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An Assessment of Waste Management in Slum Communities in Freetown. It's Implications on the Health and Safety of Inhabitants

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Abstract

Purpose: The study objective is to assess the state of Solid Waste Management (SWM) in slum communities in Freetown, its factors and effects on the safety and wellbeing of slum dwellers together with the challenges faced by authorities in combatting inadequate SWM system in slum and to provide recommendations with regards to interventions to promote adequate waste management in slums.

Materials and Methods: The study took place in three slum areas around Freetown in Sierra Leone. A total sample size of 400 respondents comprising of household heads were selected. A self-administered structured questionnaire was given to a total of 400 respondents of household heads above eighteen years old. Only 392 of the 400 respondents that were initially targeted for the study completed their questionnaires at the end of the survey. The data collected was presented in tables and statistical analytical techniques or methods such as percentages and graphs were used to analyse the data and to find out the factors, effects and challenges associated with inappropriate solid waste management services in slum areas in Freetown.

Findings: According to the study, it was found that the major categories of waste generated in households were biodegradable and food (39%) while plastic remains (31%). Most households stored their wastes in polythene bags (59.1%) and sacks (20.2%) before disposal and 10.3% of the households did not have waste storage containers and kept their wastes outside the house in the open. Poor knowledge in waste segregation practices with very minimal recycling, reuse of wastes and a resultant poor waste management system were observed in slum communities. The study helps provide a much-needed data on solid waste management (SWM) in Freetown for authorities and other stakeholders as there are limited sources of data on waste management in Sierra Leone. It also provides further literature on waste management issues for further research, policy development by the authorities and recommendations for best practice by communities and stakeholders.

Implications to Practice and Policy: It was recommended that waste management should be prioritized as a social service, with adequate budget lines. Engage several stakeholders in the management of waste to generate a sense of responsibility and interest from all stakeholders.

Keywords: *Waste Management, Slum Communities, Inhabitants Safety, Health*

1.0 INTRODUCTION

Slum and Solid Waste Management

The UN-Habitat defines a slum as a human settlement with inadequate access to safe water, inadequate access to sanitation and other infrastructure, poor structural quality of housing, overcrowding; and insecure residential status (UN-Habitat 2005; Riley et al. 2007). In 2007, these characteristics defined 43 % of combined urban populations in developing countries and about 78 % of the urban population in least developed countries Slums are known incubators of disease because slum conditions facilitate the spread of communicable diseases such as cholera, diarrhoea, tuberculosis, and polio (Riley et al. 2007). For example, a devastating cholera outbreak in Sierra Leone in 2012 that killed almost 400 people. (WHO 2012).

The term 'waste' has a different meaning for different people. In general, waste is 'unwanted' for the person who discards it; a product or material which is no longer valued by the first user and therefore thrown away. However, 'unwanted' is subjective, as it could be of value for another person under different circumstances or even in a different culture. Wastes are unwanted or any substance which is discarded after primary use, or it is insignificant, defective and of no use. If not properly dealt with, waste poses a threat to public health and the environment. (Dr. Yogalakshmi K. N).

Problems Related to Insufficient Solid Waste Management

Uncontrolled dumping of solid waste can lead to severe health hazards for local inhabitants, and pollute natural resources like water, soil, or air etc. Not having a solid waste collection service has a direct health impact on residents, particularly children. The uncontrolled burning of waste creates particulate and persistent organic pollutant emissions that are highly damaging locally and globally (N. Ferronato et al 2019). Accumulated waste and blocked drains encourage vectors to breed, resulting in the spread of cholera, dengue fever and other infectious diseases and are a major contributing factor to flooding. Uncontrolled dumpsites, and the mixing of hazardous and other wastes, can cause disease in neighbouring settlements as well as among waste workers (Wasteaid 2018/Sood D. 2004). On a larger scale, when significant quantities of municipal or industrial solid waste are dumped or burned in the open, the adverse impacts on air, surface and groundwater, soil, and the coastal and marine environment, and thus indirectly on public health, can be severe (Phillips, Willard et al 2011).

Dumpsites on land can pollute both surface and groundwater (L. Hossain et al 2014).These sites are often alongside rivers or the sea, and therefore may directly pollute them as well as the coastal environment. (A.S Mansaray et al, 2018). Other potential damage costs include losses resulting from decreases in tourism due to polluted beaches and losses incurred through damage to fisheries. (UNEP, ISWA 2017). The environmental degradation caused by inadequate waste disposal can be measured by the contamination of surface and groundwater through leachate, soil contamination through direct waste contact or leachate, air pollution by waste burning, spreading of diseases by different vectors like birds, insects, and rodents, or the uncontrolled release of methane by anaerobic waste decomposition (Eawag/Sandec 2008). Reduction of environmental quality takes the form of foul odours and unsightliness (B. Havika 2010.) Both public health and environmental quality benefit directly and substantially from the implementation of modern solid waste management practices. (UNEP, 2005, p. 3).

Basel, Rotterdam, Stockholm Conventions on Hazardous Chemical Substances and Wastes

The Basel, Rotterdam and Stockholm Conventions are multilateral environmental agreements, which share the common objective of protecting human health and the environment from hazardous chemicals and wastes. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was created to protect people and the environment from the negative effects of the inappropriate management of hazardous wastes worldwide. The Rotterdam Convention on the Prior Informed Consent Procedure for certain hazardous Chemicals and Pesticides in international trade provides Parties with a first line of defence against hazardous chemicals. It promotes international efforts to protect human health and the environment as well as enabling countries to decide if they want to import hazardous chemicals and pesticides listed in the Convention. The Stockholm Convention on Persistent Organic Pollutants (POPs) is a global treaty to protect human health and the environment from highly dangerous, long-lasting chemicals by restricting and ultimately eliminating their production, use, trade, release, and storage.

The African Perspective

As cities rapidly grow due to urbanization, so does the amount of slum communities developed and waste that they generate. Inappropriate policies have contributed to the growth of life and health-threatening slums, where urban waste management services are often woefully inadequate (Dodman et al 2017). 62% of urban populations in Sub-Saharan Africa live in slum areas dominated by uncontrolled informal spatial developments, most often located in environmentally fragile areas, and without access to basic services such as water, sanitation, energy and transport and waste management systems. (G. Ochieng 2016).

The Bamako Convention

To complement the Basel Convention, African Nations established the Bamako Convention in 1991. The Convention, which came into force in 1998, is aimed at protecting the health of populations and the environment of African countries through a ban on the import of all hazardous and radioactive wastes. It also prohibits the dumping or incineration of hazardous wastes in oceans and inland waters and promotes the minimization and control of trans-boundary movements of hazardous wastes within the African continent.

The Sierra Leone Perspective

Urban population of Sierra Leone increased from 21.8 % in 1967 to 40.3 % in 2016 growing at an average annual rate of 1.27 %. Of concern is the inability of infrastructure and land use planning methods (including for waste management) to cope with urban growth. This is particularly urgent in slum areas. Improper management of waste is a major concern in the Capital city, with only three major landfill sites; Granville Brook (Bumeh) & Bottom Oku in the east and Kingtom in the west where there is no base or top seal to prevent the flow of leachates to underground water or rivers or the infiltration of water into the waste. At the King Tom dump site, leachate seeps into White Man's Bay where it mixes with discharges of raw sewage effluent from sludge drying ponds on the same site (HARPIS – SL). This results in the spread of contagious and water-borne diseases into soil and water. The large rubbish dumps within residential areas in the capital Freetown, uncollected garbage, and the habit of depositing faeces in open places as well as the preponderance of pools of still water, have heightened the risk for the urban dwellers as well as those living in the slums (Zainab T. Clarkson 2016).

