Understanding Solid Waste Collectors' Awareness of Occupational Hazards and Personal Protective Equipment Practices in Northern Malawi

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ABSTRACT: The purpose of this study was to evaluate Solid Waste Collectors' (SWCs) knowledge of occupational hazards, their views on personal protective equipment (PPE), strategies for PPE use, and challenges in managing occupational risks. Previous studies have highlighted the importance of protective measures in addressing occupational hazards, but there was a need for further research to assess the knowledge levels of waste collectors regarding these hazards and PPE practices. This study used a qualitative research technique, specifically a phenomenological research design, to capture the lived experiences of SWCs. Focus group discussions and in-depth interviews were employed to gather data. Subgroups of topics were created by coding the data using a predefined codebook as part of the content analysis process. The findings revealed that SWCs are aware of the risks they face in their work environments. These risks range from longterm health issues caused by repeated exposure to harmful substances and injuries from sharp objects. However, a significant issue identified was the lack of accessibility and availability of PPE, which exposes waste collectors to various diseases and accidents and forces them to work without necessary safeguards. Efforts to increase PPE availability through public-private partnerships (PPPs) should be promoted. The city council should provide regular on-the-job training on health risks, occupational hazards related to waste collection, and PPE usage. Additionally, efficient channels for SWCs to report problems should be established to ensure their grievances are properly addressed.

KEYWORDS: Personal protective equipment, public health, occupational hazards, solid waste

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Introduction

The World Health Organization (WHO) and environmental agencies worldwide, including the Environmental Protection Agency (EPA) in the US, recognize the potential for solid waste to pose a serious threat to public health and the environment.[1] Nowadays, the growing production of solid waste is a result of industrialization, urbanization, and population explosion, which has detrimental effects on the environment and the socioeconomic sector.[2] As a result, over 11.2 billion tons of waste are produced annually worldwide, with 1.3 kg of waste produced per person. This amount is expected to increase to 3.402 billion tons in 2050, a 70% increase.[3] Regrettably, at least 33% of this enormous amount of solid waste is currently mismanaged worldwide, either by burning, open dumping, or other means.[4] At least 2 billion people, according to the Global Waste Management Outlook, lack access to regular waste collection, putting them at risk for health problems. Studies conducted in Denmark have revealed that SWCs in the regulated waste management sector had a 5.6 times higher risk of work-related accidents and a 1.5 times higher risk of developing an occupational disease related to waste than the national average.[5]

As urban areas continue to expand, waste production increases rapidly, even outpacing the rate of urbanization. It is estimated that global solid waste reached 2.24 billion tons in 2020, with projections suggesting this will rise to 3.88 billion tons by 2050.[6] In 1965, daily global waste generation was 635 metric tons, and it is anticipated to grow to 3539 metric tons by 2050.[7] This surge in waste generation is creating significant environmental and public health challenges worldwide. If current waste production and pollution levels persist, achieving Sustainable Development Goal (SDG 3) target 9—which aims to greatly reduce deaths and illnesses caused by hazardous chemicals and pollution of air, water, and soil by 2030—could be in jeopardy.

According to Lavagnolo and Grossule,[8] Africa produces 125 million tons of waste annually, and by 2025, this amount is expected to double. In Ghana, enormous amounts of waste are produced every day, but neither the waste collection nor the disposal of the waste are done properly.[9] As a result of leachate pollution, bad odors, fly breeding, smoke and visual nuisances, and other issues related to waste disposal, residents in the vicinity of dumpsites are unwilling to accept waste dumpsites close to their backyards.[10] Increased urbanization and population growth are major contributors to the massive amounts of waste generated in cities, overwhelming the city authorities tasked with handling the waste.[11]

Correction (December 2024): The article has been updated with some textual changes.

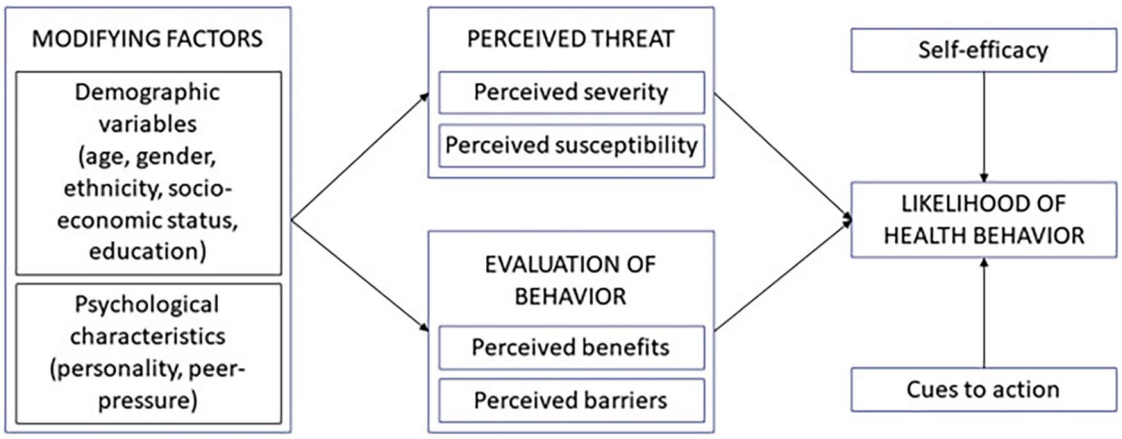

Figure 1. Health belief model.

