REVIEW OF LANDFILL IMPACTS ON INFORMAL WASTE-PICKERS AND SURROUNDING COMMUNITIES IN AFRICA (2015-2022)

by

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i. Declaration

I, Pfarelo Elen Tshifularo, student number: 47674482, declare that “Review of Landfill Impacts on Informal Waste-Pickers and Surrounding Communities in Africa (2015-2022)”, is my own work and that all the quoted or used sources have been acknowledged by means of comprehensive references. I further declare that the submitted dissertation was also submitted on the originality checking software and that it falls within the acceptable originality requirements. I further declare that I have not previously submitted this work, or part of it, for examination at the University of South Africa (UNISA) for another qualification or at any other higher education institution.

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ii. Abstract

The content nature and features of studies conducted in Africa relating to landfill impacts on informal waste pickers and surrounding communities are not known. Research trends and focus on studies conducted between 2015 and 2022 are also unknown. Currently there is no document which consolidated studies conducted in Africa relating to the impacts of landfill on informal waste pickers and surrounding communities published between 2015 and 2022, which in turn may guide future research direction. Epistemology which determined the researcher's choice of the study method, how data was collected, analysed as well as how findings were interpreted was the philosophy which grounded this study. Epistemology shaped the researcher's view of the world, the nature of knowledge, and determined how this knowledge was shared with others. The method used for this study was a systematic literature review. The identified and included studies were manually analysed using an inductive and iterative approach for qualitative data analysis. The findings from the reviewed studies indicate that informal waste pickers in landfills are faced with different occupational injuries including cuts, punctures, and animal bites. With regard to negative health outcomes, the studies reported that skin problems, respiratory ailments, and eye infections were associated with the trade of waste picking in landfills. Documented musculoskeletal problems faced by informal waste pickers included, back, chest and joint pains. Studies reported that surrounding communities were also negatively affected by landfills. The landfill location, air and water pollution were among documented concerns. The most prevalent health challenges reported within communities included cancer, malaria, asthma, and various skin and respiratory issues. This review identified research gaps which need to be further explored to ensure that the impacts of landfills on informal waste pickers and surrounding communities in Africa are wholistically investigated. It is recommended that more studies be conducted in other African countries since the reviewed studies focused more on South Africa and Nigeria.

Key terms:
Informal waste pickers; landfill impact; surrounding communities; Africa; pollution; health risks; leachate; perception; human health; recycling.

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v. Abbreviations and acronyms

AI	Artificial Intelligence
AWMO	Africa Waste Management Outlook
BRICS	Brazil, Russia. India, China and South Africa
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
GWMO	Global Waste Management Outlook
H_2S	Hydrogen sulphide
ISWA	International Solid Waste Association
MSDs	Musculoskeletal disorders
$PM_{2.5}$	Particulate Matter
PPE	Personal Protective Equipment
SDGs	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
TB	Tuberculosis
UNEP	United Nations Environment Program
USWM	Urban Solid Waste Management

1. Chapter 1

1.1. Introduction and background

Municipal solid waste has become a great concern globally and locally since waste production has increased due to population growth, industrial activities as well as consumer culture (Vaverková, 2019). It is estimated that the world generates more than 2 billion tons of waste each year, this is expected to increase to 3.4 billion by the year 2050 (Valavanidis, 2023). Valavanidis (2023) attributes 30% of globally produced food together with its packaging being disposed of in municipal bins and landfills to the lack of effective municipal waste management measures as well as ineffective recycling practices. Overall, developed countries consume more goods than developing countries and often use more packaging as well as durable items such as electronic equipment (Valavanidis, 2023). Developing countries are often in the receiving end of waste generated in developed countries through the process of importing goods and raw materials for manufacturing purposes (Tomita *et al*., 2020). The amount of waste produced per year in Sub-Saharan Africa is predicted to triple by the year 2050 (Tomita *et al*., 2020). Health and environmental concerns in developing countries can inter alia be attributed to the increase in generated waste resulting from rapid economic growth and urbanisation (Tomita *et al*., 2020; Abubakar *et al.,* 2022) and the mismanagement of waste in Africa (Godfrey *et al*., 2019).

Landfilling as a method of final waste disposal has proven to be the most cost-effective way compared to other approaches of managing waste (Vaverková, 2019). The African Union had aimed for a recycling rate of 50% of the total waste generated in Africa by the year 2023 as a response to the waste crisis (UNEP, 2018). However, statistics show that over 90% of waste generated in Africa ends up in dumpsites or landfills with only 4% being recycled predominantly by informal waste pickers (Godfrey *et al.*, 2019). The main sources of landfill emissions are waste materials as they are brought into landfills, emissions from cars transporting the waste, waste blown by wind, surface dust, generated landfill gas, and produced leachate (Vaverková, 2019).

Even though Africa generates less amounts of waste compared to developed countries, in order for it to meet its sustainable development goals, Godfrey *et al.* (2019) encourages a government that will support and prioritise waste management initiatives focusing on the health and environmental sustainability. The United Nations Environment Program (UNEP) and the International Solid Waste Association (ISWA) published their first Global Waste Management Outlook in 2015. It was in this Global Waste Management Outlook where the need for greater detail in the generation and treatment of waste was emphasised (UNEP, 2018). UNEP launched the first Africa Waste Management Outlook in 2018, providing an overview of waste management strategies throughout the whole continent. It highlights how waste is managed looking at factors such as the environmental, social, and economic impacts as well as how waste is governed (Godfrey *et al.,* 2019). This report also highlighted the rewards that can come from using effective solutions and funding methods as a way of managing waste appropriately (Godfrey *et al.*, 2019).

Studying the impacts of landfills on the environment and on human health is becoming more important as environmental concerns are increasing (Vaverková, 2019). Characteristics of solid waste management including its sources, composition, disposal methods, recycling efforts, and valorisation strategies in Egypt were analysed by (Abdel-Shafy and Mansour, 2018). While concentrating on environmental sustainability impacts, Abubakar *et al*. (2022) conducted a study in the global South cities investigating how waste management practices impact the environment as well as human health. It was reported in a study by Rafiq *et al.* (2018) that the process of producing gas in landfills generated from decomposing waste in Pakistan starts within two to six months after waste has been disposed of and can last up to 100 years. The produced gas has the potential to harm people living in close proximity to landfills.

After investigating the impacts that landfills have on South Africans who live in their close proximity, Tomita *et al.* (2020) reported that these communities suffered from various health issues. As an attempt to reduce both the health and environmental impacts, they proposed a reduction in the quantity and size of landfills (Tomita *et al.,* 2020). Souza-Silva and Mol (2021) analysed landfill impacts on informal waste pickers based in South America and established that hepatitis B and hepatitis C prevalence within informal waste pickers varied from region to region.

This review sought to investigate how landfills affect informal waste pickers and surrounding communities in different parts of Africa from studies published between the years 2015 and 2022. Adhering to the structure outlined by Xiao and Watson (2019) for conducting systematic literature reviews, this study also assessed the extent of existing research and identified gaps in the current literature.

1.2. Research problem

Through engagement with informal waste pickers at the Marie Louise landfill in Roodepoort, Johannesburg, South Africa, it became evident that these individuals encountered difficulties associated with their line of work. This realisation then sparked an interest in finding out how landfills affect nearby communities. Different researchers have conducted studies on the impacts that landfills have on informal waste pickers and surrounding communities. However, the content nature of the studies conducted between 2015 and 2022 on landfill impacts on informal waste pickers and surrounding communities in Africa was not known. There is a lack of comprehensive systematically gathered evidence on this topic across the African continent, existing studies are largely limited to individual case studies and lack clarity on research trends, focus areas, findings and recommendations from studies conducted between 2015 and 2022.

1.3. Rationale

This study systematically reviewed available literature published between 2015 and 2022 to identify impacts that were caused by landfills on informal waste pickers and surrounding communities in Africa. A systematic literature review was used by other authors as well. Zolnikov *et al*. (2021) used a systematic literature review to identify and to investigate hazards linked with the occupation of waste picking. Literature on waste pickers were systematically reviewed by Morais *et al.* (2022) in order to understand their living and working conditions, the study also aimed at exploring the issues of formalising the trade of waste picking. In Nigeria, Oguntoyinbo (2012) conducted a systematic literature review to assess the systems of informal waste management focusing on Nigeria and other developing countries. Rosyidah *et al.* (2023) used the same method when conducting a study aimed at mapping the status

of research conducted globally on waste projection and the developing trends that will shape its future. A systematic literature review study was also conducted by Al-Hazmi *et al.* (2024), the review explores emerging ways of sustainably managing landfills.

This review is important because to the best of the researcher's knowledge, research conducted regarding landfill impacts on informal waste pickers and surrounding communities in Africa published between 2015 and 2022 had not yet been systematically reviewed. A systematic literature review was used in this study because it plays a pivotal role in establishing the foundation for academic investigations (Xiao and Watson, 2019). Systematic literature review studies assumes that texts are rich in data sources and has the potential to expose important insights regarding a specific phenomenon and are most useful in cases where there is a large amount of text to be analysed (Kleinheksel *et al.,* 2020). Researchers can create an inventory of knowledge through a well conducted systematic literature review study (Gaur and Kumar, 2018). When addressing a research question, these studies go beyond what a single study can achieve (Snyder, 2019).

This review extracted important information from studies conducted in Africa relating to landfill impacts on informal waste pickers and surrounding communities. Research trends and gaps were discovered. Critical information discovered may help researchers to prioritise unexplored and under explored areas. This review will contribute to the current body of knowledge by establishing reliable information on how landfills impact informal waste pickers and surrounding communities. The information may help public and private management make decisions to reduce environmental damage and subsequently may improve the health and livelihoods of informal waste pickers and people residing next to landfills (Espuny *et al.*, 2021).

1.4. Aim

The aim of the study was to review research that has been conducted on the impacts of landfills on informal waste pickers and communities next to them in Africa between 2015 and 2022 from studies found on Google Scholar, ScienceDirect, PubMed, Sabinet, Taylor and Francis, Sage Journals, MDPI, and ResearchGate.

1.5. Research objectives

The objectives of this review were:

1. To identify research trends as well as research gaps from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

2. To identify the impacts of landfills on informal waste pickers and surrounding communities from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

3. To determine the causes of landfill impacts on informal waste pickers and surrounding communities from studies conducted in Africa relating to landfill impacts on informal waste pickers and surrounding communities published between 2015 and 2022.

4. To identify factors that influence the impacts of landfills on informal waste pickers and surrounding communities from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

5. To make recommendations based on the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

1.6. Research questions

The research questions were:

1. What research trends and gaps were seen from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

2. What were the impacts of landfills on informal waste pickers and surrounding communities identified from the studies reviewed conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

3. What were the causes of landfill impacts on informal waste pickers and surrounding communities reported by the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

4. Which factors influenced the impact of landfills on informal waste pickers and surrounding communities from the studies reviewed conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

5. Which recommendations were made by the reviewed studies conducted in Africa between 2015 and 2022 relating to the impacts of landfills on informal waste pickers and surrounding communities?

1.7. Limitations of the study

Systematic literature reviews are carried out methodically, adhering to a predefined procedure or protocol to direct the collection and analysis of data (Mancin *et al*., 2024). Inconsistency in systematic literature review studies may arise from coding rules or problems with a specified variable (Kleinheksel *et al*., 2020). The coding process required a thorough understanding of the context, making it more about the subjective, qualitative interpretation of data (Kitto *et al.,* 2023). Kleinheksel *et al.* (2020) highlighted that thorough coding guidelines foster uniformity leading to reliability.

The researcher's prior knowledge of data can potentially influence the process of the review, how the questions are formulated, or determining the inclusion and exclusion criteria (Higgins *et al.,* 2019). This bias was reduced by making decisions which were not influenced by the researcher's earlier knowledge of the data. To ensure that there was an alignment between the research question, the method of data collection, and the subsequent data analysis methods, research questions were used as a guide (Bush and Amechi, 2019). By allowing the research questions to direct both the selection of data collection methods and analysis, this study has maintained consistency and relevance in its approach.

Coder fatigue is as a result of the cognitive and administration work associated with coding tasks; this poses a risk of studies looking the same, disabling the researcher's ability to approach each study with a different perspective and clarity (Kleinheksel *et al.,* 2020). To mitigate this limitation, strategies to maintain focus such as the keeping of reflective journals and analytic notes were used (Kleinheksel *et al.,* 2020). Beyond this, the researcher ensured sufficient time for data analysis which mitigated the potential risk of feeling rushed.

1.8. Delineation of the study

Delineating a research study is important to ensure that it has boundaries and that its focus is on the research problem as well as the scope of the study. The delineation of this study concentrated on the time frames as well as the nature of the documents used.

The studies included were published between the years 2015 to 2022 found on Google Scholar, ScienceDirect, PubMed, Sabinet, Sage Journals, MDPI, Taylor and Francis, and ResearchGate. The decision to concentrate on recent literature was centred on the premise that current studies have a potential to offer relevant insights that matches the present situation (Xiao and Watson, 2019). The period of this study begins the same year as the adoption of the United Nation's Sustainable Development Goals (SDGs). The SDGs includes goals which are directly related to the management of waste. The period also aligns with policy changes, in the year 2020, South Africa published waste picker integration guideline for South Africa which underscores the need for inclusive policies as well as the importance of including informal waste pickers into the process of managing waste. The studies reviewed were published in English focusing on the impacts of landfills on informal waste pickers and surrounding communities in the African continent only. Studies conducted in countries on other continents relating to the impacts of landfills on informal waste pickers as well as surrounding communities did not form part of this review. This exclusion ensured that this review focuses on the landfill impacts in an African context. To maintain the integrity of the review process, studies which were duplicated in several databases were eliminated.

