, S., Pierpaoli, M., Kulbat, E., & Luczkiewicz, A. (2016). A modern solid waste management strategy--the generation of new by-products. *Waste Manag, 49*, 516-529. doi:10.1016/j.wasman.2016.01.022

Gabrielli, F., Amato, A., Balducci, S., Magi Galluzzi, L., & Beolchini, F. (2017). Disaster waste management in Italy: Analysis of recent case studies. *Waste Manag*. doi:10.1016/j.wasman.2017.10.012

Gaurh, P., & Pramanik, H. (2017). A novel approach of solid waste management via aromatization using multiphase catalytic pyrolysis of waste polyethylene. *Waste Manag*. doi:10.1016/j.wasman.2017.10.053

Ghanadzadeh, M., Akhavan Malayeri, N., Bollhasani, A., Eshrati, B., & Shamsi, M. (2014). Viewpoint on Waste Management for Developing Methods of Educational. *Iran J Public Health, 43*(12), 1722-1723.

Gu, B., Jiang, S., Wang, H., Wang, Z., Jia, R., Yang, J., . . . Cheng, R. (2017). Characterization, quantification and management of China's municipal solid waste in spatiotemporal distributions: A review. *Waste Manag, 61*, 67-77. doi:10.1016/j.wasman.2016.11.039

Hafner, S. C., Watanabe, N., Harter, T., Bergamaschi, B. A., & Parikh, S. J. (2017). Effects of solid-liquid separation and storage on monensin attenuation in dairy waste management systems. *J Environ Manage, 190*, 28-34. doi:10.1016/j.jenvman.2016.12.024

Ho, C. C., & Chen, M. S. (2017). Risk assessment and quality improvement of liquid waste management in Taiwan University chemical laboratories. *Waste Manag*. doi:10.1016/j.wasman.2017.09.029

Ibanez-Fores, V., Bovea, M. D., Coutinho-Nobrega, C., de Medeiros-Garcia, H. R., & Barreto-Lins, R. (2018). Temporal evolution of the environmental performance of implementing

selective collection in municipal waste management systems in developing countries: A Brazilian case study. *Waste Manag, 72*, 65-77. doi:10.1016/j.wasman.2017.10.027

Kamaruddin, M. A., Yusoff, M. S., Rui, L. M., Isa, A. M., Zawawi, M. H., & Alrozi, R. (2017). An overview of municipal solid waste management and landfill leachate treatment: Malaysia and Asian perspectives. *Environ Sci Pollut Res Int*. doi:10.1007/s11356-017-0303-9

Komakech, A. J., Banadda, N. E., Kinobe, J. R., Kasisira, L., Sundberg, C., Gebresenbet, G., & Vinneras, B. (2014). Characterization of municipal waste in Kampala, Uganda. *J Air Waste Manag Assoc, 64*(3), 340-348.

Kumar, V., Kumar, A., & Nanda, M. (2018). Pretreated animal and human waste as a substantial nutrient source for cultivation of microalgae for biodiesel production. *Environ Sci Pollut Res Int*. doi:10.1007/s11356-018-2339-x

Leading on waste reduction. (2016). *Emerg Nurse, 24*(4), 43. doi:10.7748/en.24.4.43.s30

Linzalone, N., Coi, A., Lauriola, P., Luise, D., Pedone, A., Romizi, R., . . . Group, H. I. A. P. W. (2017). Participatory health impact assessment used to support decision-making in waste management planning: A replicable experience from Italy. *Waste Manag, 59*, 557-566. doi:10.1016/j.wasman.2016.09.035

Martinho, G., Gomes, A., Ramos, M., Santos, P., Goncalves, G., Fonseca, M., & Pires, A. (2017). Solid waste prevention and management at green festivals: A case study of the Andancas Festival, Portugal. *Waste Manag*. doi:10.1016/j.wasman.2017.10.020

MLGRD-GAMA. (2017). Greater Accra Metropolitan Area (GAMA) Sanitation and Water Project, Construction of saniation institutional sanitation. *3 Biotech*.

Nau, J. Y. (2010). ["Don't drink your waste" (1)]. *Rev Med Suisse, 6*(258), 1514-1515.

Ncube, F., Ncube, E. J., & Voyi, K. (2017). A systematic critical review of epidemiological studies on public health concerns of municipal solid waste handling. *Perspect Public Health, 137*(2), 102-108. doi:10.1177/1757913916639077

Ndounga Diakou, L. A., Ntoumi, F., Ravaud, P., & Boutron, I. (2018). Correction to: Avoidable waste related to inadequate methods and incomplete reporting of interventions: a systematic review of randomized trials performed in Sub-Saharan Africa. *Trials, 19*(1), 42. doi:10.1186/s13063-017-2431-4

Nowakowski, P. (2016). The influence of residents' behaviour on waste electrical and electronic equipment collection effectiveness. *Waste Manag Res, 34*(11), 1126-1135. doi:10.1177/0734242X16669997

Nwachukwu, M. A., Ronald, M., & Feng, H. (2017). Global capacity, potentials and trends of solid waste research and management. *Waste Manag Res, 35*(9), 923-934. doi:10.1177/0734242X17715099

Oduro-Appiah, K., Scheinberg, A., Mensah, A., Afful, A., Boadu, H. K., & de Vries, N. (2017). Assessment of the municipal solid waste management system in Accra, Ghana: A 'Wasteaware' benchmark indicator approach. *Waste Manag Res, 35*(11), 1149-1158. doi:10.1177/0734242X17727066