Malawi, being a developing country, is confronted by significant environmental and health issues related to the production, movement, and elimination of waste. The City Council is in-charge of collecting, transporting, and disposing of municipal solid waste (MSW) at locations that have been approved.[12] Most city councils, according to Kasinja and Tilley,[13] only gather little amounts of solid waste and do not treat it, which contaminates the air, water, and land. However, poor solid waste management leads to serious problems like high rates of urban morbidity and mortality.[14]

Every step of the process; collection, transportation, and disposal of solid waste; carries some inherent risks and hazards. According to Kamanga et al,[15] Mzuzu city is one of the cities that has shown commitment to improving systems of waste management. One commitment is identification of risky areas along the waste management processes. It is critical to identify and manage these risks in order to enhance the overall working conditions for Solid Waste Collectors (SWCs) in terms of health and safety.[16] SWCs are responsible for gathering waste from its original storage location, loading, unloading, and transferring waste throughout the entire transportation process until it reaches its destination. Street sweeping and open storm drain cleaning are 2 of the routines.[17] Because of the materials they handle, the products' emissions, and the equipment they use, SWCs are susceptible to risks related to occupational health and accidents. They run the risk of getting hurt physically handling heavy waste and of being exposed to toxins.[18,19]

While previous studies have focused on Mzuzu's poor solid waste management[20] and[21] limited research has been conducted to assess the understanding of occupational hazards among solid waste collectors and utilization of PPE as a protective measure in Mzuzu City. This knowledge gap necessitates a study to examine the knowledge levels of solid waste collectors regarding occupational hazards associated with solid waste and their utilization of PPE, ultimately aiming to enhance their safety and well-being. Hence the study.

The aim of this study was to describe the depth of knowledge among SWCs concerning occupational hazards; explore the attitudes of SWCs regarding their utilization of PPE; analyze the practices SWCs employ in integrating PPE into their daily work routines; and assess the challenges encountered by SWCs in their work concerning occupational hazards and utilization of PPE.

The study therefore makes 3 significant contributions to the literature in the following ways. Firstly, this study adds to the body of knowledge by illuminating the notable discrepancy between the requirement and actual availability of personal protective equipment (PPE) for Mzuzu City's solid waste collectors (SWCs). Secondly, the study sheds light on the unique occupational risks that SWCs encounter, such as sharp items and dangerous compounds, and offers important insights into the health and safety issues that are present in the waste collecting process. Thirdly, the study presents a comprehensive viewpoint on SWCs' attitudes toward PPE, emphasizing both advantages and disadvantages. Malawi, like many developing countries, faces significant public health challenges related to waste management. SWCs are at the frontline of waste disposal, often exposed to hazardous materials that can lead to serious health issues. Understanding their knowledge of occupational hazards is crucial for developing effective health interventions and training programs. This study is therefore essential for understanding and improving the occupational safety of Solid Waste Collectors in Malawi. It addresses critical gaps in knowledge and practice, with the potential for far-reaching benefits for the workers, the community, and the environment.

Methodology

Theoretical framework

Health belief model. Research has shown that applying health behavior theories to the prevention of illnesses and injuries is one of the greatest ways to enhance health outcomes.[22] The Health Belief Model (HBM), an offshoot of Value Expectancy Theory, was used in this study. The HBM theoretical framework has been utilized in a number of research on health behavior to predict and explain the factors influencing people's actions

linked to their health.[23] As illustrated in Figure 1, perceived obstacles, perceived incentives, perceived severity, and perceived susceptibility are the 4 primary components of the HBM.

Perceived susceptibility refers to the notion that an individual is at risk of encountering a health problem in this case, occupational risks faced by SWCs. Perceived severity represents the belief that a health problem is significant and could have negative consequences. Perceived benefit is the belief that taking a specific action, such as wearing personal protective equipment (PPE), can reduce the risk of developing a health problem. Perceived barriers are the obstacles individuals feel hinder them from adopting certain health behaviors, such as wearing PPE.[24] The framework of this study, the Health Belief Model (HBM), can be used to explain factors influencing SWCs' Knowledge, attitudes, and behaviors regarding occupational risks and PPE use.[25] For instance, perceived severity and susceptibility may affect SWCs' assessment of the risks associated with contracting occupational illnesses.[26]

The HBM may also serve as a guide for designing interventions to encourage SWCs to use PPE.[27] For example, interventions could aim to increase SWCs' awareness of the seriousness and susceptibility to occupational hazards while reducing perceived barriers to adopting PPE. These interventions may be informed by the study's findings, which could provide insights into the specific factors influencing SWCs' knowledge, attitudes, and behaviors toward occupational risks and PPE use. Proposed interventions to address the problem include providing PPE training to reduce perceived barriers.[28]

Numerous studies on PPE compliance have concluded that the HBM is a valuable theoretical framework for PPE compliance research, as the constructs of the model predict specific behaviors and attitudes that influence PPE use.[29] The theoretical framework provided by the HBM served as the basis for this research on SWCs' knowledge of occupational hazards and PPE use in Mzuzu. In addition to offering a useful framework for examining the factors influencing SWCs' acceptance and long-term use of PPE, the HBM may also inform the development of interventions aimed at promoting PPE use in solid waste management.

Research design

This study employed a qualitative research approach, specifically using a phenomenological research design. Qualitative research is known for its inductive process, gathers data within a specific field to help the researcher develop relevant concepts from the collected information. The selected phenomenological design in this qualitative framework investigated the personal experiences, knowledge, attitudes, and practices of solid waste collectors concerning occupational hazards and safety practices. Through this approach, the study delved deeply into participants' experiences, providing a thorough understanding of their perspectives and insights.

Study setting

The study was carried out at Mzuzu city main market which is one of the big markets under MZCC. Mzuzu is the major city in the northern region of Malawi with a population of 221 272 people based on the 2018 population census in Malawi.[12] This study setting was chosen because Mzuzu City's main market is a significant site for solid waste management, including waste collection. Thus, the study directly examined the experiences, knowledge, practices and challenges faced by solid waste collectors who are involved in daily waste collection activities within a bustling market environment. The coordinates of Mzuzu Markets are Latitude: −11.4656, Longitude 34.0207.