1.9. Chapter layout

This dissertation consists of five chapters. In Chapter 1, the research idea was presented and developed. The research rationale was justified. The research aim was defined. Research objectives and questions which steered the review were outlined. This chapter gave a summary of what to expect in the rest of the review. Chapter 2 provides a literature review related to the impacts of landfills on informal waste pickers as well as surrounding communities. This chapter also gave background information on landfill pollutants, subsequently, the use of systematic literature review as a research method was also highlighted. In Chapter 3, the methodology used for this review was explained. Chapter 4 presents the findings of the review. In Chapter 5, the findings are discussed together with the importance and the limitation of the study. Recommendations and conclusions are also discussed. References along with appendices can be found at the end of the review.

2. Chapter 2: Literature review

2.1. Introduction

The first section of this chapter will provide background on landfills, the pollutants they produce, landfill solid waste management, and the role of informal waste pickers. It will also highlight the impacts that landfill has on informal waste pickers as well as on surrounding communities.

The second portion of this chapter will delve into content analysis as a research method, its application in Africa, and its use in identifying research gaps, trends, as well as in answering research questions.

2.2. Landfills

Globally, daily human activities result in the generation of unwanted or unused materials. Even though over the years different methods such as recycling, reuse, and the use of waste for producing electricity have been introduced in an attempt to minimise waste, materials that are unusable and unwanted must be disposed of (Iravanian and Ravari, 2020). Sanitary landfills are widely used for waste disposal and are characterised by the layers which are used to dispose of waste. Before new waste is disposed, waste on the first layer must be compacted and covered with soil (Vallero and Blight, 2019). An unregulated landfill or a dump site has no bottom layer meant to protect the soil from waste as sanitary landfills have (Vallero and Blight, 2019). Siddiqua *et al*. (2022) refers to an unregulated or an open dumpsite as a landfill whose waste disposal activities are less or not managed at all. Due to the lack of management and non-compliance with regulations, unregulated landfills increase the risk of harm to both people and the environment (Siddiqua *et al.,* 2022). Landfilling is generally considered an effective way of waste management, however, the impacts of pollution from landfills renders it the least preferred method of managing waste (Chakravarty and Kumar, 2019).

2.2.1. Pollution potential

Landfills can potentially harm the environment as well as human health by polluting the air, water and soil (Iravanian and Ravari, 2020). The different types of landfill pollutants can be categorised into three groups namely, organic, biological, and inorganic (Siddiqua *et al*., 2022). Sulfur oxides, hydrocarbons, carbon monoxide (CO), and nitrogen oxides are among landfill pollutants having a potential to cause harm (Yang *et al.,* 2018). Since various parts of the environment are connected, pollution caused by one source has the potential to pollute others, thereby making pollution and its effects worse (Iravanian and Ravari, 2020). Air pollution caused by landfills is as a result of dust as well as gasses which are emitted as waste decompose (Khaustov *et al.,* 2019). Soil pollution occurs when water from the rain pass through the waste causing both chemical and physical reactions which then releases the dissolved substances into the soil (Vaverková, 2019). Ground water becomes contaminated when leachate produced in landfills seeps through the landfill surface layers (Khaustov *et al.,* 2019).

2.2.2. Leachate

Landfill leachate is defined as infiltrated rainwater or water as a result of the process of biodegradation of waste (Teng *et al.,* 2021). The creation of landfill leachate is influenced by factors such as the moisture content of the surrounding soil cover as well as the inherent water within the waste (Vaverková, 2019; Ma *et al*., 2022). Lindamulla *et al.* (2022) identified four categories of leachate pollutants namely: dissolved organic matter, inorganic compounds, xenobiotic organic compounds, and heavy metals. Landfill leachates are harmful and toxic, rendering a potential threat that can ruthlessly harm the environment, ecosystem, and human health (Parvin and Tareq, 2021). Daniel *et al*. (2021) documented that diseases such as tuberculosis, pneumonia, anthrax and meningitis are caused by harmful bacteria present in landfill leachate. The composition of landfill leachate is different over time and place, thereby resulting in a variation in the type and level of contamination across landfills (Rogers *et al.,* 2021). The age of the landfill, the type of waste within the landfill, the amount of residual moisture, the degradation stage, and landfill technology are factors which influence the creation as well as the quantity of leachate (Baderna *et al.,* 2019).

2.2.3. Gas

Landfill gas which primarily consists of methane (CH_4) and carbon dioxide (CO_2) is among pollutants emanating from the degradation process of waste within landfills (Vaverková, 2019). Landfill gas composition and the rate at which it is produced is different throughout the lifetime of a landfill (Shen *et al*., 2018). CH_4 causes global warming and climate change 25 times more than CO_2 (Mishra *et al*., 2020). Although CH_4 is not generally counted as an air pollutant, however, it plays a significant role as a precursor to tropospheric ozone O_3, contributing to global air pollution (Mar *et al.,* 2022). Tropospheric ozone (O_3) is associated with different negative health outcomes such as reduced lung function and asthma, it is also harmful to plants resulting in crop losses (Mar *et al.,* 2022). Even though landfill gas primarily consists of CH_4 and CO_2 it however contains other different gases in small quantities, some of which are toxic (Mishra *et al*., 2020). While hydrogen sulphide (H_2S) is emitted in low concentrations, it is one of the gases that are major contributors to odour in landfills (Yilmaz *et al.,* 2021). Global warming, ecological degradation, and societal concerns such as human health issues are consequences of landfills emitting greenhouse gasses (Ozbay *et al*., 2021). Smoke from landfill fires cause a release of pollutants such as CH_4 (Vaverková, 2019).

2.2.4. Fires

Landfill fires are classified as surface fires, which happens because of uncompacted or buried waste, and sub-surface fires which is as a result of the biological and chemical degradation process of waste (Chavan *et al*., 2022). Unlike surface fires that can easily be maintained if they are detected early, sub-surface fires are challenging to control because they can go unnoticed while smouldering in the early stages Milosevic *et al.* (2018). Landfill fires are either caused deliberately or can ignite as a result of a spontaneous process according to Bihalowicz *et al*. (2021). Landfill fires do not only emit dangerous gases, but they also have the potential to affect the integrity of the landfill structure (Dabrowska *et al*., 2023). Along with causing environmental damage, smoke from landfill fires which contain dangerous gases such as carbon monoxide (CO), hydrogen sulphide (H_2S), CH_4, and cancer-causing compounds such as dioxins are released into the soil, water, and air (Vaverková, 2019). Susceptible

groups like the elderly, children, pregnant individuals, and those with pre-existing chronic respiratory ailments are most likely to be affected by these emitted toxic gasses (Rovira *et al*., 2018). Residents living close to landfills are exposed to fumes emanating from landfill fires and are also at risk of infections transmitted by vectors and rodents which thrive in landfill environments (Ziraba *et al*., 2016).

2.2.5. Pathogens

Waste in landfills includes potential sources of intestinal pathogens such as food waste, faecal matter, absorbents, and biosolids (Addy *et al.,* 2023). Certain types of solid waste break down rapidly, causing immediate environmental pollution through the emission of unpleasant odours and directly attracts numerous disease vectors, particularly insects (Vidyavathy, 2018). Solid waste is a favourite breeding medium for oviposition as well as the development of various flies at all stages of decomposition (Surendra *et al.,* 2020). Birds, rodents, insects, and other scavengers can act as carriers, spreading diseases directly or indirectly by contaminating resources (Nor Faiza *et al.,* 2019). Even though landfills have a negative impact, if waste is managed effectively, these impacts can be minimised (Khoiron *et al*., 2020).

2.2.6. Solid waste management

In its 2012 report, the World Bank projected that as nations continue their fast urbanisation and growth, global solid waste amounts are expected to rise significantly by the year 2025 (The World Bank, 2012). Waste disposal continues to be a big problem in many developing countries unlike in developed countries where advanced methods of managing waste are being used (Uhunamure *et al.,* 2021).

Through a comparative review on studies published from 2005 to 2015, Mmereki *et al.* (2016) compared the management of solid waste in developed, developing, and lesser developed countries. They concluded that solid waste management in lesser developed and developing countries is inefficient and not well-established (Mmereki *et al*., 2016). Mmereki *et al*. (2016) attribute the lack of policies for recycling and stakeholder involvement in less developed and developing countries as the main reason for their inefficiency in managing waste. Gonçalves *et al.* (2018) recorded that

a much bigger challenge of managing urban solid waste is faced by the BRICS (then Brazil, Russia, India, China and South Africa) countries.

With an aim to analyse the position of Urban Solid Waste Management (USWM) in the BRICS countries, Gonçalves *et al.* (2018) conducted a systematic literature review on studies published from 2006 to 2016. They concluded that due to the roles of agents involved not being clearly defined, coupled with the lack of planning, categories of waste, financial capabilities, and local infrastructure, efficient USWM is hindered. They also established that where waste management is concerned, all the BRICS countries possess the same characteristics such as, problems with the management systems, involvement of the informal sector, and the use of landfilling as the final method of disposing waste (Gonçalves *et al.,* 2018).

The study also aimed to investigate the final methods of waste disposal, along with the processes involved in waste storage, collection, transfer, and transportation as well as the various types of treatment applied to waste before its final disposal. The study pinpointed issues in India regarding waste collection. They observed that the accumulation of waste in community containers was due to infrequent collection (Gonçalves *et al*., 2018). Composting was identified as the most practical method of waste treatment (Gonçalves *et al.,* 2018). It was furthermore established that the BRICS countries use a centralised manner to manage waste (Gonçalves *et al.,* 2018). Inclusive policies that focus on waste minimisation and recycling are however being implemented by these countries. In Russia, programs focusing on managing hazardous waste, recycling, regulations, and sensitising the public have been initiated (Singh *et al*., 2021). For the reduction of waste, recycling, and management of hazardous waste, China, has started an initiative incorporating regulations and current technologies (Singh *et al*., 2021). In order to improve the management of waste, the South African and Brazilian governments are seeking to formalise the trade of waste picking (Da-Silva *et al*., 2019).

With the focus on the experience of waste pickers, a study conducted in Johannesburg, South Africa aimed at investigating how sustainable development concepts were adopted in Buy-Back Centres. The study sought to determine whether the Buy-Back Centres helped with decent jobs, poverty alleviation and social inclusion.

Although the Buy-Back Centres were framed as a sustainable development initiative, the results indicated that it failed in meeting its social goals, informal waste pickers remained excluded from formal systems and continues to work under poor conditions (Lindner, 2025).

Another study conducted in Johannesburg, South Africa sought to investigate the potential integration and incorporation of informal waste pickers into formal structures within municipal solid waste management. It was established that policies have not yet been able to successfully incorporate them into the formal waste system, this is despite their positive contribution to both the environmental health and economic development (Simatele *et al.,* 2017).

2.3. Informal waste pickers

Informal waste pickers are people who collect items discarded and considered as waste to sustain their lives (Schenck *et al*., 2019). On a global scale, millions of people, particularly those with limited skills and without any other source of income depend on waste picking as a means to earn a living (Morais *et al.,* 2022.). Informal waste pickers across the world show the same characteristics, they live in extreme poverty, are the most vulnerable group and they are often stigmatised (Morais *et al.,* 2022.).

Schenck *et al*. (2019) highlighted that half of the total plastic waste generated universally is recycled by informal waste pickers despite them working in an informal capacity. The “invisible environmentalists” as they are referred to by UNEP, protect the environment by mitigating pollutions thereby improving the overall public health (Schenck *et al*., 2019). Their efforts of recycling also help in conserving natural resources (Uddin and Gutberlet, 2018). Informal waste pickers also reduce the need for new landfills (Morais *et al.,* 2022). Through re-use, recovery, as well as recycling, informal waste pickers transform waste into resources enhancing supply efficiency thereby supporting the circular economy (Morais *et al*., 2022).

In an African context, informal waste pickers in Zingwangwa (Malawi) recovers around 20 kg and 30 kg of plastic and metal waste respectively per day (Kasinja and Tilley, 2018). In South Africa, informal waste pickers divert paper, plastics and other

recyclables away from the overburdened landfills (Mngomezulu and Senekane, 2023). Although their recycling activities helps in preserving the environment Gutberlet (2021), they are however faced with risks related to their trade (Tellado *et al*., 2020).

2.3.1. Impacts on informal waste pickers

In the year 2021, Rincón and Canoles carried out a scoping review on studies published from the year 1999 to 2019 focusing on exploring the working and health conditions of informal waste pickers universally. It was established that informal waste picker's work environment influences their working conditions (Rincón and Canoles, 2021). Contributing factors to the health concerns such as skin problems and tuberculosis included their use of tobacco and other drugs (Rincón and Canoles, 2021).