Legislations

Legislations affecting the waste management and sanitation in Sierra Leone comprise of the following: a) The Environmental Protection Act (2008): An Act (amended in 2010) which empowers the Minister of Lands, Country Planning, and the Environment to make regulations and guidelines which protect the environment. b) Local Government Act (2004): An Act which enables the establishment of nineteen local councils and provides for decentralization and devolution of functions, powers, and services to local councils. The Act devolves the water supply and sanitation responsibilities to District and Town Councils. c) Public Health Act 1996 and the 2004 Addendum: An Act which vests the responsibility for environmental sanitation in the Ministry of Health and Sanitation Fishery Products Regulations (2007):

Responsibilities of the Sierra Leone Ministry of Health and Sanitation (MoHS)

The Ministry of Health and Sanitation shall continue to be responsible in ensuring that the Environmental Health Division acts as the leading body to over-see the waste management activities in the country, using the Integrated National Waste Management Policy (INWMP). MoHS will also be responsible for developing waste management and sanitation strategies.

It will closely work with the Ministry of Internal Affairs, Local Government and Rural Development which is responsible for leading the implementation of the sanitation and hygiene strategies, together with the Ministry responsible for water (Policy and planning section) to ensure that integrated water, sanitation, and hygiene education/promotion programs are implemented by Local Councils, urban and rural communities in accordance with the Policy objectives.

The Integrated National Waste Management Policy (INWMP) and Strategic Plan (INWMSP)

To improve the present situation and to better protect public health, the Government of Sierra Leone, through the Ministry of Health and Sanitation, has launched the "Keep Sierra Leone Clean, "Play your Role for Change" initiative and produced an integrated national waste management policy (INWMP) and strategic plan (INWMSP). The overall aim of Sierra Leone's waste management policy and related initiatives is to create a clean and healthy environment that is free from biological, chemical, and physical hazards posed by waste Sierra Leone – MoHS –INSWMP Road Map 4 National Policy Roadmap on Integrated Waste Management generated from communities, health facilities, industries, and other sources. This integrated national waste management policy roadmap provides a concise overview of priority national policy regarding key sector stakeholders and the way their duties should be performed. It also provides a framework for implementing other waste sector initiatives including the National Integrated Waste Management Strategic Plan (2012-2016) and other national, district

National Environmental Protection Agency (EPA)

Responsible for all local councils, providing them with technical and training support, accountancy, auditing, ensuring transparency and public participation in the administration of councils, and for supporting local governance reforms in implementing the Government's decentralization policy (including authorising (in partnership with the Attorney General, the enactment of local byelaws submitted by local authorities). Key stakeholder in any sustainable Waste Management policies, awareness raising, and institutional support for any pilot or larger rollout activities.

Ministry of Local Government and Rural Development (MLGRD) and the Decentralisation Secretariat (DecSec)

Responsible for all local councils, providing them with technical and training support, accountancy, auditing, ensuring transparency and public participation in the administration of councils, and for supporting local governance reforms in implementing the Government's decentralization policy (including authorising (in partnership with the Attorney General, the enactment of local byelaws submitted by local authorities). Key stakeholder in any sustainable Waste Management policies, awareness raising, and institutional support for any pilot or larger rollout activities.

Ministry of Finance & Economic Development / Local Government Finance Department

Assist in the allocation and auditing of local government budgets and spending in all aspects of waste management and municipal services.

Local Councils 6 City Councils 13 District Councils 149 Chiefdom Councils

Responsible, for ensuring the provision of solid waste services, disposal facilities and adequate drainage and sewerage, Public Health information and education, primary and secondary healthcare and education, education and sensitisation on environmental issues, enterprise development, strategic local plans, community development, community-based organisations, gender issues, and have ability to allocate land for municipal functions. Have power to outsource activities to private sector. Have powers to raise revenue including local taxes, property rates, licences, fees, and charges, etc. and deliver sanitary enforcement through Public Health aides seconded to the councils through the ESICOME programme.

Non-Governmental Organisations (NGOs) (Including Associations Such as Klin Salone)

Work with communities, local councils, and other stakeholders to provide various functions including x Training and capacity building of the private and public sector, introducing new ideas and concepts in waste management, and implementing pilot studies. x Assisting communities with the planning, implementation and/or monitoring of local waste management and sanitation projects, x Assisting to bridge any gaps between communities and local government. x Providing health, hygiene and sanitation education promotion, and x Financing and implementation of waste management and sanitation projects x Promotion and lobbying for adequate waste management services to members and government – with particular attention to health and safety issues and training.

Informal Sector (Waste Pickers, Waste Collectors etc)

A private sector entity active in collecting/transporting waste from individual households/businesses and/or by reselling materials recovered from waste obtained at the point of generation, storage, or final disposal sites. Must be acknowledged by all stakeholders and all efforts made to maintain the informal community's involvement in the sector as other private and public sector entities deliver more waste management activities.

Waste Generators (Households, Enterprises, Public Institutions, Hospitals, and Clinics, etc.)

Have responsibility to minimise waste generation, store generated wastes appropriately (including separation of hazardous and non-hazardous materials as a minimum, and separation of different waste materials for recycling initiatives if required), engage with an appropriate entity to handle waste in a responsible manner and adequately compensate such entity for the safe handling and treatment of the materials in accordance with national and local stipulations.

Street Traders

Tasked with complying with city ordinances and rules on where and how to operate the business; ensuring streets and footpaths are kept clear and free from obstruction that might impede cleansing activities; and keeping area clear and tidy by taking waste directly to official designated collection point or engaging an officially registered waste collection SME to do this on their behalf.

Problem Statement

Freetown is the capital and largest city of Sierra Leone. A major port city on the Atlantic Ocean located in the western region of West Africa. The other main towns in Sierra Leone include Bo, Kenema, Makeni and Koidu. Sierra Leone's ten-year rebel war severely impacted Freetown's economy and its infrastructure. Waste management equipment such as the skip trucks, skips and others were vandalized or destroyed by the end of the war, thousands of displaced people migrated to Freetown, swelling its population from 850,000 in 1994 to an estimated high of 1.85 million in 2004 with a proportionate increase in the solid waste quantities generated (Sood D. 2004).

The result of heavy population migration has been squalor, poor housing giving rise to more slum communities, inadequate sanitation, congestion, pollution, poor public services etc. The ubiquitous pile-up of garbage can be seen everywhere especially in slums. Also, most city drains are clogged with garbage which usually leads to flooding that badly affects slum communities at the Kroo Bay, Susan's Bay, Grey Bush, Mabela Wharf etc (Sood D. 2004. Several manhole covers have been removed to dump garbage. Many existing skips (large containers) that also act as transfer station for the solid waste are broken. Often, the garbage is strewn around, where scavengers, mostly children and wandering dogs, birds, pigs, and other stray animals, forage amongst the rubbish, spreading it around. City's coastal area residents dump the wastes into the sea. In poor neighbourhoods, collected waste is often set on fire. The situation is a major contributor to the city's significant rise of the incidence of vector-propagated diseases (Grogra et al, 2010).

Refuse blocking storm drains can cause flooding and unsanitary conditions such as malaria and other diseases. Flies breed in some constituents of solid wastes, and flies are very effective vectors that spread disease (A.S Mansaray et al, 2018). Mosquitoes breed in blocked drains and in rainwater that is retained in discarded cans, tires, and other objects. Mosquitoes spread disease including malaria and dengue. Rats find shelter and food in waste dumps (UKEssays 2018). Rats spread disease, damage electrical cables and other materials and inflicts unpleasant bites (A.S Mansaray et al, 2018).