Sampling techniques

A purposive sampling method was employed to select participants who have relevant knowledge and experiences about solid waste generation and collection in Mzuzu with respect to occupational hazards and the use of PPE. This approach was chosen because the study aimed to gather in-depth insights from solid waste collectors who had direct experience in the subject matter. Although purposive sampling can be biased, it is appropriate in situation where focus is on obtaining detailed perspective from a particular group.[16]

The first step in purposive sampling was to identify key characteristics that were relevant to the research objective. The Second step was defining to define and set specific criteria to guide the selection process. These criteria helped ensure that the chosen participants had the necessary experiences and perspectives to contribute meaningfully to the study. Based on the established criteria, solid waste collectors who fulfilled these criteria were purposefully selected to participate in the study. On recruitment: it involved sending a permission letter to the MZCC and approaching solid waste collectors individually at their workplace. The letter sought official permission and support from the council, while the individual approaches aimed at explaining the study's objectives and invite voluntary participation.

Sample size

The sample size for this study was determined using the data saturation approach. A minimum sample size of 12 solid waste collectors was initially established, with the idea that data saturation would be the guiding element. Data saturation occurs when fresh information or themes stop emerging from the collected data, it indicates that a full comprehension of the topic has been obtained. This study eventually interviewed 15 solid waste collectors, which is parallel with previous qualitative studies in a similar context.[30,31] The decision to interview 15 participants ensured a varied representation in terms of gender, age, and years of experience, ensuring a well-rounded analysis of solid waste collectors' experiences and viewpoints in the study area. The study also interviewed 2 MZCC officers to acquire in-depth and comprehensive data, to enrich the findings.

Data collection methods and instruments

Data was collected through the use of in-depth interview (IDI) and focus group discussion (FGD). Solid waste collectors and MZCC officers were interviewed through the use of in-depth interview (IDI) and focus group discussion (FGD) guides.

The average length of an IDI was 25 minutes, compared to 60 minutes for FGDs. They were designed with semi-structured interview guidelines and FGD tools. An interview guide was developed, utilizing the study goals. Because the interviews are semi-structured, participants were free to elaborate on their opinions, firsthand knowledge, and other ideas about using personal protective equipment (PPE) and occupational dangers. Solid waste collectors were interviewed in Tumbuka and Chichewa languages which are local languages commonly spoken in Mzuzu city. This was impotant for successful communication between the interviewer and the interviewee.

Furthermore, 2 focus group discussions (FGDs) with 5 female participants and 5 male participants were conducted. Participants were invited to share their experiences and opinions on the topic through targeted focus group discussions. In addition 2 IDIs on MZCC staff were conducted. Interviews went on till the data reached saturation point. The researchers documented observations on the kind of solid waste created, the collection method, and the use of personal protective equipment by visiting the dumping site and other collecting sites, taking field notes, and taking images.

Data management and analysis

Data management. The first step following data collection was transcribing the collected data. Written text was created by transcribing audio recordings. After transcription, a thorough and methodical analysis was performed on the transcribed data to ensure its thoroughness. Repeatedly listening to and reading the transcribed interviews allowed for a deep understanding of the interviewees' perspectives and allowed for a thorough analysis. Coding involved methodically labeling data parts with keywords in order to categorize and organize content. This methodical approach made it possible to identify recurring ideas, themes, and patterns in the dataset. Every data point (e.g. phrases or paragraphs) was given a special code.

The coded data was processed and examined manually. This involved grouping related codes into more general themes and examining the relationships between these themes. The context and underlying meanings of the participants' responses were examined during the interpretive stage. Through constant comparison and reflection, the reliability and validity of the interpretations were guaranteed.

Data analysis. We selected the data units that were amenable to analysis in order to facilitate further organization. For ease of retrieval, all data, including field notes, were arranged using the date, time, and pseudonyms. The reading and reflecting process also enabled the us to become fully immersed in the data, comprehend the participant's perspective, and select an analytical framework for additional analysis. The data coding phase, entailed organizing and classifying data in order to comprehend the phenomenon. The codes served were labels for various phrases and expressions. "Open coding" was then done, in which interpretive code was created by going line by line through the initial data.

Every code's definition and set of requirements was documented in a comprehensive codebook. This codebook served as a reference, ensuring uniformity and standardization throughout the analysis procedure. To identify themes and patterns, the code tree arranged qualitative data on SWCs' knowledge, attitudes, practices, and challenges regarding occupational hazards and PPE use. Each level reflects a more particular aspect of the main themes and offers a thorough evaluation of SWCs knowledge, attitudes, practices, and difficulties related to occupational hazards and the use of personal protective equipment. The developed codes were applied systematically throughout the coding process, segmenting and classifying the data in accordance with the themes that were identified. This process involved assigning pertinent codes to specific data extracts or segments.

After the coding was completed, similar codes were connected to create larger themes. These themes provided a summary of the primary topics discussed with the participants. Subthemes and patterns arose from a methodical code comparison and continuous environmental reflection, offering a more profound understanding of the experiences and viewpoints of the participants. As part of the content analysis procedure, the frequency and prominence of different codes and themes within the dataset were also looked at. Finally, data verification was done to confirm the analysis's dependability and accuracy. This meant reviewing the transcripts and codes once more, comparing the interpretations, and confirming the results. The process offered the opportunity to validate or modify previously proposed themes, strengthening the validity of the study's findings.