The prevalence of musculoskeletal disorders (MSDs) among Mumbai (India) informal waste pickers was explored in a cross-sectional survey study by Singh and Chokhandre (2015). The study also aimed at gaining a deeper understanding on the risk factors of MSDs on various body parts. More than half of the respondents reported having MSDs problems. Lower and upper back concerns were reported by 52% and 40% of the waste pickers respectively, knee issues were reported by 48% and shoulders problems were reported by 34% (Singh and Chokhandre, 2015). The trade of waste picking is detrimental to informal waste pickers in other countries as well.

In Latin America, Cruvinel *et al*. (2019) investigated the risks and diseases associated with the trade of waste picking. Majority of the participants in this cross-sectional survey study only had attained primary level education. The most prevalent diseases were reported to include hypertension, diarrhoea, diabetes, cough, and intestinal worms, injuries due to sharp objects were reported by most of the waste pickers (Cruvinel *et al.,* 2019).

Cuts from glass or needles were reported to be injuries associated with waste picking in a review by Yang *et al*. (2018) which aimed to explore management of waste, informal recycling, pollution, and public health. This study focused on informal waste pickers within developing countries. Documented health issues included skin rashes,

headache, respiratory, diarrhoea, cholera, malaria, high blood pressure as well as musculoskeletal and psychological problems (Yang *et al*., 2018). This study also concluded that due to the lack of washing facilities in landfills, informal waste pickers carry toxic materials home which can potentially affect their families (Yang *et al*., 2018). Due to financial constraints and a lack of risk awareness, informal waste pickers reported that they do not use Personal Protective Equipment (PPE) (Yang *et al*., 2018).

Concerning health conditions of informal waste pickers and their lack of access to public medical care were established in a cross-sectional descriptive study carried out by Auler *et al*. (2014) in Southern Brazil. The study was designed to examine the health conditions and access to public medical services amongst informal waste pickers. The lack of access to public health services resulted in 36.9% reporting to not have visited a doctor in over a year and 15.7% not having access to medical care altogether (Auler *et al*., 2014). In terms of their body weight, 57.8% had abdominal obesity while 25.7% were obese, and 51.1% were reported to be overweight (Auler *et al*., 2014). Furthermore, they concluded and reported that 11.4% had problems with diabetes,16.4% suffered from dyslipidaemia and 32.8% of the respondents suffered from hypertension (Auler *et al*., 2014).

Digestive issues including episodic diarrhoea, intestinal worms and hepatitis A were reported as the most common concerns in a mixed method study conducted by Bihałowicz *et al*. (2021). The aim of the study was to explore the sociodemographic characteristics, health and working conditions of informal waste pickers in Bangladesh. The results also indicated that the informal waste pickers lived and worked under terrible and unhealthy conditions, but were drawn to the waste picking trade due to a lack of job opportunities (Bihałowicz *et al*., 2021).

Waste pickers in urban areas face vulnerabilities due to limited education and skills, low income, poor living and working conditions (Paul and Bhattacharjee, 2022). The qualitative study focused on investigating the livelihoods and health status of informal waste pickers in Bangladesh. Informal waste pickers indicated that they mainly suffered from cuts and being pierced by sharp objects, however, due to financial constraints, they are unable to visit medical centres and instead rely on traditional

methods for treatment (Paul and Bhattacharjee, 2022). The results also revealed conflicts amongst waste pickers fuelled by competition for resources, jealousy, personality clashes, cultural differences, and substance abuse (Paul and Bhattacharjee, 2022).

The results from a cross-sectional study carried out by Karki *et al*. (2022) indicated that there was no clear evidence linking drug abuse to depressive symptoms. The study aimed to investigate the causes of mental ill health amongst informal waste pickers in Nepal. It was established that older informal waste pickers and women were more likely to report symptoms of depression (Karki *et al*., 2022)**.** Risk factors included having a disability, experiencing recent illness, and perceiving their work as hazardous. In contrast, belonging to a certain group or having social protection served as a protective factor (Karki *et al*., 2022).

Chan *et al.* (2025) conducted a survey study aimed at exploring the role that gender and socio-economic status play in shaping the work environment, income and mental health of waste pickers in Hong Kong. The results of the study indicated that female waste pickers, particularly those with low socio-economic status, experienced poorer health conditions and earned less compared their male counterparts (Chan *et al.,* 2025). Landfills not only affect informal waste pickers working within them, but they also affect communities in their close proximity.

2.4. Communities surrounding landfills

Communities surrounding landfills refer to people who live or work near dumpsites or landfills. These nearby communities may be directly affected by social, environmental, or health-related issues because of the presence of the landfill (Ogbuehi *et al*., 2022). The release of potentially harmful gases from decomposing waste, air and water pollution, as well as soil contamination were the most reported environmental issues in a study by Siddiqua *et al.* (2022). With regard to social impacts, Olawoye *et al.* (2019) documented reduced property values, negative aesthetic effects, and disruptions to the quality of life of people staying close to landfills. Exposure to hazardous substances or pollutants generated by the waste disposal processes may lead to health issues (Townsend, 2018). South African government has mandated a

one-kilometre buffer zone around landfills (DWAF, 1998). This buffer is however being encroached upon by informal settlers. These settlers have moved in and made make-shift homes within the demarcated protective buffer areas. The encroachment of these buffer zones heightens the impacts of landfills on surrounding communities.

2.4.1. Impacts on the health of surrounding communities

Mattiello *et al*. (2013) conducted a systematic literature review on studies published between 1 January 1983 and 1 June 2012 to investigate how landfills affect the health of communities in their vicinity. They concluded that residing close to landfills was highly linked to respiratory problems as well as an increased rate of hospitalisation, especially among children (Mattiello *et al*., 2013).

Due to heavy metals observed to be above the permissible limit in drinking water, children and infants were reported to be at risk of potential lifetime cancer development (Ojekunle *et al.,* 2022). These were the findings from a study conducted in Nigeria to determine the health risks associated with exposure to heavy metals in drinking water contaminated by leachate on residents living close to landfills. Heavy metal concentration within the sampled groundwater was 14 times higher than the permissible limits, posing a significant health risk to individuals (Ojekunle *et al.,* 2022). The presence of heavy metals in drinking water was different in all 15 sampling points, this then implies that exposure to heavy metals through drinking water also varies (Ojekunle *et al.,* 2022).

The results from a study by Salah *et al*. (2019) indicated that nearby communities do not consider ground water, noise and dust pollution as significant impacts from the landfill. This study, through interviews, focused on exploring the perceptions of residents with regards to the impacts of a landfill in Zahrat AI-Finjan (Palestine). The results indicated that 95% of the residents reported that the landfill has a negative impact on their lives (Salah *et al*., 2019). From the total number of respondents, 87% reported an increase in the number of rodents and insects present in their households, 85% reported that emissions from the landfill can potentially affect animals and plants in a negative way, while 78% complained of bad odour (Salah *et al*., 2019).

The decomposition process of waste together with the activities within the landfill such as transportation, compacting and levelling are a potential contributor to poor air quality faced by surrounding communities (Khoiron *et al*., 2020). These are conclusions from a study conducted aimed at understanding the impacts of landfills on surrounding communities internationally. The study was a literature review conducted on articles published between the years 1997 to 2017. The findings also revealed that through the degradation process of waste, landfills produce leachate which can cause water pollution (Khoiron *et al*., 2020). In terms of health concerns, results show that asthma, allergies, skin problems, eyes and nose irritation, bronchitis as well as intestinal problems were the most reported (Khoiron *et al*., 2020). More health concerns as a result of exposure to landfill hazards were reported by De and Debnath (2016).

De and Debnath (2016) conducted a case study in Garia, Kolkata (India) aimed at investigating the prevalence of health problems related to the disposal of waste among communities within close proximity to landfills. Health concerns reported as the most frequent included common cold, cough, diarrhoea, malaria, and skin rashes (De and Debnath, 2016). It was documented that residents also suffer from allergies, bronchitis, intestinal disease, and respiratory infections (De and Debnath, 2016).

Cardiorespiratory disease and cancer are amongst the most reported negative health outcomes in a multidisciplinary approach study conducted by Limoli *et al*. (2019). The study aimed to investigate the impacts of illegal dumping on surrounding communities in Italy. Toxins from landfills are directly linked to these impacts on human health (Limoli *et al*., 2019). Because their immune systems and lungs are still developing, children are more at risk due to exposure to landfill pollution (Limoli *et al*., 2019). The study also concluded that people and animals can potentially be infected by insects carrying diseases through consumption of food or contact (Limoli *et al.,* 2019).

The following section will give background on content analysis as a research method.

2.5. Content analysis as a research method

A systematic literature review study which aimed at reviewing the current developments of artificial intelligence (AI) techniques within different facets of waste management was conducted by Ihsanullah *et al*. (2022). The study focused on understanding how AI techniques have been used to predict performance of different methods such as the generation, collection, treatment, collection, segregation, recycling and disposal of waste. Furthermore, the study wanted to establish key challenges, limitations and research gaps in relation to the implementation of AI in waste management systems. The results indicated that AI has contributed significantly to improving efficiency, accuracy and decision making across several phases of municipal waste management (Ihsanullah *et al*., 2022). Limited access to high quality data was identified as one of the challenges in implementing AI in municipal waste management (Ihsanullah *et al*., 2022). For AI implementation to be largely adopted, the study recommended the need for field testing, the use of hybrid AI and the development of frameworks which address ethical, economic and environmental issues.

Andeobu *et al*. (2022) conducted a systematic literature review study addressing the application of AI on solid waste management in Australia. The reviewed studies were published between the year 2005 and 2021. The study also aimed at assessing the effectiveness of these AI applications and their potential to support sustainable waste management solutions. The results indicated that AI technologies are used to improve waste collection, sorting and recycling, thus improving waste management practices and reducing the amount of waste going to landfills and emissions (Andeobu *et al*., 2022).

Waste sorting at the source, improved landfill optimisation, and methods to harness the value of waste are some of the proposed tailored solutions aligned with local conditions (Zhang *et al*., 2024). These are the results from a systematic literature review study conducted in Asia and Africa published between 2013 and 2023. The aim of the study was to establish barriers, challenges and trends in waste management specific to these areas. It identified major obstacles such as limited infrastructure, weak policy enforcement, financial constraints, low public participation, and socio-

economic barriers (Zhang *et al.,* 2024). Current waste practices are dominated by open dumping and poorly managed landfills, with minimal recycling and source separation (Zhang *et al.,* 2024). Content analysis as a research method can be used in other fields as well.

Gaur and Kumar (2018) concluded that the use of software to assist in content analysis was not yet popular in international business literature. They conducted a content analysis on studies published from 1991 to 2015. This article explains how to use content analysis to conduct review studies in a structured and efficient way. The results indicated that 70% of the reviewed studies used content analysis to explore international business trends while only 10% used content analysis in the process of conducting literature reviews (Gaur and Kumar, 2018). They also established that most studies used an inductive approach in their research (Gaur and Kumar, 2018). The study also aimed to evaluate validity when using content analysis in the literature on international business. They concluded that of the total number of articles reviewed, seven did not report inter-coder reliability, while six of the studies presented a coding scheme with no details of how it was developed (Gaur and Kumar, 2018). Failure to report on the development of coding schemes can negatively impact the validity of such schemes (Gaur and Kumar, 2018).

A study by Page *et al.* (2021) was conducted intending to estimate in a random sample of systematic literature review studies, the occurrence of the statements of data as well as code availability. The aim was to establish the frequency of data and code sharing. They retrieved studies from databases such as PubMed, Scopus, and ProQuest. The reviewed studies were published between 2 November and 2 December 2020. The results indicated that of the 300 articles, 86 included data availability statements while seven articles included both data and code availability statements (Page *et al.*, 2021). The results also revealed that the statements indicating the availability of data and code in systematic reviews appear occasionally (Page *et al.*, 2021). Content analysis can also be used to establish research trends.

Chan and Hsu (2016) wanted to establish trends in the hospitality industry by reviewing hospitality-related studies that were published from the year 1993 to 2014 pertaining to environmental management. They further wanted to identify research

gaps. Studies in green practices and environmental concerns including environmental management systems, indoor air quality, water and energy, conservation, and environmental management were the most frequently published (Chan and Hsu, 2016). They also established that areas, including green marketing, environmental reporting, environmental technology, carbon foot printing, green behaviour of employees, environmental management efforts on stakeholders, and environmental management on small-medium enterprises needed more attention (Chan and Hsu, 2016).

Bozkurt *et al.* (2015) also examined trends in Turkish distance education research from 1986 to 2014. They found that distance education and distance learning were the most frequently used terms in dissertations, while virtual education and mobile learning were less commonly used. Quantitative research methodologies, particularly experimental designs, were the most popular, followed by mixed designs with explanatory methods. Qualitative designs, especially case studies, were the least utilised in the dissertations analysed (Bozkurt *et al*., 2015). Vierula *et al.* (2016) carried out a study to identify research gaps in the field of nursing.

Keywords such as nursing education research, doctoral dissertation, and literature review were used to conduct a literature search by Vierula *et al.* (2016) when conducting a study on Finland's nursing education. The study aimed to establish gaps in the research from available studies relating to Finland's nursing education. After reviewing 51 doctoral dissertations that were published between 1999 and 2014, they concluded that Finland nursing education studies have been relatively focused on students while studies that focus on other aspects of the nursing professions are limited (Vierula *et al.*, 2016). Content analysis was originally used in the fields of psychology and education (Littell *et al.*, 2008). Since then, it has been used in other fields as well.