Owamah, H. I., Dahunsi, S. O., Oranusi, U. S., & Alfa, M. I. (2014). Fertilizer and sanitary quality of digestate biofertilizer from the co-digestion of food waste and human excreta. *Waste Manag, 34*(4), 747-752. doi:10.1016/j.wasman.2014.01.017

Pardo, G., Moral, R., & Del Prado, A. (2017). SIMSWASTE-AD - A modelling framework for the environmental assessment of agricultural waste management strategies: Anaerobic digestion. *Sci Total Environ, 574*, 806-817. doi:10.1016/j.scitotenv.2016.09.096

Ragossnig, A. M. (2017). What is the real scope of waste management? *Waste Manag Res, 35*(11), 1097-1098. doi:10.1177/0734242X17738667

Report from the Fourteenth International Waste Management and Landfill Symposium - Sardinia 2013. (2014). *Waste Manag, 34*(1), 242-244. doi:10.1016/j.wasman.2013.10.017

Ribic, B., Voca, N., & Ilakovac, B. (2017). Concept of sustainable waste management in the city of Zagreb: Towards the implementation of circular economy approach. *J Air Waste Manag Assoc, 67*(2), 241-259. doi:10.1080/10962247.2016.1229700

Rogoff, M. J. (2014). Solid waste collection automation in the United States. *Waste Manag Res, 32*(11), 1031-1033. doi:10.1177/0734242X14558164

Saidan, M. N., Drais, A. A., & Al-Manaseer, E. (2017). Solid waste composition analysis and recycling evaluation: Zaatari Syrian Refugees Camp, Jordan. *Waste Manag, 61*, 58-66. doi:10.1016/j.wasman.2016.12.026

Schouw, N. L., Bregnhoj, H., Mosbaek, H., & Tjell, J. C. (2003). Technical, economic and environmental feasibility of recycling nutrients in waste in Southern Thailand. *Waste Manag Res, 21*(3), 191-206. doi:10.1177/0734242X0302100303

Seng, B., Kaneko, H., Hirayama, K., & Katayama-Hirayama, K. (2011). Municipal solid waste management in Phnom Penh, capital city of Cambodia. *Waste Manag Res, 29*(5), 491-500. doi:10.1177/0734242X10380994

Steyer, A., Gutierrez-Aguirre, I., Racki, N., Beigot Glaser, S., Brajer Humar, B., Strazar, M., . . . Rupnik, M. (2015). The Detection Rate of Enteric Viruses and Clostridium difficile in a Waste Water Treatment Plant Effluent. *Food Environ Virol*. doi:10.1007/s12560-015-9183-7

Sumithra, S., Sunitha, V., & Nagaraju, G. (2014). Municipal Solid Waste Management in Kadapa Town: A Case Study. *J Environ Sci Eng, 56*(1), 123-126.

Tabata, T., Wakabayashi, Y., Tsai, P., & Saeki, T. (2017). Environmental and economic evaluation of pre-disaster plans for disaster waste management: Case study of Minami-Ise, Japan. *Waste Manag, 61*, 386-396. doi:10.1016/j.wasman.2016.12.020

Wakabayashi, Y., Peii, T., Tabata, T., & Saeki, T. (2017). Life cycle assessment and life cycle costs for pre-disaster waste management systems. *Waste Manag, 68*, 688-700. doi:10.1016/j.wasman.2017.06.014

Wan, C., Shen, G., & Choi, S. (2017). An indirect pro-environmental behavior: Public support for waste management policy. *Waste Manag, 69*, 1-2. doi:10.1016/j.wasman.2017.10.005

Waste Disposal Session Q&A. (2016). *Health Phys, 110*(2), 176-177. doi:10.1097/HP.0000000000000425

[Waste management and health. Position paper of the Italian Association of Epidemiology]. (2008). *Epidemiol Prev, 32*(4-5), 183-187.

Weidemann, E., Allegrini, E., Fruergaard Astrup, T., Hulgaard, T., Riber, C., & Jansson, S. (2016). Size fractionation of waste-to-energy boiler ash enables separation of a coarse fraction with low dioxin concentrations. *Waste Manag, 49*, 110-113. doi:10.1016/j.wasman.2016.01.027

Wu, Z., Yu, A. T., & Shen, L. (2017). Investigating the determinants of contractor's construction and demolition waste management behavior in Mainland China. *Waste Manag, 60*, 290-300. doi:10.1016/j.wasman.2016.09.001

Yeasmin, F., Luby, S. P., Saxton, R. E., Nizame, F. A., Alam, M. U., Dutta, N. C., . . . Winch, P. J. (2017). Piloting a low-cost hardware intervention to reduce improper disposal of solid waste in communal toilets in low-income settlements in Dhaka, Bangladesh. *BMC Public Health, 17*(1), 682. doi:10.1186/s12889-017-4693-x

Yoada, R. M., Chirawurah, D., & Adongo, P. B. (2014). Domestic waste disposal practice and perceptions of private sector waste management in urban Accra. *BMC Public Health, 14*, 697. doi:10.1186/1471-2458-14-697

Zhang, T., Zheng, F., & Yu, T. (2016). Industrial waste: Citizens arrest river pollution in China. *Nature, 535*(7611), 231. doi:10.1038/535231e

Zhao, P., Xie, J., Gu, F., Sharmin, N., Hall, P., & Fu, J. (2018). Separation of mixed waste plastics via magnetic levitation. *Waste Manag, 76*, 46-54. doi:10.1016/j.wasman.2018.02.051