Ethical clearance

This study underwent the ethical clearance process through the University of Livingstonia Research Ethics Committee (UNILIA-REC), which granted written permission for the data collection with approval number of UNILIA-REC/PGS/09/2023. Additionally, informed consent was obtained from all participants prior to the commencement of data collection. A consent form confirming their complete involvement in the study was sent to the participants to confirm and sign for their involvement in the study. Following a thorough explanation of the study's objectives, advantages, and risks, the respondents were asked if they could be willing to take part. This was done in advance of their involvement in the study to make sure that everyone who responded understood the goal of

the research so that they could decide whether or not to participate. Participants were free to leave the research at any moment without facing any prejudice or other consequences if they felt uncomfortable answering certain questions.

Results

Research themes

The study was divided into 3 themes. These included:

1. Knowledge of occupation hazards
2. Attitudes and practices regarding utilization of Personal Protective Equipments
3. Challenges faced by SWCs about occupation hazards

Knowledge among SCWs concerning occupational hazards

It was evident from the responses that the respondents were well aware of the risks associated with their jobs. The individuals expressed recognition of often coming across diverse hazards, especially with hazardous job settings. Stumbling across glass bottles or other sharp items, which may cause wounds and infections, was one of the most often mentioned dangers. The participants also highlighted the inadequacy of protective gear, specifically mentioning that their footwear did not provide sufficient protection against these hazards. Additionally, many respondents expressed concern over the presence of sharp nails commonly found in waste heaps, which pose a significant risk of injury. The vulnerability of thin or worn-out boots to nail penetration was a particular concern, as this could lead to wounds and infections. The participants recognized that the poor quality of their personal protective equipment (PPE) exacerbated their exposure to these dangers, further increasing the risks in their work environment.

A 42-year-old respondent, IDI

> *Yes, we do face a lot of occupational hazards, we get hurt by stepping on glass bottles of alcohol, nails sometimes because the boots we wear are not of good quality*

Every participant acknowledged that not having the necessary personal protective equipment (PPE), especially gloves, contributes significantly to the occupational dangers they confront. The lack of this essential safety equipment exposes them to the numerous health hazards that come with handling trash with just their hands. A significant number of participants said that they frequently come into touch with sharp items, toxic chemicals, and unhygienic materials while carrying out their job responsibilities, hence raising the risk of accidents and infections.

Additional dangers associated with handling waste without gloves include the potential exposure to biological pollutants, such as bacteria, viruses, and other pathogens that may be present in organic waste that is decaying. Additionally, it was noted that there is cause for worry regarding bare-handed contact with potentially harmful materials such as industrial chemicals or cleaning agents contained in the waste stream, since this might result in burns, skin irritation, or long-term health problems.

The participants stressed how their hands are always vulnerable to cuts, abrasions, and other ailments when they are not wearing the correct gloves. If left untreated or exposed to unhygienic surroundings, these little wounds might worsen and become more serious infections, endangering their health even more.

A 30-year-old man in an IDI said,

> "We know of the dangers we face every day, especially when handling waste without proper protection. We know that without gloves, our hands are exposed to hazardous materials that can cause infections or injuries, but we often don't receive them.

A 45-year-old woman, in an IDI

> "We are well aware that without PPEs like masks, gloves, and boots, we are exposed to various risks, including respiratory diseases from inhaling harmful air and injuries from sharp objects. We know that using proper PPE is critical to preventing these health issues.

Understanding of occupational hazards. All participants demonstrated a good awareness of the various dangers they encounter during waste collection, recognizing multiple types of occupational hazards. Physical hazards were commonly cited, such as sharp objects like broken glass, nails, and metal pieces, which pose significant risks of cuts and puncture wounds. In addition, participants acknowledged chemical hazards, including exposure to toxic substances, harmful chemicals, and contaminated waste, all of which can have serious health implications. Biological hazards were also mentioned, with workers expressing concerns about exposure to pathogens, bacteria, and viruses present in waste materials, which can lead to infections and disease. Many respondents emphasized that inadequate personal protective equipment (PPE), such as low-quality gloves and boots, exacerbates these risks. The workers' increased knowledge of the risks present in their workplace is reflected in the general identification of the hazards they face.

A 32-year-old man in an IDI said,

> We are aware that while sweeping the market every morning, we encounter various physical dangers, such as broken bottles, glass, and other sharp objects, which can pierce our worn-out gloves and cause injuries.

One participant expressed that he knew of the dangerous nature of waste handling, with a special emphasis on the foul odors from human waste and filthy circumstances associated with their profession.

In an IDI a 58-year-old man,

"In our market, we often work in the mornings after people have urinated and defecated in the area, and discarded used sanitary pads. We are exposed to foul odors and handle these waste materials with bare hands.

Respondents expressed that they were experiencing these hazards, particularly injuries caused by broken glass bottles. They related incidents in which these dangers resulted in injuries to their hands and legs.

A 55-year-old man, IDI

> Yes, I have, I stepped on the nail when we were collecting waste in the bins, I went to the hospital, I was given medication and they cleaned the wound and put on a bandage

Mzuzu City Council (MZCC) officials verified the hazardous work practices of solid waste collectors (SWCs), especially their inadequate use of personal protective equipment (PPE). Many of the incidents that have been recorded involving SWCs, in the opinion of these officials, can be directly linked to inadequate compliance with workplace safety protocols, such as the irregular usage of PPE. The MZCC officers stressed that even while workers are aware of the risks associated with waste collection, many continue to participate in unsafe behaviors. Examples of these behaviors include handling waste without gloves, using protective gear that is insufficient or defective, or disregarding other safety regulations.

These risky behaviors greatly raise the possibility of injuries such cuts, puncture wounds, and chemical exposure in addition to the physically taxing and dangerous nature of the task. The officers said that the problem is exacerbated by the absence of enforcement of safety regulations and the restricted availability of high-quality personal protective equipment (PPE), which exposes workers to avoidable mishaps.