In the banking field, Akomea-Frimpong *et al.* (2021) conducted a content analysis to review research gaps and to identify future research direction on banks' green finance. They reviewed 46 existing literatures relevant to their study. The results indicated that carbon and climate finance, green insurance, credit, securities, investment, and infrastructural bonds are a part of the bank's green finance products (Akomea-

Frimpong *et al.*, 2021). They also established that interest rates, changes in climate and environmental policies, religion, banking regulations, social justice, and social inclusion were found to be relevant causes of influencing the bank's green financing policies (Akomea-Frimpong *et al.*, 2021). Dissanayaka and Vasanthapriyan (2020) used content analysis to answer research questions.

Dissanayaka and Vasanthapriyan (2020) retrieved 11 articles to review and answer research questions. The reviewed articles were published between the years 2012 and 2018 relating to the lack of advanced technology used to improve smart solid waste sustainability. They first wanted to know where and when studies were published. They discovered that magazines, conferences, and journals were used in 2017, with magazines the most preferred network (Dissanayaka and Vasanthapriyan, 2020). Secondly, which topics on the waste management perspective were focused on in 2014. The focus was on the collection and routing of waste (Dissanayaka and Vasanthapriyan, 2020). Thirdly, what type of research has been done. Solution proposal, evaluation and validation research were carried out (Dissanayaka and Vasanthapriyan, 2020). Lastly, what aspects of the smart city perspective were focused on. Smart city and smart energy were mostly focused on in 2014 while smart transport and smart house were mostly focused on between 2017 and 2018 (Dissanayaka and Vasanthapriyan, 2020).

2.5.1. Content analysis in Africa

Chisholm *et al.* (2021) used a systematic literature review on journals and book chapters published from 1998 to 2020 related to waste management practices in Africa. The review aimed at exploring different waste management methods, their associated risks and solutions used by African countries. The results revealed that incineration and landfilling as methods of waste management were used in Botswana, South Africa, and Nigeria. The primary cause of concern with regards to incineration was airborne contamination due to emissions, these countries' solution was to harness energy from incinerators (Chisholm *et al.,* 2021). The issues with landfills were land contamination and their potential impacts on surrounding communities, recycling and general waste segregation for biofuels were the methods used to curb the risks associated with incineration on landfills (Chisholm *et al.,* 2021).

Nigeria and South Africa also used autoclaving as a method of waste management; a major disadvantage of this method are the associated electrical costs. For autoclaving to be more sustainable, solar or wind energy should be considered as power sources (Chisholm *et al.,* 2021). Algeria used an indiscriminate waste management method; this practice results in solid waste build up in the communities, the recommended solution to this risk was the establishment of designated recycling centers and the prevention of illegal dumping (Chisholm *et al*., 2021).

The results from a study conducted by Maphosa and Maphosa*.* (2020) established that poor e-waste management primarily emanates from lack of policies and inadequate recycling facilities. The study was a systematic literature review conducted on studies published between the year 2008 and 2020. The aim of the study was to investigate the state of e-waste management in Sub-Saharan Africa. The results also revealed that over 80% of the studies on e-waste management during the study period were conducted in Ghana, Nigeria and South Africa (Maphosa and Maphosa*,* 2020). Another study on Sub-Saharan Africa was conducted by (Adedara *et al.,* 2023).

Adedara *et al.* (2023) used a systematic literature review based on a concerning gap between waste generation and collection. The study focused on investigating the status of municipal solid waste collection and factors influencing how much of the generated waste is being collected in Sub-Saharan Africa. They concluded that the average waste collection in the urban areas was from 45-50%, other countries had a higher rate of 50-70% while others showed a much lower collection rate of below 30% (Adedara *et al*., 2023). Results also indicated that, due to its higher population density and infrastructure, urban areas had better waste collection rates (Adedara *et al.,* 2023).

2.6. Insights and gaps from the literature

Current literature highlights environmental as well as health risks associated with waste picking or living close to landfills. Informal waste pickers are often exposed to unsafe and unhygienic environments (Bihałowicz *et al*., 2021). These environments expose informal waste pickers to conditions that negatively impact both their physical and mental health. Common physical ailments include musculoskeletal disorders,

infectious diseases such as tuberculosis and diarrhoea, as well as chronic illnesses like hypertension and diabetes (Yang *et al*., 2018; Cruvinel *et al.,* 2019). Injuries from sharp objects which are worsened by the lack of PPE is also common (Yang *et al*., 2018). Literature reveals a heightened risk of depression among older and female waste pickers (Karki *et al*., 2022)**.** Additionally, female waste pickers, especially those from lower socioeconomic backgrounds experience poorer health outcomes and lower incomes compared to their male counterparts (Chan *et al.*, 2025). Communities living close to landfills also suffer from adverse health effects, including respiratory problems, skin irritations and exposure to air and water pollution (Khoiron *et al*., 2020). Pests and environmental degradation further indicate the negative impact of landfills on nearby communities (Salah *et al*., 2019). Children were reported to be particularly at risk as a result of being exposed to landfill pollutants due to their developing immune systems (Limoli *et al*., 2019; Ojekunle *et al.,* 2022).

Although the impacts of landfills on informal waste pickers and surrounding communities are well documented, there is a lack of evidence proving that landfills are the primary source of the impacts. Bihalowicz *et al*. (2021) acknowledges that linking specific health outcomes to landfill exposure is challenging because of factors such as various sources of pollution, differences in exposure levels, and the absence of long-term epidemiological studies. Paul and Bhattacharjee (2022) highlighted that informal waste pickers face serious health risks because of poor hygiene, unsafe work, and low income. Cruvinel *et al.* (2019) do not claim that landfills are the primary cause of health problems amongst informal waste pickers, instead, they attribute these challenges to wider issues including living conditions and social factors. Cruvinel *et al.* (2019) further acknowledges that the dependence on self-reported information, absence of a control group, and unaddressed confounding variables restrict the capacity to establish a causal relationship between landfill exposure and health outcomes, indicating associations rather than confirmed links. Furthermore, De and Debnath (2016) notes that a direct causal relationship between landfills and their reported health impacts on surrounding communities has not been established, acknowledging the absence of conclusive evidence that the landfill is the primary cause of sicknesses.

While existing literature consistently show challenges affecting informal waste pickers and nearby communities, most studies are isolated. A systematic literature review will bring the findings together, highlight key issues and gaps, and offer a clearer, more comprehensive understanding of the impacts from an African perspective.

2.7. Conclusion

This chapter defined landfills and their accompanying negative environmental and human health impacts. Furthermore, landfill impacts on surrounding communities were also discussed. The information contained in Chapter 2 provides a firm foundation for improving understanding of the environmental, health and socio-economic challenges faced by informal waste pickers and surrounding communities. The chapter additionally demonstrated the use of systematic literature review method to answer research questions and to identify gaps in the existing literature. As the background and contexts of this study and its main constructs are clarified; the methodology of the research can now be discussed.

3. Chapter 3: Research design and methodology

3.1. Introduction

After the formulation of the research problem and the investigation of the research context, discussions concerning the type of data, data collection methods, as well as data analysis commenced (Taherdoost, 2021). The clarification of the research design and methodology was to ensure maintenance of research rigor. Research rigor encompasses the thoroughness, accuracy, and reliability of study methods, ensuring credible and replicable results (Sovacool *et al.,* 2018). Sovacool *et al. (*2018) further highlighted that research rigor can be attained through observation of a set standard in the collection, analysis, and interpretation of data, this assisted to reduce bias thus enhancing confidence in the results. Because of this, the research method was outlined first, then a step-by-step discussion on how data was collected to answer the research problem and to reach the objectives followed.

3.2. Research design

The research philosophy which influenced the development of knowledge in the field of waste management was epistemology (Saunders *et al*. 2019; Tamminen and Poucher, 2020). These sets of assumptions determined the researcher's choice of the study method, how data was collected, analysed as well as how findings were interpreted (Kivunja and Kuyini, 2017). Epistemology shaped the researcher's view of the world, the nature of knowledge, and determined how this knowledge was shared with others (Saunders *et al*., 2019). It also guided the discovery of information and reflected the view of the researcher as to what they considered as acceptable and legitimate knowledge (Alharahsheh and Pius, 2020).

Interpretivism which was an attempt by the researcher to interpret the world was the research philosophy that supported this review. Rather than focusing on an objective stratified method, interpretivism involved the researcher interpreting the sections of a study objectively and subjectively (Al-Ababneh, 2020).

The research approach linked to the philosophy of this review was inductive. This approach involved collecting data in order to explore a phenomenon after which themes were identified, these themes were derived from the data itself (Jones, 2022). The coding method used in this review was iterative, which included documents going through the coding process a number of times (Vears and Gillam, 2022). The findings from this review were thereafter combined and are subsequently presented in an organised manner in Chapter 4 (Page *et al.,* 2021).

This review's methodology was qualitative using systematic literature review. The review aimed at exploring the impacts that landfills have on informal waste pickers as well as communities living close to such landfills in Africa. For the research objectives to be reached, this systematic literature review necessitated the collection of all available and relevant current data in the field of impacts of landfills on informal waste pickers and surrounding communities. This study as a qualitative systematic literature review aimed at generating an understanding of meaning within the content of a dataset (Vears and Gillam 2022). The creation, testing as well as the evaluation of the study protocol, and the process of formulating data extraction forms were techniques used to ensure reliability and validity. The guarantee that information from the studies was accurately gathered was enhanced using data extraction forms (Büchter *et al.,* 2020).

3.3. Research methods

Research methodology is an approach researchers use to formulate their problem, objectives, and present their results based on data obtained during the study period (Sileyew, 2019). This study followed the guidelines established by Xiao and Watson (2019) for conducting a systematic literature review, consisting of three distinct phases (Table 1).

Table 1. A systematic literature review process (Adapted from Xiao and Watson, 2019).

Planning the review	Formulate the problem (step 1)
	Develop the review protocol (step 2)
Conducting the review	Search for literature (step 3)
	Screen for inclusion (step 4)
	Assessing quality (step 5)
	Extracting data (step 6)
	Analysing and synthesising data (step 7)
Reporting the review	Reporting the findings (step 8)

The systematic literature review process began with formulating the research problem and questions (Step 1), as detailed in (Sections 1.2 and 1.6). Following this, still on the planning phase, a research protocol (Step 2) which included decisions regarding sampling techniques (Section 3.3.1) was developed. To minimise bias in both data collection and analysis, it was important to develop a study protocol thereby enhancing the quality of the review (Xiao and Watson, 2019). The research protocol included all relevant articles found on Google Scholar, ScienceDirect, PubMed, Sabinet, Sage Journals, MDPI, Taylor and Francis, and ResearchGate related to the impacts of landfills on informal waste pickers and surrounding communities in Africa published in English between the years 2015 and 2022. Conducting the review phase which comprises of 5 steps then followed. Step 3 included searching for literature to identify and collect data (Section 3.3.2), subsequently screening for inclusion or exclusion (Step 4, Section 3.3.2), as well as quality assessment (Step 5, Section 3.3.2) was carried out. While still on the conducting the review phase, the collected data was extracted (Step 6, Section 3.3.3), analysed and synthesised (Step 7, Section 3.3.4 and Chapter 5). The final phase entailed the reporting of outcomes which involved tasks such as interpreting the findings (Step 8), discussing the results, and formulating conclusions (Chapters 4 and 5).

3.3.1. Data sampling

Given the wide array of available literature in the field of waste management in the universe that are too large to be examined as a whole, this systematic literature review focused on narrowing its scope to a manageable set of texts. While attempting to answer research questions with limited set of data can lead to sampling bias, collecting data using sampling strategies helps reduce this bias (Krippendorff, 2019).

Krippendorff (2019) defines census as a sampling method which gathers data from every member of the population, thus reducing sampling error since all units were incorporated. Studies in English conducted in Africa and published between 2015 and 2022 relating to the impacts of landfills on informal waste pickers and surrounding communities were included in this review. The other sampling method used for this review is purposive sampling. This is a method which is based on the researcher's knowledge and understanding of the requirements of the study, for this reason, specific samples from a population were selected (Etikan and Babtope, 2019).

The use of purposive as a sampling method helped in the alignment between the chosen sample and the research objectives thereby ensuring that the study is more robust and the data more reliable (Campbell *et al*., 2020). The review sourced studies from Google Scholar, ScienceDirect, PubMed, Sabinet, Sage Journals, MDPI, Taylor and Francis and Research Gate. The chosen sources have a good reputation within the academic sphere, thus enhancing the credibility as well as the trustworthiness of the information gathered.

3.3.2. Data collection

The development of a search strategy for the identification of studies became crucial after the definition of the research question and the overall establishment of the review approach. This included the selection of key words and determining a criterion of inclusion or exclusion. The key words were directly aligned to the study's aim and objectives (Snyder, 2019). Xiao and Watson (2019) also recommend developing key words from the study's objectives. Words closely linked to the research questions and topic were used to enhance efficiency in the retrieval of literature (Snyder, 2019). This

review focused on the scope of investigation through the inclusion of restrictions in the search boundaries (Snyder, 2019). Protocols were outlined for the identification of literature according to the research questions, author, and years in order to effectively organise, and facilitate the analysis (Torres-Carrión *et al.,* 2018). See Appendix C.