Fires set at disposal sites can cause major air pollution, causing illness and reducing visibility, making disposal sites dangerously unstable, and possibly spreading contaminants to adjacent property (C.C. Harilal et al 2007). Aerosols and dusts can spread fungi and pathogens from uncollected and decomposing wastes (OP Gupta 2018). Uncollected waste degrades the urban environment, discouraging efforts to keep streets and open spaces in a clean and attractive condition (H. Nisir et al 2008). Plastic bags are aesthetic nuisance, and they cause the death of grazing animals which eat them. (Gogra et al 2010).

Where special dumps or public "dustbins" or containers (skips included) are provided, garbage is often dumped outside due to lack of capacity, poor collection, and/or public insensitivity. Open Dumps allow free access to waste pickers, animals, and flies; and often produce unpleasant and hazardous smoke from slow-burning fires. (A.B Gogra et al 2010). Garbage can be seen everywhere, scattered, or in small or large piles. Also, in regular household waste

generation, plastics, paper and cartons, tin cans, glass, bottles, and fibre are on increase in selected neighbourhoods. (World Bank Report, Project no. P078389 Dave Sood, 2004).

Most waste dumped in the streets and in the drainage systems all over the city will end up at the Kroo Bay slum, so all causing a health risk and a serious environmental disaster to the inhabitants. Drains along the streets of Freetown, meant to collect rainwater in the rainy season, become clogged with waste and during heavy rainstorms entire areas of the city are flooded (A.B Gogra et al 2010). At the two dumpsites (i.e., Granville Brooke Landfill in the East and Kingtom Landfill in the West of the city) in Freetown, thousands of scavengers make their living from the collection of waste) (A.B Gogra et al 2010). Healthcare waste is also dumped at the dumpsites, mixed with domestic waste, increasing the risk of infection with Hepatitis B and HIV and other diseases (Ndukwe VA et al 2019).

Devastating flash flooding and landslide killed thousands in Freetown in August 2017 (E. O'Donnell 2019). The flooding displaced 5,000 slum dwellers in Freetown alone and caused significant financial losses. Blocked drainage by plastic waste causes water to stagnate and mosquitoes to breed in a region where malaria is endemic. In times of floods, water contaminated by mud and waste is washed into open drinking water wells and can lead to disease like cholera. In 2012, 12 districts in Sierra Leone suffered the worst cholera outbreak in 15 years, reporting more than 19,000 cases and 274 deaths. Slum communities in Freetown city was the most affected, reporting more than 50% of total cases. (UNDP 2018).

2.0 LITERATURE REVIEW

Solid waste may be defined as all discarded solid materials resulting from households, industrial, healthcare, constructional, agricultural, commercial, and institutional sources (A.K Ziraba 2016). Solid waste generated in a city is often referred to as municipal solid waste. Solid or municipal solid waste management refers to the planning, financing, and implementation of programs for solid waste collection, transportation, treatment, and final disposal in an environmentally and socially acceptable manner (UNEP 2009).

Solid Waste Management Practices

Solid waste management practices greatly vary across regions, countries and even within country. Modern waste management approaches encourage reduced waste generation, re-use, recycling, composting, and safe disposal through landfills, however, these are often not practiced. In developing countries, a large proportion of waste is not re-used. Waste sorting is also rare and therefore this makes it difficult to re-cycle or compost. As a result, a large proportion of solid waste in developing countries is disposed of on open dump sites and many times burnt. Collection is often from source or temporary dumping ground, and final disposal is often at an open dumping site on the outskirts of the city. Dumping sites are often sprawling open grounds where truckloads deposit the waste. Dumped waste is often scavenged for usable articles, recyclable materials and many times burnt to reduce the bulk (A.K Ziraba 2016).

Waste Classification

Municipal solid waste is often categorized into two major groups: organic and inorganic. The organic municipal solid waste can further be divided into three categories: putrescible, fermentable, and non-fermentable. Putrescible wastes include products such as foodstuff that decompose fast. Inorganic solid waste includes articles like metals, plastics, and other non-biodegradable materials. In terms of toxicity, some solid wastes are classified as hazardous including pesticides, medical waste, electrical waste, herbicides, fertilizers, and paints and are

recommended to be disposed of in special ways and not to be mixed with general municipal waste (A.K Ziraba 2016).

Municipal Solid Waste Categories

MSW generally consists of organic waste, paper, plastics, glass, metal, textiles, leather, and other inert materials. In industrialized countries, domestic waste consists mainly of packaging materials, such as paper and plastics, whereas waste from low and middle-income countries contains high biodegradable organic waste fractions. (Eawag/Sandec 2008).

Theory and Conceptual Framework

This study was guided by the theory of Waste Management which emphasizes the prevention of wastes causing harm to human health and the environment and highlights the importance of defining waste accurately to construct a sustainable waste management agenda. It is based on the expectation that waste management is to prevent waste causing harm to human health and the environment. There is a strong correlation between poor solid waste management and adverse health outcomes of a population.

This paper presents a framework to aid understanding the interlinkages between poor solid waste management and health and gives the rationale for maintaining proper solid waste management as an investment in preventing ill-health and promoting wellbeing. Finally, a discussion and interrogation of the interlinkages and pathways between solid waste and the ill-health and how these can be exploited for implementation of cost-effective interventions is provided. The literature supporting the framework is summarized in two major categories: exposure to solid waste and the mechanism that bring about adverse health outcomes; and adverse health impacts.

Exposure to Solid Wastes

Exposure to solid wastes may take the form of bodily contact, penetrating injuries, inhalation, or ingestion. Exposure to solid waste is a function of how much solid waste is generated, how it is collected, transported, and the proportion disposed of safely (Hoornweg D, Bhada-Tata P, 2012). At a higher level, risk of exposure to solid waste is influenced by presence or absence of good policies and allocation of financial resources to manage it. Categories of people exposed to solid waste range from those who generate the waste, those who collect waste it, such as the municipal workers, those who pick waste for a living and those living or working near disposal site such as landfills or dump sites and incinerators. (Hoornweg D, Bhada-Tata P, 2012).

Health Impacts of Exposure to Solid Waste

For ease of understanding, health impacts of exposure to solid waste have been conceptually categorized into four:

(i) Infection transmission: This could be bacterial, viral, and other disease-causing organisms.
(ii) Physical bodily injury: These may include cuts, drowning, blunt trauma, and chemical or radiation injury. This may range from immediate skin or inhalation burns, to longer terms effects.
(iii) Non-communicable diseases- long term exposure may lead to cellular damage and development of cancer while other might result in bodily organ injury and damage.
(iv) Emotional/psychological effects (strong smells, unsightly waste as human body parts).