MZCC officer, in an IDI

> "Solid waste collectors mostly pay no attention to the potential accidents, diseases, and injuries associated with their job. Most of the accidents they face are because they do not use PPE. When it comes to handling waste there are many actions that solid waste collectors must take to safeguard their safety which must be taken seriously."

Attitudes and practices regarding utilization of personal protective equipments

The present investigation revealed a dichotomy in the attitudes of solid waste collectors (SWCs) toward personal protective equipment (PPE). Positively, the majority of participants acknowledged the benefits of personal protective equipment (PPE), noting that it greatly decreased their exposure to work-related accidents and offensive waste-related odors. They appreciated personal protective equipment (PPE) because it helped reduce the chance of injury by preventing contact with hazardous chemicals and sharp items. But other SWCs also showed unfavorable opinions of PPE, frequently as a result of the equipment's inadequacy, uncomfortable fit, or poor quality. These problems made people reluctant to use personal protective equipment (PPE) even though they knew it would keep them safe.

A young lady aged 39, in an IDI said

> Putting on PPE is crucial since gloves and safety boots prevent us from getting wounded by sharp objects and coming in contact with urine, faeces, and other foul-smelling waste materials that can be found in waste bins

Some participants had negative attitudes, they expressed concerns with the availability of PPE.

A young man of 27 years old said,

> "MZCC occasionally provide PPE for us to use, but now it's been a while since they gave us PPEs. Most of the time we simply continue working as usual without it, we use our bare hands."

Officers from the Mzuzu City Council (MZCC) addressed the claim that the organization does not give personal safety equipment (PPE) to solid waste collectors. They verified that there are in fact regular delays in getting fresh PPE supplies and other logistical tools. Because PPE inventories are replenished slowly, solid waste collectors are frequently obliged to operate without sufficient protection, which has a substantial negative impact on their safety and well-being. The officers clarified that these kinds of delays are frequently brought on by financial strains, ineffective procurement practices, or logistical difficulties, all of which led to sporadic shortages of vital safety equipment. As a result of these PPE supply gaps, waste collectors are more vulnerable to work-related risks and hazards, such as cuts from sharp items, chemical exposure, and negative health impacts from insufficient protection. The officers agreed that reducing hazards for solid waste collectors and enhancing job safety depended on resolving these delays and establishing a more dependable supply chain for PPE and other equipment.

MZCC officer, in an IDI

> "It's not like we don't provide them with PPE; we do. It's only that, due to delays, we don't provide regularly as an institution. You are aware of how delayed government institutions may be in getting new supplies and other logistical equipment."

Challenges encountered by SWCs about occupational hazards and PPEs

The female participants mentioned some significant challenges they face in obtaining proper PPE. One participant said there are delays in receiving equipment.

A 39-year-old female, in an IDI, said

> When we don't have PPEs we report to our supervisors, they just tell us that we have heard your request, but it takes ages to provide PPE

She further added that most of them resort to purchasing their safety boots and gloves due to prolonged waits for supplies.

A 39-year-old female, in an IDI

> When we tell them we do not have PPE like gloves, and they respond we will buy. We usually think it's wise to just buy ourselves

Physical hazards challenge. The respondents mentioned that being injured while at work was a physical hazard they faced while working. One respondent stated the issues arising from injuries and illnesses, and the pressure to return to work quickly despite health concerns.

A 42-year-old man, in an IDI

> When we are injured or ill, our supervisor advises us to visit the hospital, but since we are few these days, we end up returning to work as soon as possible, even when we are not feeling well

PPE availability challenge and adaptation. The availability of PPE was a major concern among male respondents in FGD. The respondents expressed they had to work without PPE due to unavailability. One middle-aged man said she experienced the challenges associated with the availability and accessibility of PPE, especially after the end of specific provisions like during the Covid era.

A 44-year-old man, in an FGD, said

> "During the Covid era, our bosses provided us with PPE, but since Covid has ended, we haven't received any. We are required to buy ourselves"

Another male also mentioned that they purchase PPE on their own as a means to deal with the lack of PPE, he further stated the need to maintain her job despite the harsh working conditions.

A 55-year-old male, in an FGD

> "We buy ourselves the PPE so that the work should be done, the salary we get we educate our children. Whether we like it or not we are supposed to work despite the risks."

On their access to the PPE. Male Experiences: Male participants recognized the importance of PPE but expressed concerns regarding its availability and quality.

A 32-year-old man, in an FGD

> We were trained to use gloves and masks but the quality of gloves is often poor, they are easier broken. We buy our PPE when we have money

Female Experiences: Female participants mentioned financial constraints that prevented them from purchasing adequate PPE.

A 39-year-old woman, in an FGD

> We cannot afford proper gloves or boots, we work without them, and we are at risk of diseases every day

Observations from a field visit. An SWC group was sorting through rubbish mounds next to the market area's waste collection containers. This action included 4 persons that were observed. To some extent, their hands were protected because they were wearing safety gloves. When it came to protection against sharp items on the ground, just one of them had safety boots on. Women collecting solid debris were observed using only their hands to sweep the area. A lack of protective gear appeared to be the reason why gloves were not being used. This finding revealed a discrepancy in the availability and use of PPE among SWCs, potentially exposing them to greater risk of injury.

Their refusal to wear personal protective equipment (PPE) brought attention to the grave issue of a shortage of PPE, which forces SWCs to compromise their safety in order to complete their task on time. In the field, there were mounds of broken glass strewn among regular trash. These glasses were mixed with organic trash, plastic, and paper. In addition to immediately threatening SWCs, inadequate waste segregation and disposal practices raised the potential of injury to humans who came into touch with the material. The condition of the drainage systems in the market was one important discovery revealed during the inspection. It was found that a variety of waste including food remnants, plastic bags, and other waste was clogging multiple drains. These clogged drains' stagnant water produced an unhealthy atmosphere due to the foul stench of rotting waste.