Keywords used to conduct the search included, landfill, waste management, causes, human health, perception, informal waste pickers, and Africa. The use of forward and backward searches and sources or references cited in previous reviews were also used to trace studies. For each study identified, initial significance was identified from the title. If the title appeared to discuss the impacts of landfills on informal waste pickers and/or surrounding communities, then the entire article was retrieved for further analysis.

In total, 69 studies were identified. Out of these, 31 focused on the impacts of landfills on informal waste pickers, while 37 investigated the impacts on surrounding communities, and one focused on both waste pickers and surrounding communities. The studies underwent the screening for inclusion or exclusion process, entailing reading the whole study to establish its relevance to this review. Studies published between 2015 and 2022 on health impacts from landfills on informal waste-pickers and surrounding communities in Africa were the focus of the review. Studies that discussed informal waste pickers as well as those that utilised alternative terms such as scavengers, recyclers, and collectors were included in this review. Studies that focused on landfill impacts on waste pickers who belong to an organised group were excluded. Waste pickers belonging to an organised group have a support structure which limits their chances of suffering from ill mental health. Organised groups can also develop rules including the use of PPE. Studies that concentrated on street waste collectors were also not included in this review. In relation to surrounding communities, studies that concentrated on landfill impacts on the environment only were excluded from this review. Studies that concentrated on both regulated and unregulated landfills were included in this review.

This review included studies of all research designs. Relevance, availability and legibility of data were used as a condition for assessing eligibility.

3.3.3. Data extraction

In order to accurately analyse, summarise and interpret the findings, this systematic literature review required a data extraction process (Büchter *et al.,* 2023). This process was only successful through the development of the data extraction form. Apart from laying the foundation for evaluating and understanding evidence, data extraction form served as an assurance that information contained in the dataset was accurately recorded (Büchter *et al.,* 2020). Some of the fields in the data extraction form are, the name of the study, author, year, country, and a section for notes.

3.3.4. Data analysis

In order to establish their content, studies which made up the dataset were manually analysed. This process involved the researcher analysing the data and arranging it into meaningful groups (Graue, 2015). For a researcher to extract meaning to develop knowledge from the content of the data set, individual texts contained therein were critically analysed (Mezmir, 2020). The examination of these individual texts was done without looking for specific content beforehand (Vears and Gillam, 2022). While focused on understanding the meaning contained within the data set, inductive coding enabled the researcher to be free and flexible when examining data (Bush and Amechi, 2019). An inductive and iterative approach for qualitative data analysis from Vears and Gillam (2022) was followed on this review (Table 2).

Table 2: Inductive content analysis: a guide for beginning qualitative research (Adapted from Vears and Gillam, 2022).

Step 1	Read and familiarise
Step 2	First round of coding-identify big picture meaning units
Step 3	Second round of coding - developing subcategories and fine-grained codes
Step 4	Refining the fine-grained subcategories
Step 5	Synthesis and interpretation

The first step of data analysis involved the researcher prior to sifting and categorising data, familiarising themselves with the content of the data set. Studies were read line by line to gain a thorough understanding and to subsequently record and make a summary of the retrieved information in order to draw conclusions (Kleinheksel *et al.,* 2020). Inductive coding was employed; hence codes emerged from the texts themselves.

Information from the dataset was broken down into manageable portions and assigned codes in Step 2 (See Appendix E). The relationship between data and the objectives was the basis on which portions of texts were identified and labelled for organising purposes. This process initiated the identification of units of meaning. According to Kleinheksel *et al.* (2020), units of meaning is an idea expressed in a statement, sentence or in a few words. Kleinheksel *et al. (*2020) recommend that longer units of meaning be condensed to reduce the mental load when analysing data. The reduction of these longer units of meaning was done only to shorten them while they kept their primary meanings (See Appendix D). Emergent codes which were subject to enhancement as the analysis continued were identified (Mezmir, 2020).

In Steps 3 and 4, after the second round of coding, subcategories were created while expanding on more detailed codes. The correctness of fine gained codes was also improved. The datasets were coded multiple times comparing them with each other (Vears and Gillam, 2022). The process of coding data multiple times resulting in a more detailed coding, enabled the discovery of new aspects embedded within the data every time a new study was analysed. Iterative coding assured that codes which were identified during the initial round of coding were not overlooked (Vears and Gillam, 2022). For data to be organised effectively, the codes identified as the most frequent or significant were subsequently organised and grouped into categories. (Kleinheksel *et al.,* 2020; Mezmir 2020).

Data synthesis and interpretation (Step 5) is covered in Chapters 4 and 5.

3.4. Conclusion

Chapter 3 has thoroughly provided an overview of the research design. The research methodology used to answer the research questions and reach the objectives was also discussed.

4. Chapter 4: Data presentation and findings

This chapter intended to provide a comprehensive overview of the results obtained from the review of studies conducted in Africa to investigate the impacts of landfills on both informal waste pickers and surrounding communities from studies published between 2015 and 2022.

4.1. Reviewed studies on informal waste pickers

A total of 31 studies on the impacts of landfill on informal waste pickers were identified. After going through the screening for inclusion or exclusion process discussed in section 3.3.2, 11 studies were excluded from this study. Of these, five studies focused on the impacts of landfills on municipal workers while six concentrated on the impacts on street waste pickers. The included studies amounted to 20.

Most studies described informal waste pickers by gender, majority of them were males. The ages of waste pickers ranged from 18 to 70, with the years between 20 and 45 as majority. It is important to note that there was a single study with participants below the age of 15 years (Nuripuoh *et al*., 2022). It was discovered throughout the review that majority of respondents from the reviewed studies only had secondary or high school educational qualifications. Most of those who disclosed their marital status were single. It was also established that most of the waste pickers worked throughout the whole year with just a few who were seasonal workers. Majority of waste pickers had been involved in waste picking for two to five years, there is however one study which involved waste pickers who had been picking waste for 10 to 15 years (Nyathi *et al*., 2018). Most informal waste pickers worked five to seven days a week from four up to 12 hours per day. Of the reviewed studies, four were conducted by the same author **"**Risk factors associated with self-reported health among waste pickers in landfill sites in Johannesburg municipality, South Africa" (Made *et al*., 2019); "Illness, self-rated health and access to medical care among waste pickers in landfill sites in Johannesburg, South Africa" (Made *et al*., 2020a); "Hypertension and associated risk factors among informal waste pickers in Johannesburg, South Africa" (Made *et al*, 2020b) and "Ten-year risk of fatal cardiovascular disease and its association with metabolic risk factors among waste pickers in South Africa" (Made *et al*., 2021).

4.1.1. Number of studies conducted in Africa

Figure 4.1 represents the number of studies conducted and published in African countries relating to the impacts of landfills on informal waste pickers to determine where the most research was done on this topic.

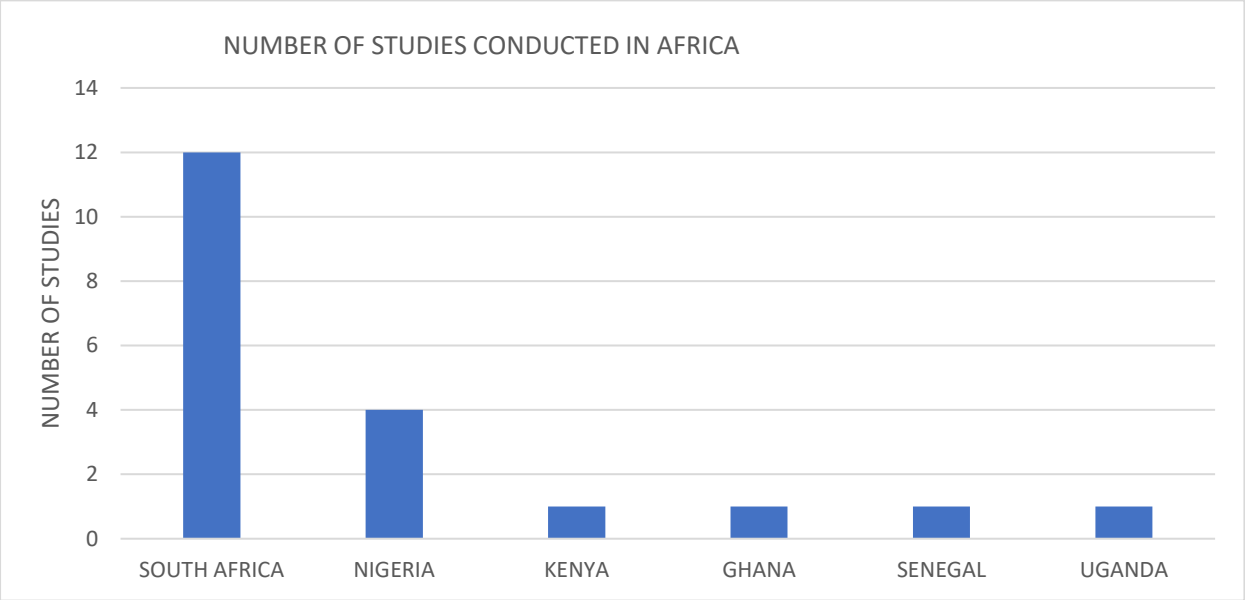


Figure 4.1: Number of studies conducted on Africa

In South Africa,12 studies were done, followed by Nigeria with four studies. Kenya, Uganda, Senegal, and Ghana had one published study each.

4.1.2. Number of studies published per year

Figure 4.2 represents the number of studies published in African countries per year between 2015 and 2022 relating to the impacts of landfills on informal waste pickers, to determine when the most research was published on this topic within the studies period.

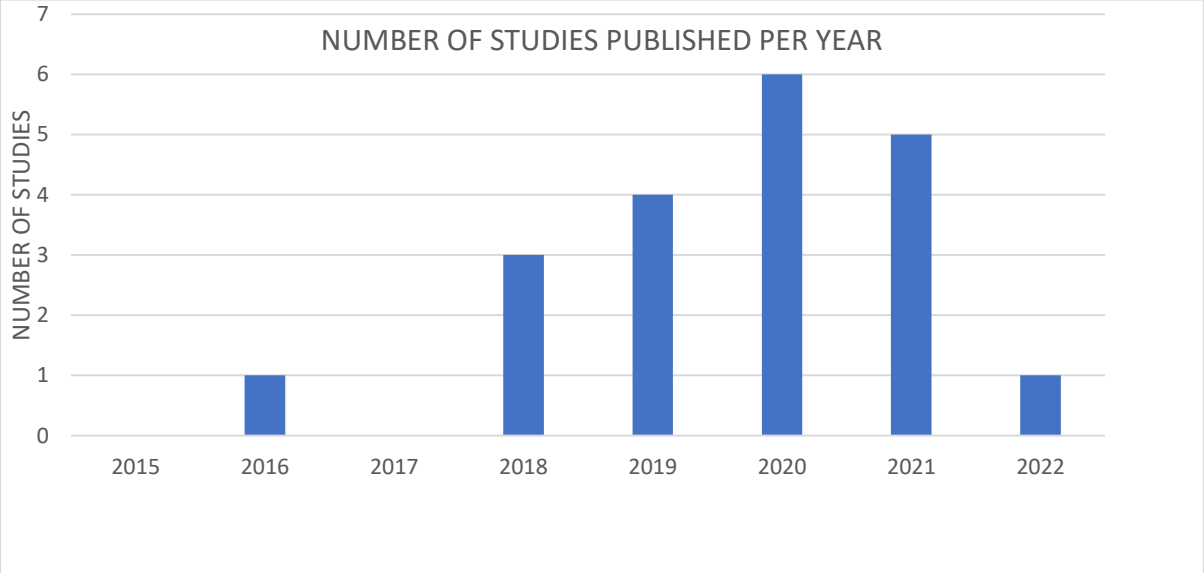


Figure 4.2: Number of studies published per year

In 2020, there were six studies published. The years 2021, and 2019 had five and four studies published respectively, whereas three studies were published in the year 2018. The years 2016, and 2022 had one study published each. In 2015 and 2017 there was none.

4.1.3. Research design used on reviewed studies

Figure 4.3 represents the research design used on studies done in Africa relating to the impacts of landfills on informal waste pickers. This was done in order to establish the most preferred design during the studies period.