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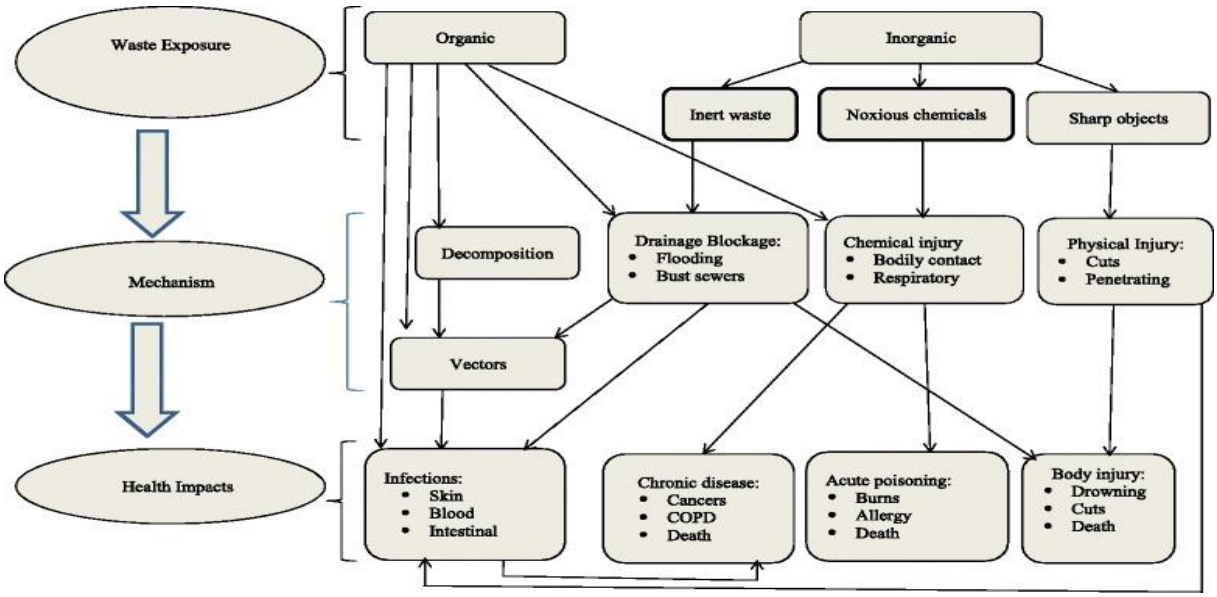

Figure 1: Showing Linkages between Poor Solid Waste Management and Adverse Health Effects

One type of solid waste may lead to more than one health outcome directly or through an intermediate mechanism for example through vectors and other individual level predisposing factors (A.K Ziraba 2016).

Study Review

With regards to a similar study done in Uganda titled "Practices, Concerns, and Willingness to Participate in Solid Waste Management in Two Urban Slums in Central Uganda" by Trasias Mukama et al in 2016, slum residents are concerned about the presence of vectors such as mosquitos, rats etc and diseases related to improper use and disposal of waste. They are not so much concerned about the presence of wastes in their immediate environment. In the same study, residents would like to live in a clean and healthy environment if the awareness, knowledge, resources, and services are available or provided. They had a positive attitude towards improving solid waste practices in their communities. Most (90%) said that, as community members, they played an important role in solid waste management in their areas. The same study shows that a high number of respondents were willing to participate in proposed solid waste management initiatives. Willingness for separation of solid wastes was 93%. Also, food wastes and plastics remains are the major categories of household generated wastes. Polythene bags is the most form of storage used.

In a related study done in South India titled "Solid Waste Disposal practices in an Urban Slum Area of South India" by Abhay Nirgude in 2014, the lack of dust bins, low knowledge about waste segregation hence low segregation practice and the low practice of reuse and recycling of household wastes are major factors in determining the poor state of waste management system in slum areas. Results shows that lack of resources like adequate funding, trained, qualified and competent waste management staff, equipment like municipal vans and the lack of knowledge with regards to solid waste segregation accounted for the major factors in slum communities. The most common problems for waste disposal reported were non – availability of dust bins and lack of municipal vans for regular collection of solid wastes. In Ghana by Emmanuel Aggrey-Korsah and Joseph Oppong in 2013. Slums are known incubators of disease because slum wastes mismanagements facilitate the spread of communicable and

pathogenic diseases such as cholera, diarrhoea, typhoid fever, malaria, tuberculosis, and polio. Poor environmental sanitation conditions will give rise to the breeding of vectors.

Gaps

As none of the above studies was conducted in Sierra Leone, a similar study to assess the state of solid waste management and its challenges to the health and safety of slum dwellers is required. The study that was conducted in Uganda relied heavily on responses provided by household members and did not directly observe the waste management practices. There is thus a chance that they gave socially desirable responses in some instances. Also, a project focusing on improving water, sanitation, and hygiene was being implemented in the two slums during the research, although this was in its early stages of implementation. The same study was carried out in urban slums and results might not be generalized for slums in smaller towns. Hence other studies should be conducted for slums in different contexts, particularly in developing countries such as Sierra Leone. Despite these challenges of slums, our understanding of the spatial dynamics underlying urban slum health is severely limited. In Africa, slum health studies have focused primarily on few countries such as Uganda, Nigeria, Ghana and Kenya to the neglect of other countries. Thus, very little is known of the health conditions of slum dwellers in other countries in Africa. Moreover, the few studies conducted in the urban slums of Africa, especially in Nima-Maamobi Ghana, have not addressed the associated health issues but have often focused on the social and economic vulnerability (Weeks et al 2001, Arku et al 2011). Thus, this research seeks to shed some light on the slum health situation in Sierra Leone.

3.0 MATERIALS AND METHODS

This chapter explains in detail the methodology, the approach and strategy adopted. Furthermore, this chapter describes the sample population and how the primary and secondary data collected are processed into meaningful results. This chapter further explains the data collection tools used and highlights the validity, authenticity, and reliability of the data collected.

General Methods

This study was generally carried out in three selected slums in Freetown of Sierra Leone. Namely, the Kroo Bay slum, the Grey Bush slum and the Mabela Wharf slum respectively. This study was a cross-sectional study design.

Specific Methods

The specific method employed in this study included a designed and structured questionnaire targeting households at the three selected slum communities for the study. Related and relevant pieces of literature were also consulted during this study to come up with a comprehensive Literature Review for the work.

Study Area

The study was conducted in three urban slums (the Kroo Bay, Grey Bush and Mabela) in the western, central, and eastern parts of Freetown, the capital city of Sierra Leone. These slums are congested and unplanned, characterized by poor access to social amenities and poor solid waste management practices, and inhabited by people of low socioeconomic status. The areas are primarily residential with a few dwellers operating small scale trading businesses.

The Study Design and Population

The study was primarily cross-sectional and involved the use of quantitative data collection methods. The study population is comprised of 400 household heads ove18 years of age in the three slums with more than six months of residence being the respondents. A semi-structured questionnaire was used which assessed the factors, effects and challenges posed by poor SWM in slum areas in Freetown. For secondary data collection, existing documents on Freetown solid waste management obtained from government sources were reviewed.

Data Collection and Sampling

A study questionnaire was developed in English. The questionnaire was used to collect data on social demographic characteristics such as age, education level, marital status etc. and to assess the factors, effects of poor SWM and the challenges faced by authorities in providing adequate waste management services in slum areas. Sampling method was used to select households that participated in the study. The questionnaire was administered to one respondent from each selected household. A total of 400 households were targeted. The sampling technique used for determining the sample size for the study was based on the following formula:

$N= (Z^2 \times p\ (1-p))/m^2 = (1.96)^2 \times 0.5(1-0.5)/\ (0.05)^2 = 384.$

The sample size was then increased to 400 for convenience and was proportionately distributed among the three selected slums according to their population size based on the National Electoral Commission's (NEC) 2018 Electoral List. Based on the calculation, the three slums in Freetown with electoral populations of 2924, 1989, and 2713 were therefore proportionately allocated samples of 153, 105 and 142 households respectively. A descriptive cross-sectional study was then conducted from 14th May to 20th September 2019.