Social domain

The social domains in this study showed a complex interaction of knowledge, attitude, economic challenges and employer support systems. The participants were aware of the risks associated with their work but barriers such as; financial constraints, employer support, health risks and public health impacts hindered their ability to protect themselves effectively.

The social domains of economic status, healthcare issues, government policies, employer support, community health, and hygiene are interrelated and significantly influence the personal protective equipment (PPE) used by solid waste collectors. First of all, the inability of solid waste collectors to afford PPE on their own underscores the crucial connection between their financial situation and PPE accessibility. Second, the lack of appropriate PPE increased the health risks they faced, including infections, respiratory issues, and injuries, underscoring the urgent need for protective gear to protect their health. Thirdly, since organizations like MZCC are in charge of supplying the proper PPE, employer support is crucial. The challenges that the solid waste collectors encountered were made worse by irregularities in the safety equipment supply. Finally, the public's health and the occupational health of solid waste collectors are both impacted by inadequate personal protective equipment (PPE). The community's health and hygiene were seriously at risk due to their exposure to hazardous materials,

unhygienic working conditions, and a lack of personal protective equipment (PPEs).

Emerging findings

The emerging findings of this study shed light on 3 crucial aspects: the reason for choosing a job, reporting and feedback mechanism within the workplace and adaptation strategies employed by solid waste collectors on the faced challenges.

Reason for choosing the job. The main reasons given by all the solid waste collectors for choosing the job were illiteracy, poverty and helplessness. Even though they were not happy with the kind of work and the pay for their work, they were helpless to be in the job.

A 39-year-old woman, in FDG

> "I chose this job because I did not want to stay at home, and because of our lack of education, there is no place for us to work. Although our income is low, I can pay my children's school fees. I have been working here for 12 years."

Reporting and feedback. Respondents mentioned that they were reporting their challenges to their supervisors or higher authorities including to foremen who were their supervisors but, this did not result in effective solutions.

A 45-year-old man in an IDI said,

> When we do not have PPE, we tell the foreman, they do not do anything about it, and they claimed MZCC is aware of our problems

Women said there were instances where the supervisors responded with shouting or raised voices, creating a challenging environment for employees

A woman of 44-years-old said,

> "The problem of PPE has been there for some time, when we tell the Capitao (junior supervisors) our gloves are broken and we need new ones, he just shouts at us, there is no effective solution from them"

In response to reports highlighting the difficulties faced by solid waste collectors in effectively reporting PPE issues, MZCC officers acknowledged the validity of these concerns but stated that there are defined communication channels that must be followed to report issues. They do not receive direct reports from solid waste collectors. However, as an institution, they make every effort to assist solid waste collectors.

MZCC officer, in an IDI

> Yes, the existence of these challenges is a possibility, as there are defined communication channels that must be followed to report issues. These collectors are unlikely to approach us directly; instead, they may be reporting to their supervisors who may have mishandled their complaints. However, as an institution, we strive to assist solid waste collectors to the best of our abilities.

Adaptation strategies. In response to the challenges mentioned by respondents, they took the initiative to manage the situation by purchasing their safety boots and gloves. Participants in FGD said that this adaptive strategy although costly for solid waste collectors who had limited income, was seen as essential to ensure their safety and enabled them to continue working.

A 42-year-old woman, said

> From a distance, these issues appear to be getting better, however, it takes some time for PPEs to be provided; like now it has been *three* years for our superiors to give safety boots and gloves. We believe it is best just purchasing the boot and gloves ourselves, as long as we don't get sick

Women participants said they took action in specific situations such as dealing with clogged drains, workers resorted to purchasing masks from retailers to protect themselves.

A woman of 39-years-old in a FGD said,

> When the drains have clogged, mostly there are bad smells and we need to sweep it, we buy masks in China shops and wear them to protect ourselves

Emerging model-presentation of findings

Results in this section follow a format presented in Figure 2.

Context

Economic status. Most participants were unable to acquire PPE due to budgetary constraints, making access to PPE difficult.

Health care challenges. SWCs expressed a variety of health concerns, including injuries, respiratory distress, and diseases such as tuberculosis, highlighting the difficulty they have in managing their health.

Government policies and employer support. MZCC's role in providing PPE was inconsistent because they had not provided PPE for solid waste collectors in a long time, contributing to the issues that solid waste collectors confront.

Community health and hygiene. Participants indicated unsatisfactory working conditions, such as exposure to urine, feces, and used sanitary pads, providing a public health risk to both collectors and the community.

Process

Knowledge and awareness. SWCs are aware of occupational hazards such as sharp objects and dangerous compounds. Most have firsthand experience with injuries caused by broken glass bottles, and they are aware of the possible health consequences of long-term exposure.

Safety protocols. SWCs were aware of formal safety protocols, such as the use of PPE such as gloves, masks, and boots. They also indicated that training on the need to wear PPE had been delivered a long time ago.