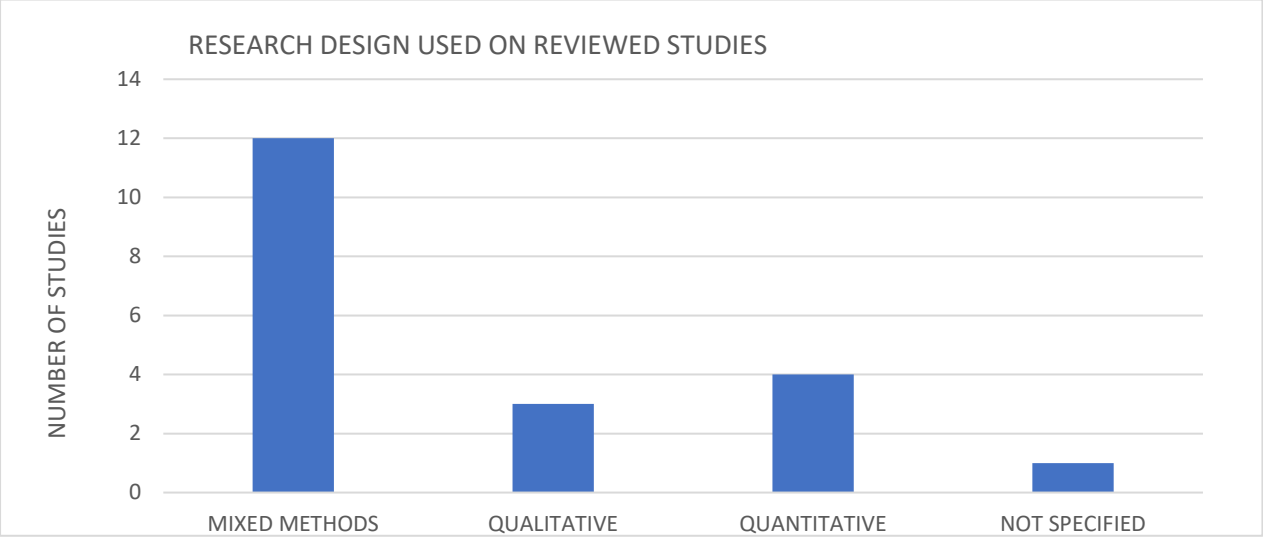


Figure 4.3: Research design used on reviewed studies

Mixed methods were used in 12 studies, quantitative and qualitative were used in four and three studies in descending order. The research design used was not mentioned in one study.

4.1.4. Research methods used on reviewed studies

Figure 4.4 represents research methods used on studies published in Africa focussing on the impacts of landfills on informal waste pickers, aiming at determining the research method mostly used on this topic during the period of the studies.

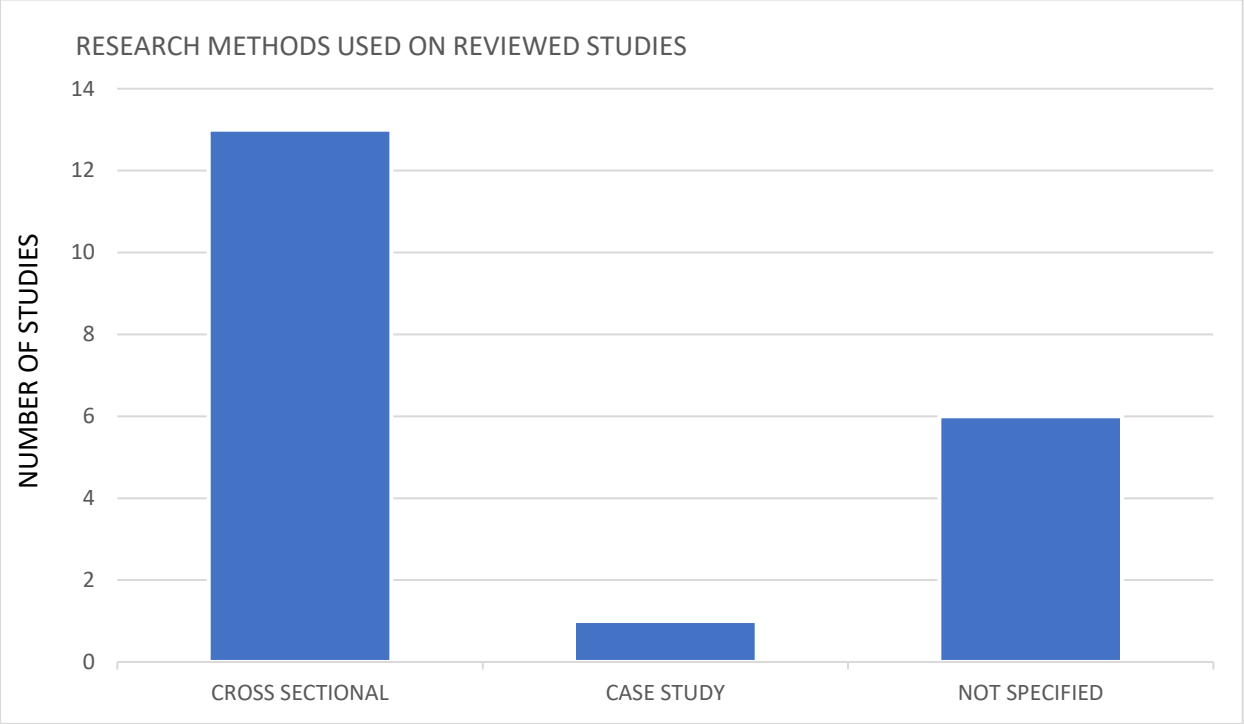


Figure 4.4: Research methods used on reviewed studies

Cross-sectional method was utilised in 13 studies. Case study method was used in one study. The research method used was not specified in six studies.

4.1.5. Sampling method used on reviewed studies

Figure 4.5 represents sampling methods used by studies conducted in Africa relating to the impacts of landfills on informal waste pickers in order to determine the frequently utilised method.

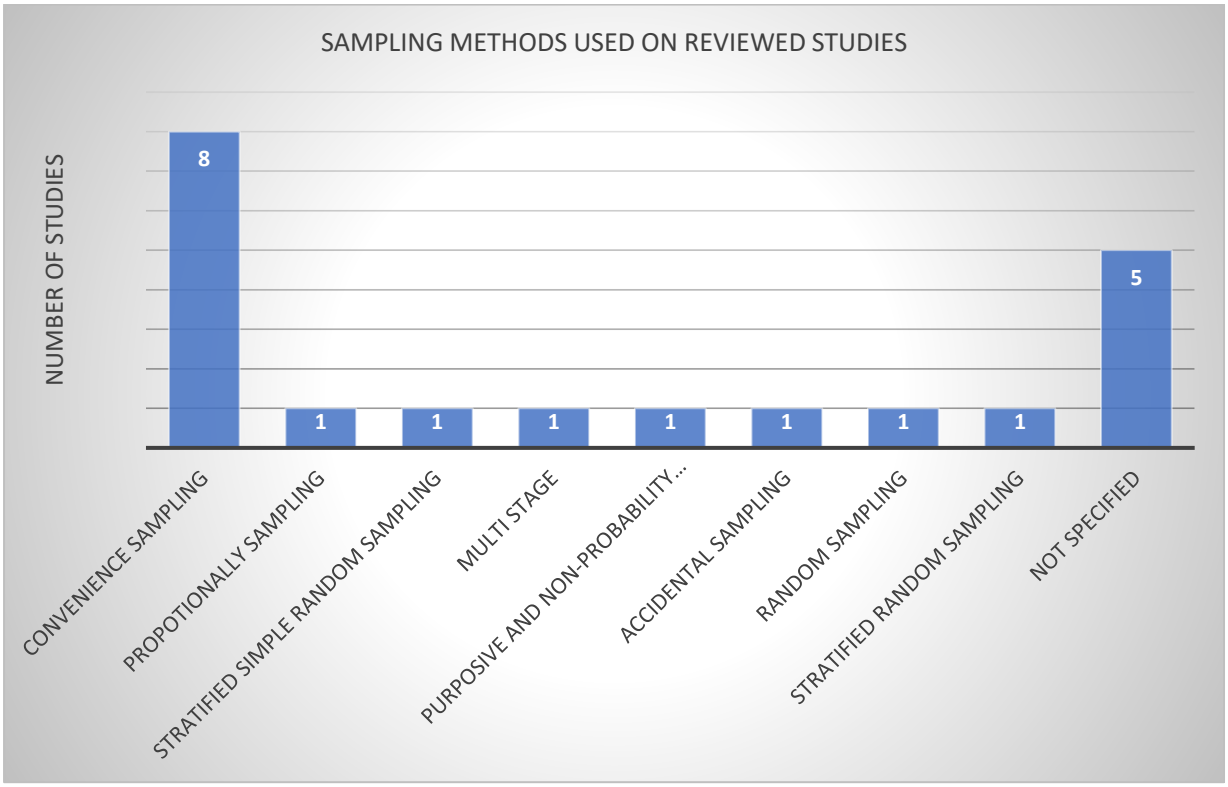


Figure 4.5: Sampling method used on reviewed studies

Convenience sampling was employed in eight studies. Proportionally, stratified simple random, stratified random, accidental, random, purposive, and non-probability as well as multi- stage sampling were sampling methods used in one study each. Sampling methods used were not mentioned in five studies.

4.1.6. Data collection methods used on reviewed studies

Figure 4.6 represents data collection method used on studies conducted in Africa relating to the impacts of landfills on informal waste pickers. This aimed to identify the method of data collection which was mostly used on these studies.

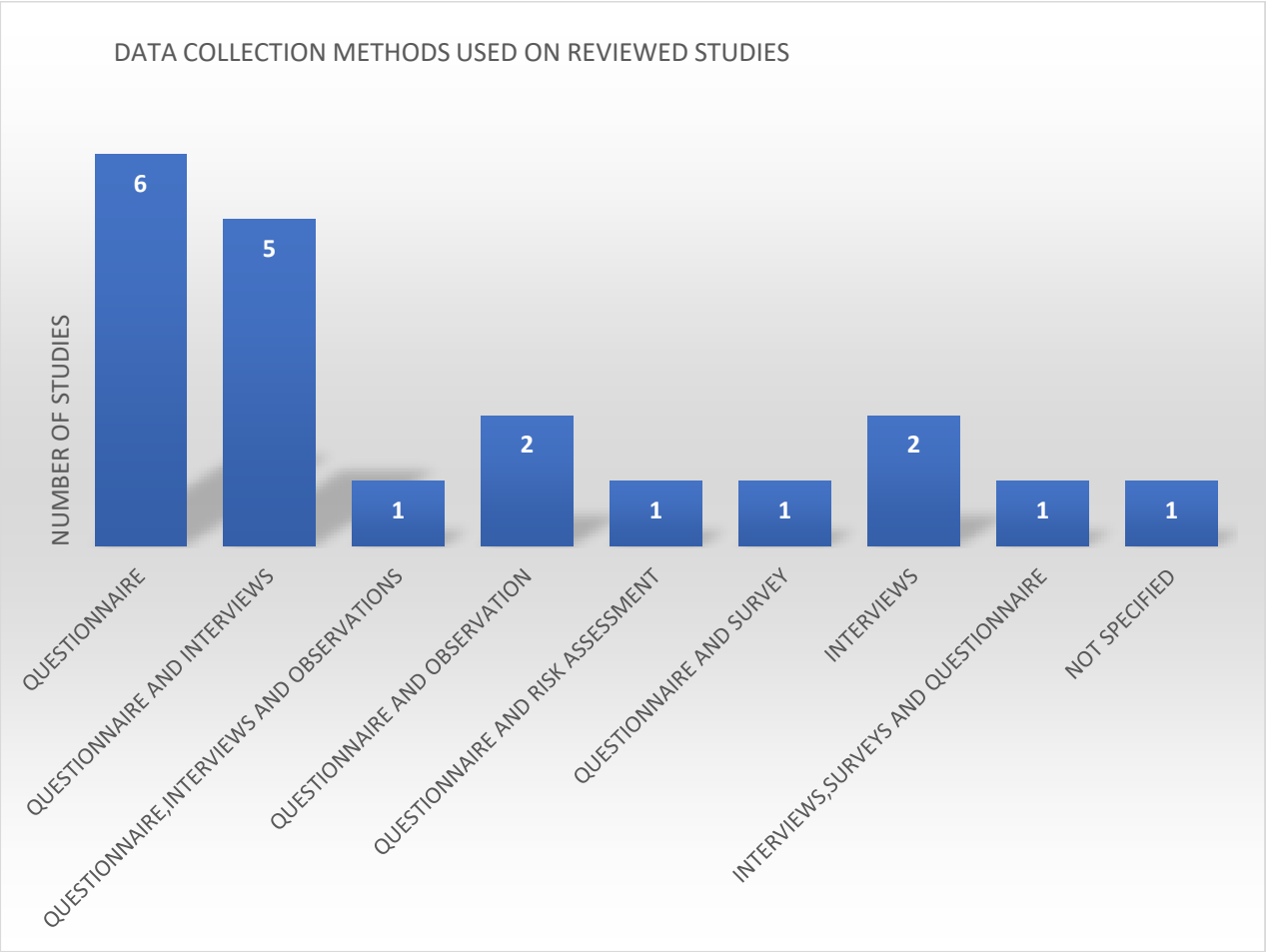


Figure 4.6: Data collection methods used on reviewed studies

Questionnaire was used in six studies, while a combination of questionnaires and interviews was used in five. Interviews as well as questionnaires with observation were used in two studies. The use of both questionnaire and risk assessment, questionnaire, and survey, as well as the combination of interviews, surveys, and questionnaires, were methods of data collection used in one study each. Questionnaire, interviews, and observation was a combination that was also utilised in one study. In one of the reviewed studies, the method used for data collection was not revealed.

4.1.7. Type of waste collected from landfills

Figure 4.7 represents the type of waste collected from landfills by informal waste pickers as reported by the reviewed studies. These studies shed light on the type of waste present in landfills and highlighted the predominant type of collected waste material during the period of the studies.