Data Entry and Analysis

The data collected was presented in tables and statistical analytical techniques or methods such as percentages and graphs were used to analyse the data and to find out the factors, effects and challenges associated with inappropriate solid waste management services in slum areas in Freetown.

4.0 FINDINGS

392 of the 400 households who were selected participated in the study, representing 98% response rate. Majority of respondents (59%) were female while 50% were married. The mean age of respondents was 34years.

Table 1: Slum Respondents

Slum	**Respondents (%)**
Slum 1	136(34.7)
Slum 2	125(31.9)
Slum 3	131(33.4)
Total	**392(98)**

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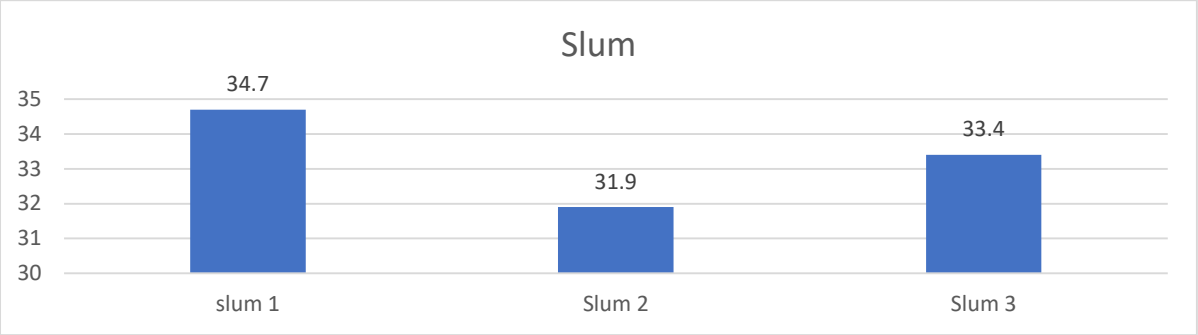


Graph 1: Respondents Distribution in Slums

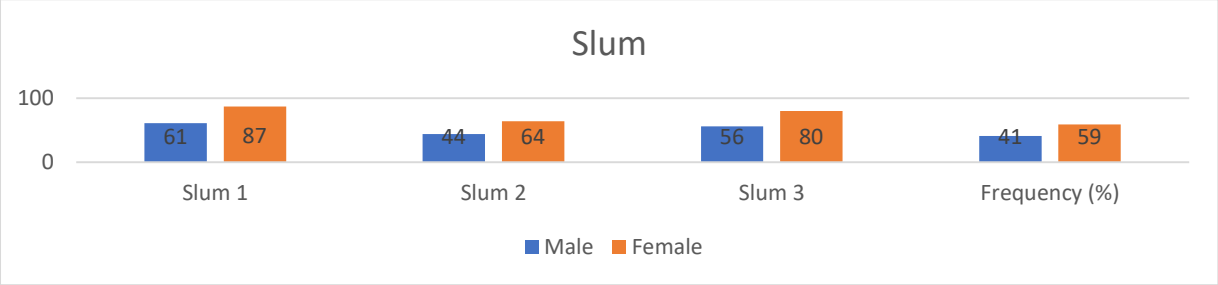
Table 2: Demographic Distribution of Respondents

Characteristics	Category	Total (N =392)/Frequency (%)
1. Sex	Male	161 (41)
	Female	231 (59)
2. Age	18 – 20	52 (13)
	21 – 30	125 (32)
	31 – 40	98 (25)
	41 – 50	78 (20)
	Above 50	39 (10)
3. Marital Status	Married	196 (50)
	Single	179 (45)
	Divorced	20 (5)
4. Household Head	Yes	278 (71)
	No	114 (29)

Table 2 above shows that most of respondents were married (50%) and are household heads (71%)

Table 2: Sex Distribution in Slums

Sex	Slum 1	Slum 2	Slum 3	Frequency (%)
Male	61	44	56	161(41)
Female	87	64	80	231(59)
Total	**148**	**108**	**136**	**392**

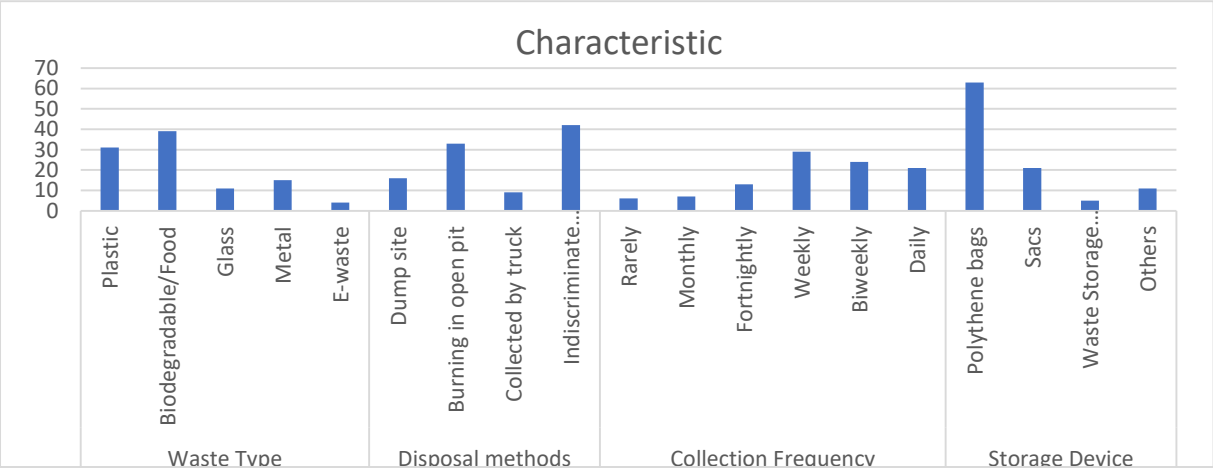


Graph 2: Sex Distribution of Respondents

The graph above shows that majority of the household respondents were female.

Table 3: State of Solid Waste Management in Slums

Characteristic	Category	Frequency (%)
Waste Type.	Plastic	122 (31)
	Biodegradable/Food	153 (39)
	Glass	43 (11)
	Metal	59 (15)
	E-waste	16 (4)
Disposal methods.	Dump site.	63 (16)
	Burning in open pit	129 (33)
	Collected by truck.	35 (9)
	Indiscriminate disposal	165 (42)
Collection Frequency.	Rarely	24 (6)
	Monthly	27 (7)
	Fortnightly	51 (13)
	Weekly	114 (29)
	Biweekly	94 (24)
	Daily	82 (21)
Storage Device.	Polythene bags	247 (63)
	Sacs	82 (21)
	Waste Storage Containers	20 (5)
	Others	43 (11)