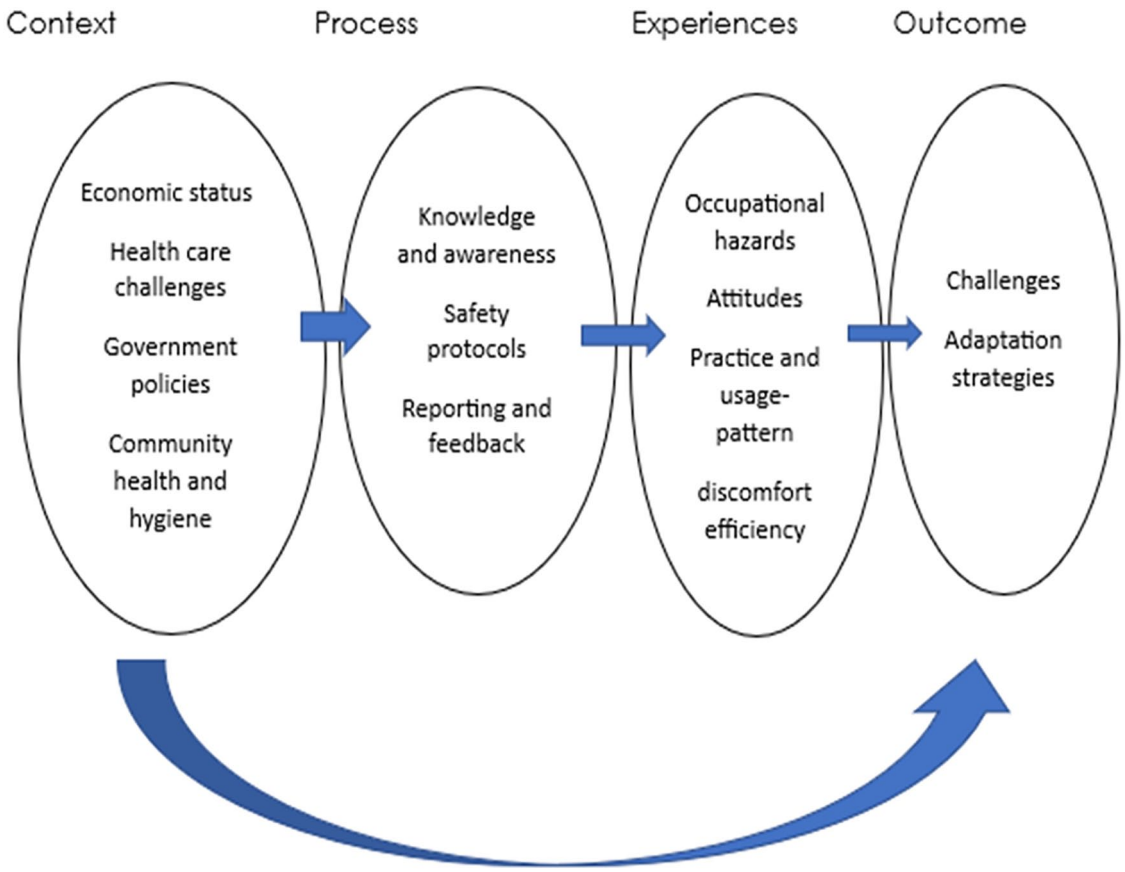

Figure 2. Figurative presentation of findings.
Adapted from technologies for municipal solid waste management; current status, challenges and future perspective chemosphere.[44]

Reporting and feedback. SWCs reported their challenges to their supervisors but effective solution was lacking. The supervisors' responses involved shouting or raising voices, which created a challenging environment.

Experience

Occupational hazards. SWCs face hazards due to a lack of essential working materials, resulting in injuries from broken glasses and other sharp objects. Long-term exposure to these risks causes a variety of health issues, including non-functioning limbs and backaches.

A 44-year-old man said,

> "For the years we have been working we have been exposed to broken glasses which hurt our hands and legs, this left hand as you can see (pointing at his left hand) does not work properly"

Attitudes. SWCs had both positive and negative attitudes regarding PPE. Positive attitudes focused on the necessity of PPE in preventing accidents and diseases, while negative attitudes stem from PPE's scarcity and high cost.

A 48-year-old man in an IDI said,

> "If you don't wear PPE like gloves or boots, you risk getting sick from a disease that comes from waste because people urinate and defecate all over the market."

Practices and usage patterns. The use of PPE by solid waste collectors varied. Some people always wear gloves and boots, while others do not wear any safety equipment due to financial constraints. Damaged gloves are still being used, resulting in poor protection.

A 39-year-old woman, in an IDI said

> I always wear gloves at work, although this glove I am wearing is damaged; my hands are still filled with debris but I still wear it every day

Discomfort and efficiency. Some SWCs found PPE unpleasant, and they claimed it reduced their productivity. The mask, in particular, was mentioned as being uncomfortable owing to sweating and difficulty breathing.

A 42-year-old man, in an IDI

> "I don't feel comfortable wearing the mask since I find it difficult to breathe correctly when we work early in the morning and it slows us down when we have to push heavy objects with our hands."

Outcome

Challenges. SWCs experience difficulties obtaining PPE, prompting them to purchase their own. Delays in acquiring PPE equipment and inconsistency in PPE supplies were prevalent problems.

Adaptation strategies. SWCs adapted by purchasing their safety equipment, such as gloves and boots. Although costly, this method was deemed necessary for their safety and capacity to continue working.

Discussion of Key Findings

In this study, solid waste collectors demonstrated an understanding of the risks associated with their jobs, including exposure to sharp objects and hazardous substances. In line with the study's conclusions, SWCs in Ghana were aware of the risks associated with their line of work, which included accidents and unhygienic working conditions.[32] In our study, a few SWCs reported having skin rashes, back issues, coughing, and one of them even developed tuberculosis. In a similar vein, Madian and Wahed's[33] study in Egypt discovered that skin issues like itching, injuries related to their jobs, and respiratory and musculoskeletal complaints were the most prevalent medical conditions among SWCs. SWC attitudes in this study were mixed, with some highlighting the importance of PPE and others raising questions about its availability and caliber.[33] Studies conducted in Ethiopia and India revealed similar conflicting opinions, emphasizing the need to address financial obstacles and provide PPE on a regular basis.[34,35] A study carried out in Ghana by Lissah et al[32] found that the majority of SWCs have unfavorable opinions about the use of PPE. The lack of use of PPE can be attributed to managers and supervisors who fail to prioritize the provision of PPE. Melaku and Tiruneh, on the other hand, discovered that the majority of SWCs in Ethiopia had a positive outlook and engaged in occupational health hazards prevention.