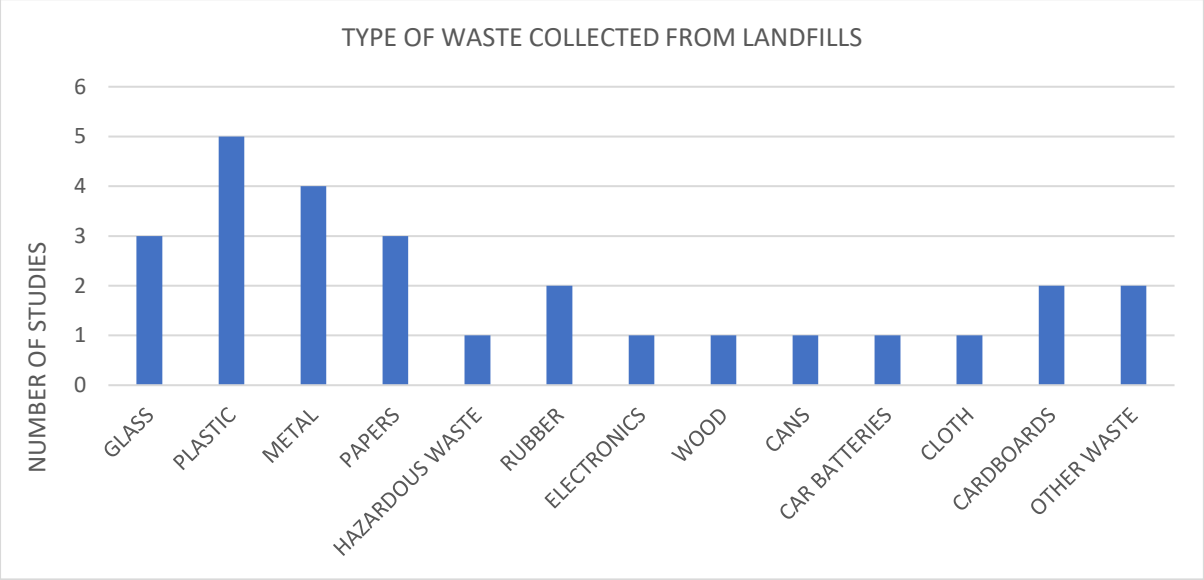


Figure 4.7: Type of waste collected from landfills

Only five of the reviewed studies mentioned the types of waste that informal waste pickers collected from landfills. Some of the studies reported more than one type of waste. Plastic was mentioned in all five studies, metals in four, glass and papers in three. Cardboard, other waste, and rubber were each mentioned in two studies. Hazardous materials, electronics, wood, cans, car batteries, and textiles were mentioned in one study each.

4.1.8. Sources of hazards faced by informal waste pickers

Figure 4.8 illustrates sources of hazards faced by informal waste pickers in order to establish which source was reported the most during the study period.

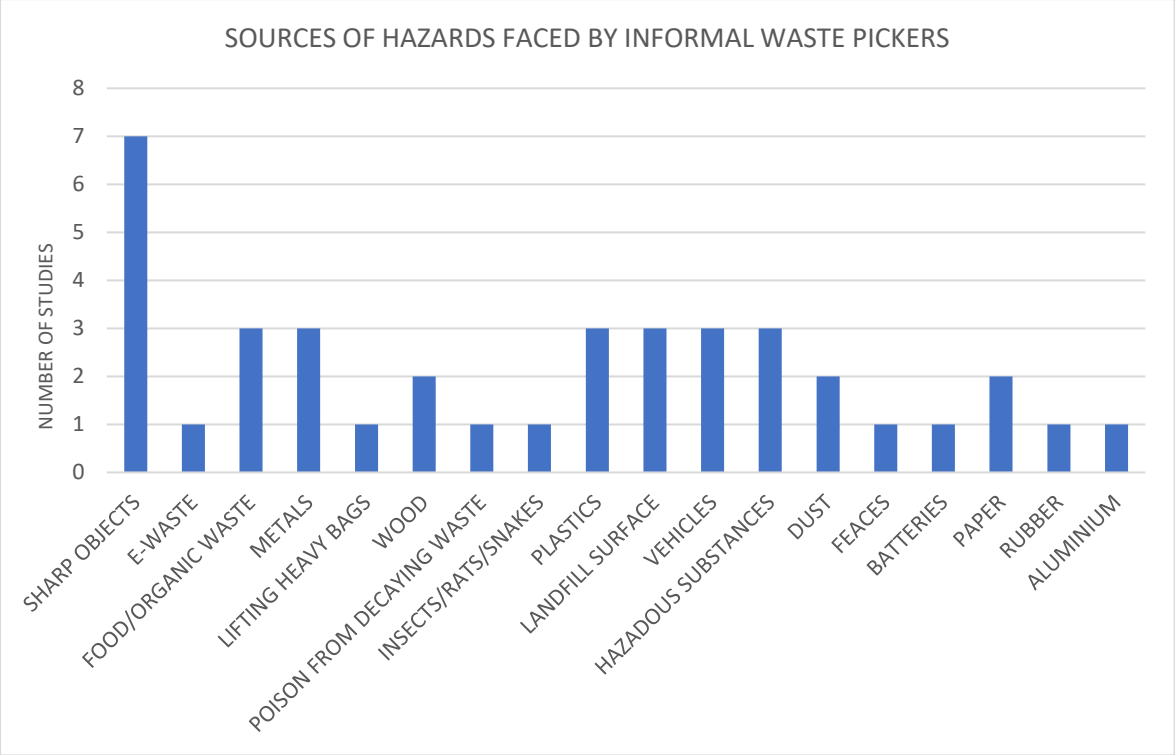


Figure 4.8: Sources of hazards faced by informal waste pickers

Of the 20 reviewed studies, nine outlined the origins of hazards encountered by informal waste pickers within landfill environments. Notably, some studies documented more than one hazard. Sharp objects were cited in seven studies, while food or organic waste, metals, landfill surfaces, and vehicles were mentioned in three studies each. Hazardous substances and plastics were each mentioned in three studies as well, while wood, dust, and papers were mentioned in two studies each. Furthermore, electronic waste (e-waste), lifting of heavy bags, exposure to toxins from decaying waste, faecal matter, batteries, rubber, and aluminium were mentioned in one study each. Insects, rats, or snakes were also documented in one study.

4.1.9. Type of (PPE) used by informal waste pickers

Figure 4.9 illustrates the type of PPE informal waste pickers used as reported by the reviewed studies. These studies highlighted the commonly used PPE by informal waste pickers within 2015 and 2022 study period.

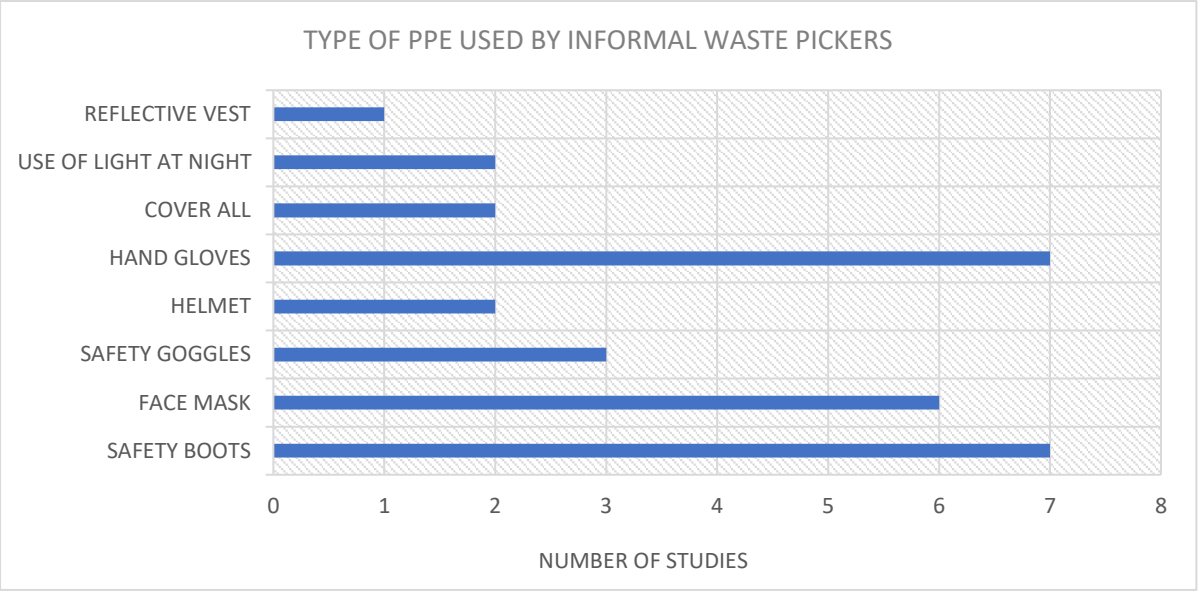


Figure 4.9: Type of PPE used by informal waste pickers

A total of 15 of the 20 reviewed studies provided information regarding the specific PPE used by informal waste pickers during their waste collection activities in landfills. Other studies documented more than one type of PPE. Safety boots and hand gloves were reported in seven studies. Face masks and safety goggles were documented in six and three studies respectively. The use of light during night-time activities, covers all, and helmets were each highlighted in two studies. Reflective vest was only mentioned in one study. Although some of the studies reported on the use of PPE, they, however, did not mention the type of PPE by name. These studies only reported on whether informal waste pickers used PPE or not.

4.1.10. The use of PPE per year of publication

Figure 4.10 demonstrates the number of studies and years of publications that studied the use of PPE by informal waste pickers to determine the years that focused on the use of PPE.

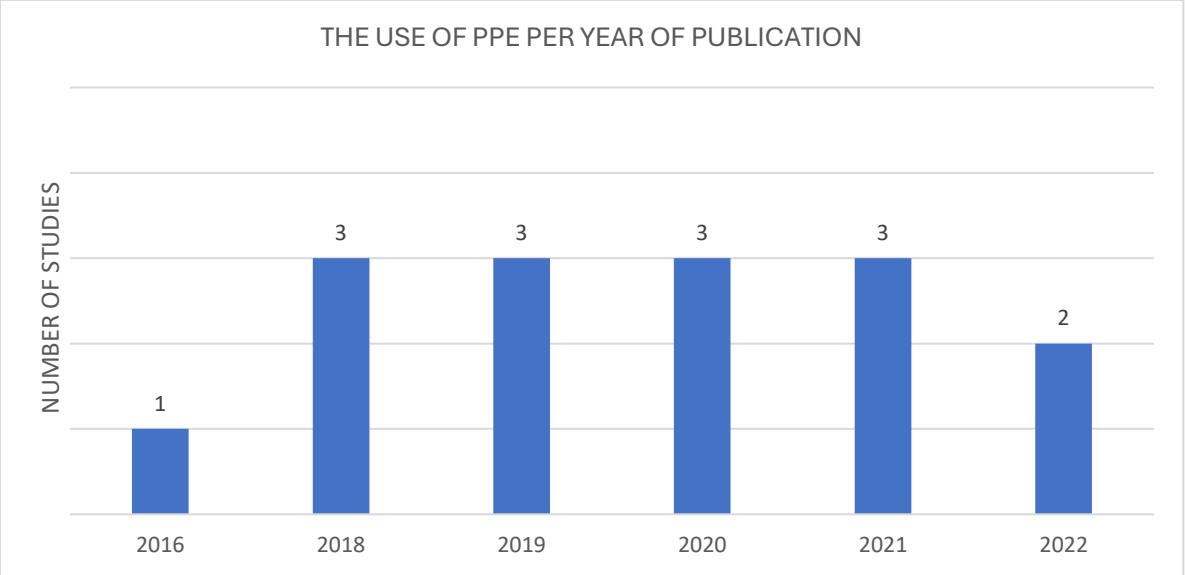


Figure 4.10: The use of PPE per year of publication

For each year, 2018, 2019, 2020, and 2021, three of the studies reported on the utilisation of PPE. The year 2022 and 2016 each had two and one studies that reported on the use of PPE by informal waste pickers.

4.1.11. Encountered occupational hazards

Figure 4.11 illustrates hazards linked to waste picking as documented by the studies reviewed. These studies identified the primary hazards associated with landfill waste picking during the study period.