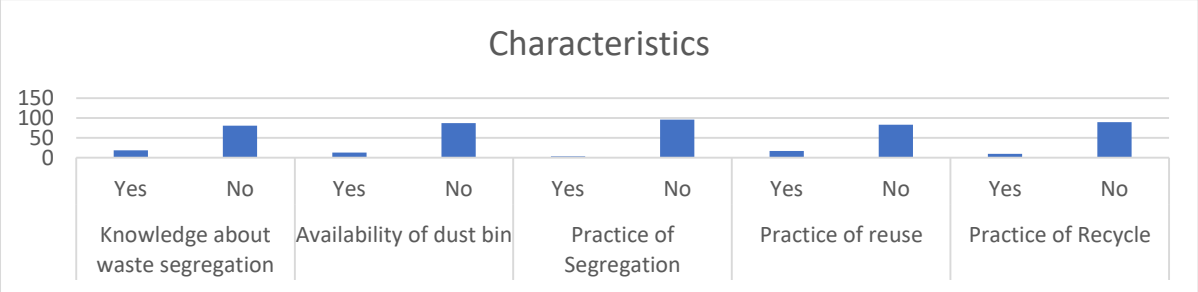


Graph 3: State of Solid Waste Management in Slums

The major categories of waste generated in households were Biodegradable and food (39%) while plastic remains (31%). Most households stored their wastes in polythene bags (59.1%) and sacks (20.2%) before disposal and 10.3% of the households did not have waste storage containers and kept their wastes outside the house in the open. Few respondents (3.4%) reported carrying out some form of waste segregation at the household level. 11% did separate biodegradable wastes, especially food peelings which were mainly collected as animal feed. The most common frequencies of waste collection from households were weekly (29%) and biweekly (24%). 42% disposed of their waste by indiscriminate disposal, 33% burnt it in open pits, 16% at dumping site, while, and 9% had it collected by trucks. This study is in line with a similar study done in Uganda by Trasias Mukama et al in 2016. Food wastes and plastics remains are the major categories of household generated wastes. Polythene bags is the most form of storage used.

Table 4: Knowledge, Segregation Practice, Reuse and Recycling of Solid Waste

Characteristics	Category	Frequency (%)
Knowledge about waste segregation	Yes No	75 (19) 318 (81)
Availability of dust bin	Yes No	51 (13) 341 (87)
Practice of segregation	Yes No	13 (3.4) 379 (96.6)
Practice of reuse	Yes No	67 (17) 325 (83)
Practice of recycle	Yes No	39 (10) 353 (90)

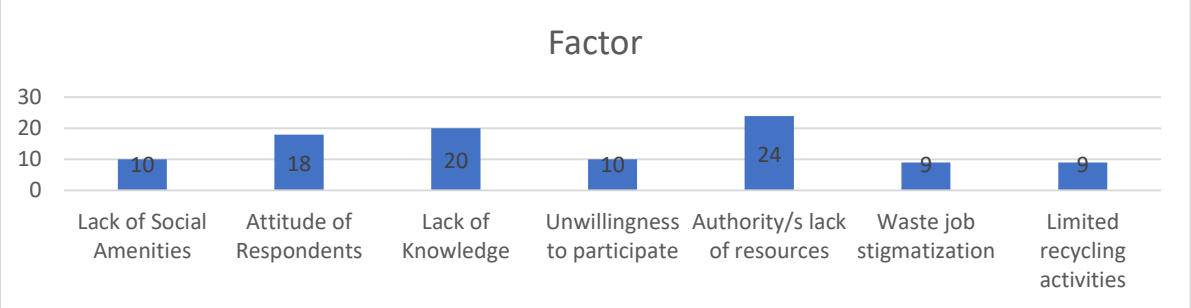


Graph 4: Knowledge, Segregation Practice, Reuse and Recycling of Solid Waste

Dust bin was present in (13%) of households but only (3.4%) were having separate dust bins for dry and wet refuse. Most of respondents i.e. 81% were having no knowledge regarding segregation of solid waste. Only 17% of the respondents had knowledge about reuse and recycle of household waste and 15% practicing it. This result is in line with a similar study done in South India by Abhay Nirgude et al in 2014. The lack of dust bins, low knowledge about waste segregation hence low segregation practice and the low practice of reuse and recycling of household wastes are major factors in determining the poor state of waste management system in slum areas.

Table 5: Factors Responsible for Poor Solid Waste Management in Slums

Factor	Frequency (%)
Lack of Social Amenities	39 (10)
Attitude of Respondents	71 (18)
Lack of Knowledge	78 (20)
Unwillingness to Participate	39 (10)
Authority/S Lack of Resources	94 (24)
Waste Job Stigmatization	35 (9)
Limited Recycling Activities	35 (9)

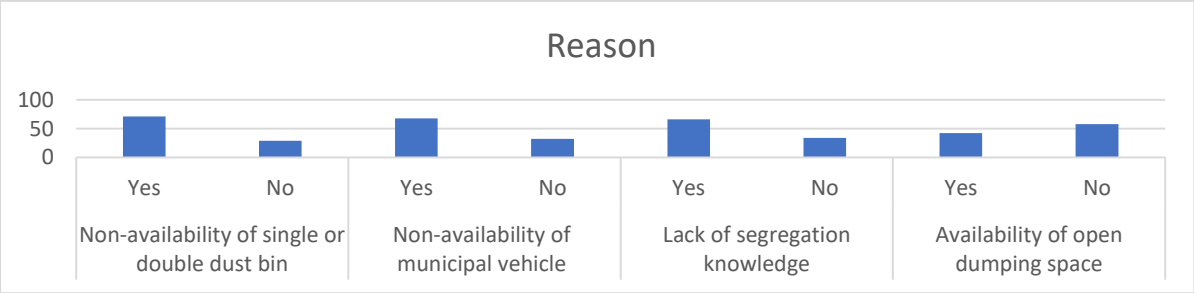


Graph 5: Factors Responsible for Poor SWM in Slums

Lack of resources/Constraints by authorities to provide solid waste management services (24%) and lack of knowledge with regards to solid waste segregation (20%) accounted for the major factors responsible for poor waste management in slum while lack of social amenities such as road network (inaccessibility) (10%) and limited use of recycling activities (9%) were the least factors. This result is in line with a similar study done in South India by Abhay Nirgude et al in 2014. Lack of resources like adequate funding, trained, qualified and competent waste management staff, equipment like municipal vans and the lack of knowledge with regards to solid waste segregation accounted for the major factors in slum communities.

Table 6: Specific Reasons for Improper Solid Waste Disposal

Reason	Category	Frequency (%)
Non-availability of single or double dust bin	Yes No	71 29
Non-availability of municipal vehicle	Yes No	68 32
Lack of segregation knowledge	Yes No	66 34
Availability of open dumping space	Yes No	42 58

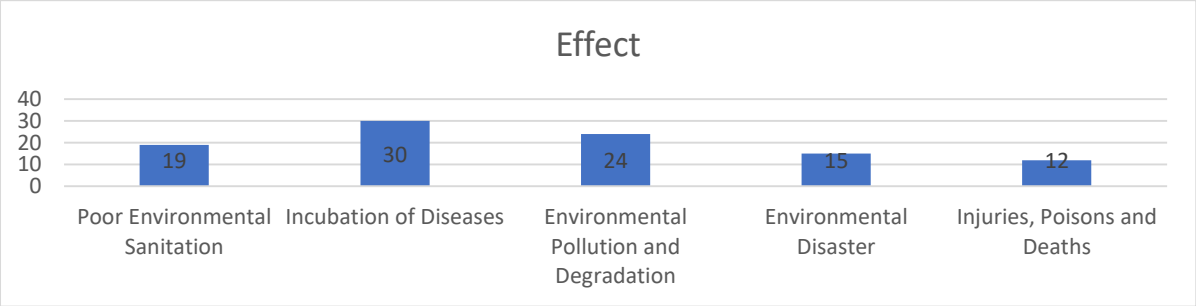


Graph 6: Specific Reasons for Improper Solid Waste Disposal

Dumping the waste outside the house indiscriminately was preferred by majority (42%) of the families. Only 9% of households admitted that municipal vehicle is collecting their solid waste. The most common problems for waste disposal reported were non-availability of dust bin (71%) and municipal van (65%) for regular collection of solid waste. This result is in line with a similar study done in South India by Abhay Nirgude et al in 2014 wherein the most common problems for waste disposal reported were non – availability of dust bins and lack of municipal vans for regular collection of solid wastes.