The study also found that although SWCs understood the value of PPE, its availability varied. This conclusion is comparable to the challenges encountered by solid waste collectors in African nations, where PPE supply was inconsistent because of budgetary constraints and procedural roadblocks.[33] On the other hand, study conducted in Thailand demonstrated that developed nations have a more organized PPE distribution among them, guaranteeing a safer working environment.[36] The study's conclusions pointed out that the MZCC officer's confirmation of dangerous workplace practices—specifically, some SWCs' use of no personal protective equipment (PPE)—highlighting a critical problem in solid waste management. Comparably, a study conducted in Ghana by Lissah et al[37] examined the perspectives and experiences of managers and supervisors of municipal waste companies regarding solid waste management. The study found that low PPE use by SWCs, poor policy implementation, inadequate funding, and a lack of technical skill regarding skill at hand are some of the factors leading to the breakdown of waste management regulations.

According to the study's emerging findings, the main reasons given by many solid waste collectors for choosing the job were illiteracy, poverty and helplessness. Similarly, in a study by Vinti and Vaccari[38] in Kenya, the findings highlighted similar factors influencing career choices among SWCs, the study emphasized that limited employment opportunities for people with lower education backgrounds, have led them to waste management jobs despite unfavorable working conditions. Likewise, a study by Rani et al[39] in Nigeria, found out the challenges faced by SWCs, including low pay and hazardous working conditions, reinforcing the idea that economic desperation often forces people into such professions.

The results of this study indicated that SWCs encountered difficulties in disclosing PPE-related issues. SWCs claimed that complaining to supervisors had elicited inadequate responses, varying from a hostile response involving shouting to inaction. This result is consistent with a study carried out in Mexico by Smith et al,[40] which highlights the pervasive problem of inadequate feedback and support systems for waste collectors in a variety of situations. MZCC officers stated that while they acknowledged the legitimacy of the concerns, reporting issues must go through specific channels of communication. The officer stated SWCs do not provide them with direct reports. In a similar manner, Gupta et al[41] in India noted that a prevalent problem in the informal sector is a lack of direct reporting protocols and miscommunication between workers and management. Their results made clear how important it is to have clear channels of communication when addressing employee concerns, especially in fields where formal and informal management structures frequently interact. The coping mechanisms used by SWCs, like buying their own PPE, were highlighted in this study.

The research study identified a variety of difficulties consistent with the Health Belief Model, including perceived susceptibility and severity, where SWCs may not fully realize the dangers, they face or the severity of potential accidents or health issues caused by poor protection. Furthermore, perceived benefits; and the efficiency of personal protective equipment (PPE) in preventing injuries and diseases is critical. If SWCs do not believe that wearing PPE will considerably lower their risk, they may be less inclined to utilize it on a regular basis. Barriers to Action and Cues to Action are 2 further topics addressed by the Health Belief Model. They may underestimate the requirement for PPE if they do not fully understand the hazards. SWCs encounter challenges such as restricted access to high-quality PPE and insufficient training which can be viewed as significant barriers to taking protective action. Addressing these barriers is essential for promoting safer practices among SWCs. Increased awareness campaigns, training programs, and supportive workplace cultures can help SWCs prioritize safety and use

PPE. The Health Belief Model provides insight into the psychological and social elements that influence safety practices. Comprehensive methods, such as increasing access to high-quality PPE, offering ongoing education, and addressing informal work conditions, can improve health and safety. Addressing constraints such as inadequate access to PPE and insufficient training is critical for promoting safer practices among SWCs while also maintaining public health and sanitation. This is in line with research by Kinyua et al[42] and Ye et al,[43] who highlighted the necessity for occupational health professionals to take the initiative in promoting the overall health of workers by integrating health-promoting activities into their regular responsibilities for managing work-related injuries. For instance, educating them on how to use the proper safety measures may be aided by seeing employees in their surroundings carry out their job responsibilities.

Conclusion and Recommendations

The study reveals that the understanding of work dangers among Solid Waste Collectors (SWCs) is varying, with some being aware of specific risks like contact with sharp objects or infectious materials, but many lack comprehensive knowledge about all hazards related to their work. This highlights the need for educational initiatives to raise awareness and understanding of occupational health risks. The use of personal protective equipment (PPE) also differs among SWCs, with many acknowledging its importance but also having misconceptions about its comfort and efficacy. Factors such as discomfort, perceived stigma, and lack of faith in the equipment can influence their regular use. Dispelling these myths is crucial to promote a culture of safety and improve PPE use. However, there is a gap between knowledge and practice when it comes to incorporating PPE into daily activities. Many SWCs report inconsistent use due to availability issues, poor training, and workplace conditions. Other obstacles faced by SWCs include lack of access to high-quality PPE, lack of ongoing education on proper PPE usage, and the informal nature of their business. To address these issues, the study recommends improvised and frequent training sessions; establish efficient channels for SWCs to report problems and ensure that their grievances are properly addressed; partnership with institutions through Public Private Partnerships for it was found that the city council faces significant h; campaigns to change people's perceptions of safety; and allocat adequate financial support through increase inbudget allocations specifically for PPE and essential safety eqipment.

Author Contributions

Mercy Ngwira: Conceptualization, methodology; software; writing—review and editing.

Moses MN Chitete: validation; formal analysis; investigation; resources; writing—review and editing.

Mary Sibande: data curation; writing—original draft preparation.

Yoram Ngwira: writing—review and editing; funding acquisition.

Chitsanzo Damazio: visualization; supervision investigation, review and editing.

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