Table 7: Effects of Improper SWM in Slums

Effect	Frequency N = 392(%)
Poor Environmental Sanitation	18
Incubation of Diseases	28
Environmental Pollution and Degradation	23
Environmental Disaster	14
Psychological/Emotional Impacts	7
Injuries, Poisons and Deaths	10

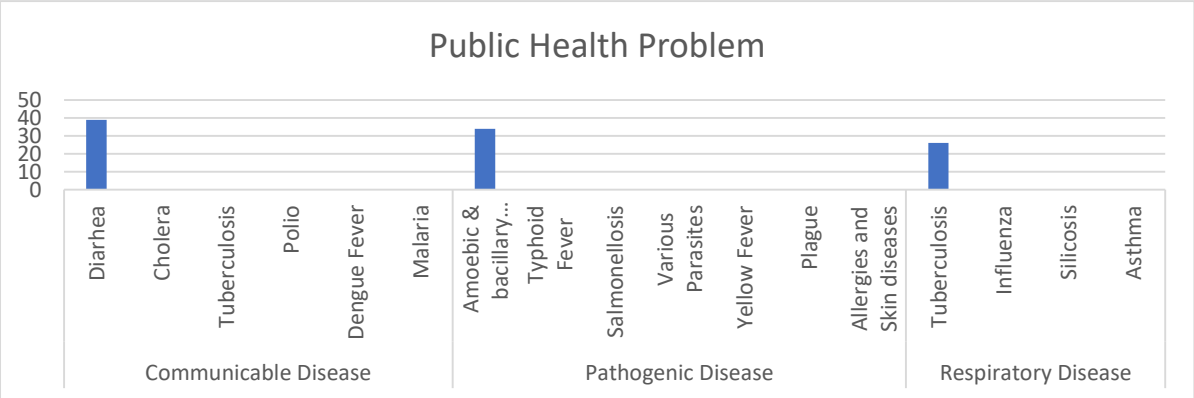


Graph 7: Effects of Improper SWM in Slums

Incubation of diseases (28%) and environmental pollution and degradation (23%) were the major effects identified by respondents while Environmental disasters (1%) and injuries, poisons, and death (12%) were considered the least effects of improper solid waste management systems.

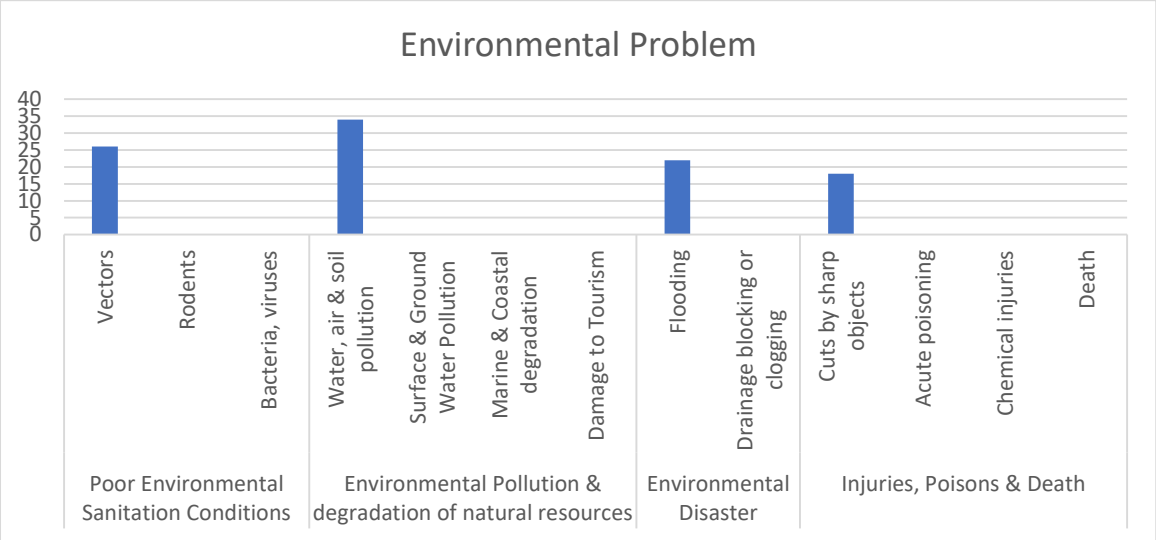
Table 8: Challenges Faced by Authorities in Solving SWM Problems in Slums

Factor	Frequency (%)
Lack of social amenities	12
Attitude of respondents	20
Unwillingness to participate	10
Authority's lack of resources	24
Waste job stigmatization	9
Lack of trained qualified & competent waste personnel	14
Residents' poor knowledge in waste segregation, recycling, and reuse	12



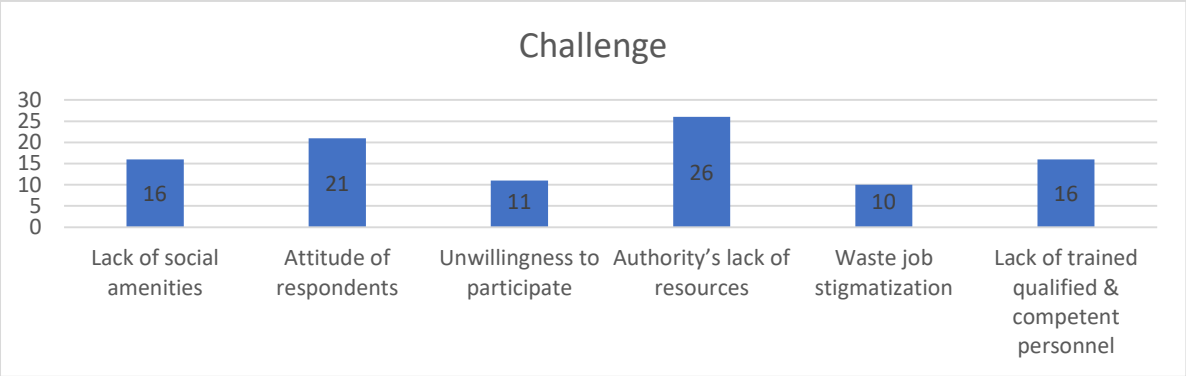
Graph 8: Specific Public Health Problems Identified

The graph above shows that Communicable and Pathogenic diseases are the major public health consequences of inadequate solid waste management systems in slums. This is in line with a related study conducted in Ghana by Emmanuel Aggrey et al 2017 on a topic titled "Assessing the Supply Chain Strategy for Waste Management in Ghana: *a case study of Zoomlion Company Limited – Kumasi*". Slums are known incubators of disease because slum wastes mismanagements facilitate the spread of communicable and pathogenic diseases such as cholera, diarrhoea, typhoid fever, malaria, tuberculosis, and polio.



Graph 9: Specific Environmental Problems Identified

According to the graph above, poor environmental conditions and environmental pollution and degradation are the major consequences of inadequate waste management in slum areas. This is in line with a related study conducted in Ghana by Emmanuel Aggrey-Korsah and Joseph Oppong in 2013. Poor environmental sanitation conditions will give rise to the breeding of vectors, rodents, bacteria, and viruses that will facilitate the incubation of diseases. Environmental pollution will affect the water, air, soil, surface, and ground water environment etc. Hence will affect humans, animals, plants, and the entire environment.



Graph 10: Challenges Faced by Authorities in Solving SWM Problems in Slums

Lack of Resources (26%) and attitude of residents in discriminate solid waste disposal (21%) were considered as the most challenges faced by authorities in providing adequate solid waste management systems in slum communities while the low social status stigmatization associated with waste worker jobs (11%) and unwillingness by slum dwellers to participate in solid waste management initiatives (10%) were the least mentioned.

Discussion

With the rapid urbanization and changing consumption pattern among people living in Freetown, it is obvious that there will be fast increase in the generation of municipal solid waste. In this study, only 19% of the respondents had knowledge about segregation of waste but only 6% reported to have separate dustbins and 3.4% were practicing it. (Gogra et al 2010) in their study reported that 39.8% subjects suggested making separate dustbins available for segregation of waste and proper disposal of household waste. Knowledge (17%) and practice

(10%) about reuse and recycle of the waste were very poor. For minimization of waste and reduction in the demand for landfill, residents need to practice recycling of household wastes and NGOs can play important role in promoting recycling of wastes. In this study only 6% households were disposing their household waste through municipal vehicles. Majority of residents stated that this is because of non-availability of separate dustbins and municipal waste collection vehicles. Some households reported availability of open dumping space and common practice as the reasons for not following scientific methods of waste disposal. This reflects the need to create awareness in the community on the need for segregation, recycling, and proper disposal of solid wastes. Resources like separate dust bins should be provided to the community and regular house to house collection of solid wastes should be done on regular basis to follow the practice of proper solid waste disposal.

Biodegradable wastes such as leftover food formed the bulk of wastes generated in slums in this study. Biodegradable wastes disposed of at open dumping sites are likely to cause nuisances like foul smells and breeding insect vectors and vermin that endanger the health of slum dwellers and the environment (Halage A. et al 2016). According to the study Biodegradable wastes also contributed the largest portion of municipal waste (39%) that is disposed by slum residents. The large proportion of biodegradable wastes provide an opportunity for waste recovery through separation and composting and provides an alternative to reduce waste volumes and stress on waste collection and disposal services (Halage A. et al 2016). Although respondents frequently reused plastics, the many residents finally disposed of them in open dumping sites or burnt them in open pits (33%). Slum residents reused plastics for carrying and covering food, which can increase exposure to phthalates which have been documented to affect the reproductive system, impacting fertility Burning of plastics also has potential to expose residents to chlorinated organic compounds such as dioxins which are carcinogenic and hence should be discouraged (Trasias Mukama et al 2016). Plastics collection and disposal practices observed among slum residents in this study create difficulty for recollection, recycling, and profitable reuse by individuals. Providing incentives for separation and collection of plastics can ease their collection. Only a tiny part of the overall waste is being collected. Just a tiny fraction of the collected waste is being treated. Then a tiny fraction of the treated waste is properly disposed of.

According to the study, poor solid waste collection and disposal practices and limited mitigation against known risks are observed. Handlers of medical wastes can benefit from consistent use of personal protective equipment, and vaccination against the certain infection such as hepatitis B virus. These can be ensured through legislation enforcement, health education to all those involved in the solid waste management chain, and provision of vaccinations to those at risk and provision of treatment to those already affected (A.K Ziraba 2016). Constraints by Solid wastes management department such as non-availability of dust bins (71%), irregular visits of municipal vans for household waste collection (68%) and lack of knowledge regarding importance of segregation of waste (66%) were observed to be the principal problems in the practice of solid waste disposal by slum households. A limitation of this study is that it relied on responses provided by household members and did not directly observe the waste management practices. There is thus a chance that they gave socially desirable responses in some instances. Secondly, this study was carried out in three slums in Freetown and results might not be generalized for slums in smaller towns in Sierra Leone. Hence, other studies should be conducted for slums in different contexts, particularly in other regions in the country.

5.0 CONCLUSION AND RECOMMENDATIONS

From the study, there is a strong correlation between poor solid waste management and adverse health outcomes. A broad spectrum of groups of individuals such as slum dwellers, waste workers, children etc. are at risk of ill-health emanating from poor solid waste management. As the volume of waste generated increases with urbanization and industrialization, so does the complexity and content of the waste. The existing policies are not encompassing enough, and their implementation is far from addressing the challenge interventions aimed at protecting workers including use of personal protective wear and the public are not fully implemented and this leaves many at-high-risk populations not protected.

Solid waste management practices such as storage and disposal practices in the slum were unsatisfactory, and separation and composting were minimally practiced. Slum residents' practices, concerns, and attitudes indicated lack of enough knowledge about good waste practices, their responsibilities, and consequences of poor waste management. However, slum residents had high willingness to participate in waste separation and composting. Therefore, there is a need for concerned authorities to engage residents of urban slums to improve their practices in solid waste management such as waste separation and disposal.

Due to weak implementation, existing policies and interventions, surveillance is almost non-existent. Existing research is also limited particularly in assessing exposure risk and health outcomes. Recognizing the extent of the challenge, and acknowledging the limited resources, there is need to engage strategically at various levels to generate evidence that will help highlight the problem and feed into advocacy plans for sensitization of the public, public health officials, employers, and all those at heightened risk of ill-health from solid waste. This framework can be used as an advocacy tool to demand for sensitization at all levels including policy, researchers, employers, waste handlers and the public. This is important because the effects are not limited to those handling, picking, or living near disposal sites. It is a health challenge for the public and requires a well-grounded approach to ensure that all waste is managed and disposed of in a safe manner. Based on the foregoing discussion, the following recommendations are proposed:

- The findings of this study have provided significant empirical data and information on the state of solid waste management in slums which will further justify that the problem is real.
- As a research, it has provided literature review for further research or academic work on solid waste management systems in Sierra Leone.
- It helps to address the issue of scanty information or documents on solid waste management in Sierra Leone.
- The findings are expected to help the Ministry of Health and Sanitation, the Ministry of Country Planning Lands and the Environment, The Environment Protection Agency, The Freetown City Council, NGOs, and other state and private stakeholders in understanding, the state of waste management in slum communities in Freetown, hence help them develop intervention strategies.

It has provided recommendations listed below to address the issue of waste management in slums and other similar settings in large cities in Sierra Leone.

(i) Waste management should be prioritized as a social service, with adequate budget lines. It is important to note that allocating money to waste management will not translate

into better results unless there is adequate sensitization, good fiduciary practices and accountability.

(ii) Engage several stakeholders in the management of waste to generate a sense of responsibility and interest from all stakeholders.

(iii) Individuals involved in waste management should always wear recommended protective gears. This is partly the responsibility of employers, but employees also need to be sensitized on the need to adhere to safety precautions.

(iv) Public education on individual citizen's role in ensuring that waste is appropriately managed. Simple actions such as no littering on the road, can go a long way in ensuring a cleaner environment. Gradual introduction of more concrete actions such as waste sorting at point of generation will go a long way in improving solid waste management.

(v) Moving from policy to comprehensive implementation plan drawing on success stories from other countries. A starting point is to characterize waste, adapt good waste management practices, and promote use of technology in activities such as energy generation from waste.

(vi) Waste is not useless or rubbish! It should be treated as a resource. The culture of recycling should be encouraged. Recycling can help in reducing volume of waste and reduce need for exploitation of raw materials. For example, the growing demand of plastics means more petroleum is needed which comes with a cost but also impact on the environment.

(vii) Waste reduction and other waste recovery options like waste for fuel should be encouraged for biodegradable waste.

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