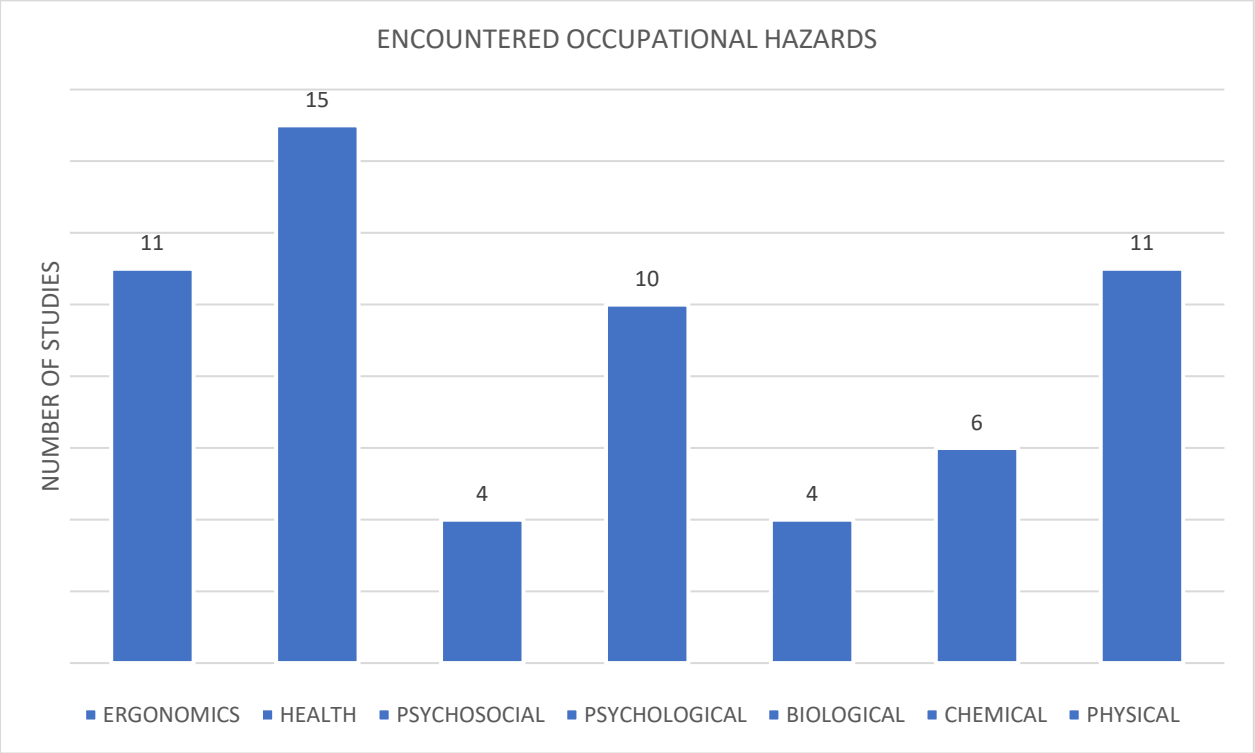


Figure 4.11: Occupational hazards encountered

All the analysed studies focused on the occupational hazards faced by informal waste pickers at landfill sites. Some of the studies reported on more than one of these hazards. Health hazards associated with waste picking was addressed in 15 studies, followed by ergonomics and physical hazards which were reported in 11 studies each. Psychological and chemical hazards were documented in 10 and six studies respectively, while psychosocial and biological hazards were each reported in four studies.

4.1.12. Occupational injuries suffered

Figure 4.12 presents occupational injuries experienced by informal waste pickers as documented in the reviewed studies. The aim was to identify the types of injuries encountered by these workers and ascertain which ones were most frequently reported.

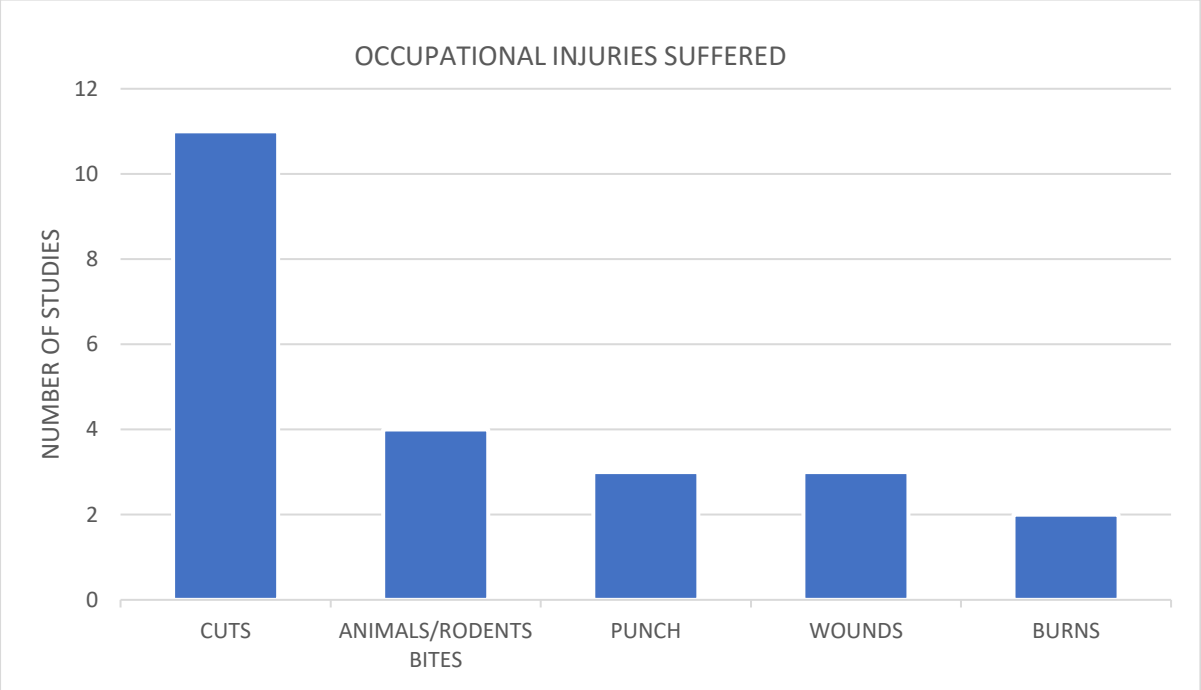


Figure 4.12: Occupational injuries suffered

Some of the studies reviewed documented more than one injury. Cuts were reported and documented in 11 out of the 20 reviewed studies. Animal or rodent bites were each highlighted in four studies. Punches and wounds were reported in three studies each. Burns were reported in two studies.

4.1.13. Health impacts from landfills

Table 3 is an illustration of health outcomes experienced by informal waste pickers caused by landfills as reported by 15 of the 20 reviewed studies. Each row on the table represents a different study, while the columns indicate different health outcomes. Only studies encompassing any form of health issues as a result of being an informal waste picker were included in the table. For each study the "X" mark indicates the presence of a health problem. Excluded studies did not cover any negative health outcomes.

Table 3: Negative health impacts suffered by informal waste pickers

	Health outcomes																						
Study name	Infectious diseases	Chronic diseases	Asthma	TB	Cancer	Hypertension	Hepatitis	Cholera	Typhoid	Diabetes	Lung problems	Malaria	Headache	Coughing	Respiratory problems	Gastrointestinal/ diarrhoea	Dysentery	Vomiting	Skin symptoms	Impetigo	Eyes problems	Conjunctivitis	Ears problems	Nasal irritation
Uhunamure *et al*. (2021)	X	X											X		X	X			X		X		X	
Nyathi *et al*. (2018)													X		X			X	X	X		X		
Ali and Yusuf (2021)																			X		X		X	X
Made *et al*. (2020b)						X															X			
Schenck *et al.* (2020)				X											X									
Makhubele *et al.* (2019)		X	X	X	X	X				X			X			X		X			X		X	X
Made *et al*. (2020a)	X	X																						
Made *et al*. (2019)	X	X																						
Tlotleng *et al.* (2019)															X	X								
Magaji and Osigbemhe (2018)							X	X	X						X	X	X		X		X			
Mothiba (2016)													X	X	X	X			X		X		X	
Hashim *et al*. (2020)			X	X							X													
Nuripuoh *et al*. (2021)									X			X	X	X	X	X		X	X					
Vasina (2018)																								
Byonanebye *et al.* (2022)																			X		X		X	X

Skin, respiratory problems and eye ailments were each documented in seven studies. Gastrointestinal troubles including diarrhoea were noted in six studies each. Ear infections and headaches were each highlighted in five studies, while chronic diseases were mentioned in four. Infectious diseases, tuberculosis, vomiting, and nasal irritation were each identified in three studies. Typhoid, hypertension, coughing, and asthma were each reported in two studies. Reported in one study each, were hepatitis, cholera, cancer, lung problems, diabetes, dysentery, conjunctivitis, and impetigo.

4.1.14. Musculoskeletal problems

Table 4 is an indication of various musculoskeletal problems suffered by informal waste pickers at landfills as reported by 11 of the 20 reviewed studies done on Africa relating to the impacts of landfills on informal waste pickers. Studies that were excluded from the table did not address any musculoskeletal issues. Only studies encompassing any form of musculoskeletal problems resulting from being an informal waste picker were included in the table. For each study, "X" mark indicates the presence of a particular musculoskeletal issue. The rows represent the studies, while the columns represent different types of symptoms that the participants reported in different reviewed studies.

Table 4: Musculoskeletal problems

Ergonomics (musculoskeletal)											
Study name	Back pains	Chest pains	Neck pains	Shoulder pains	Joint pains	Muscular	Swelling/ numbness of limbs	Tiredness/weakness	Cramp	Tetanus	Slip and fall
Patrick *et al*. (2022)	X										
Nyathi *et al*. (2018)							X	X	X		
Ali and Yusuf (2021)	X	X	X	X	X		X				
Wilson *et al*. (2021)					X						X
Naicker *et al.* (2019)						X					X
Magaji and Osigbemhe (2018)	X	X			X	X	X	X		X	
Mothiba (2016)	X	X			X						X
Hashim *et al*. (2020)					X						
Nuripuoh *et al*. (2021)	X	X									X
Vasina (2018)	X	X						X			
Byonanebye *et al*. (2022)	X	X									

Back pain was documented in seven studies. Chest pain was reported in six studies, with joint pain reported in five studies. Slip and fall incidents were noted in four studies. Swelling/numbness of limbs and tiredness/weakness were reported in three studies each. Muscle pain was documented in two studies, while neck pain, shoulder pain, tetanus, and cramps were each addressed in one study.

4.1.15. Landfills impacts by socio-demographics

Figure 4.13 illustrates landfill impacts on informal waste pickers by socio-demographics. The study's goal was to determine the relationship between exposure to landfill hazards and socio-demographics and to also determine the mostly documented socio-demographics during the study period.

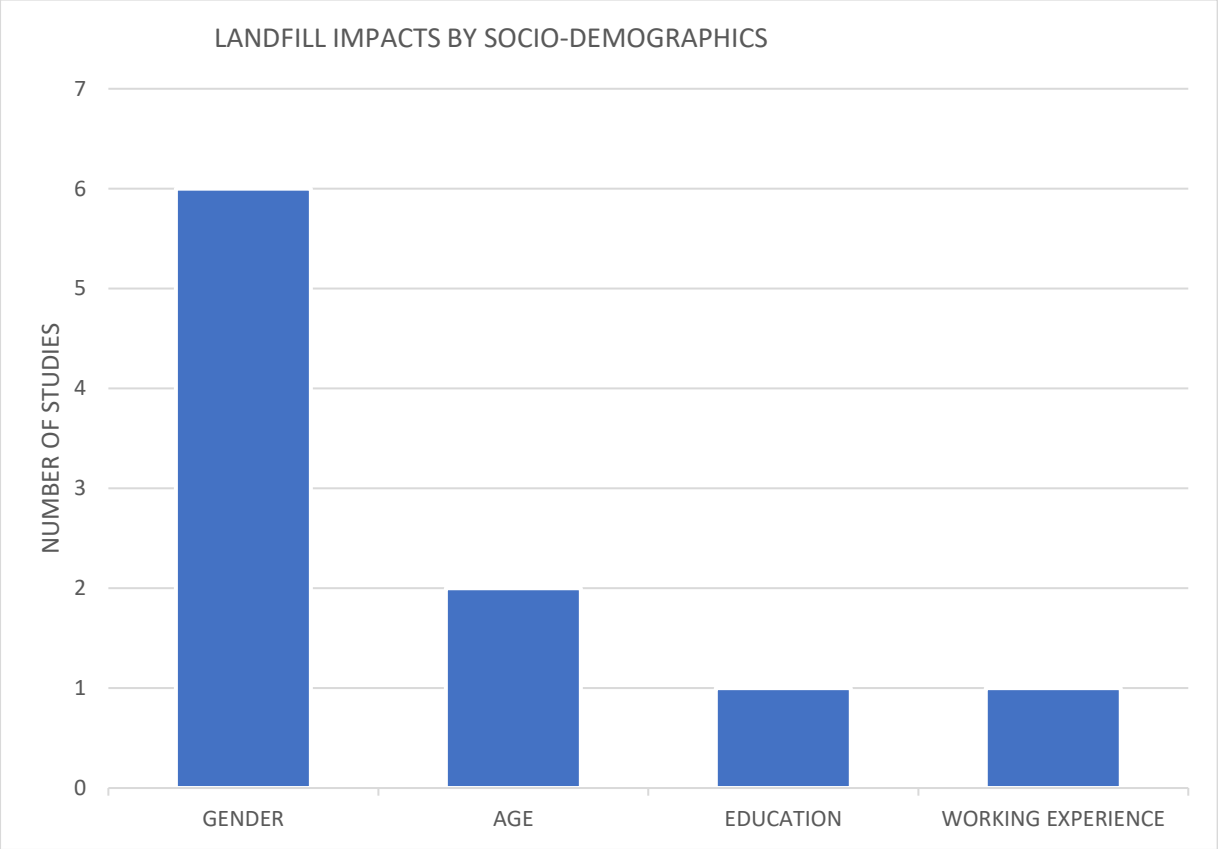


Figure 4.13: Landfill impacts by socio-demographics

Out of the 20 reviewed studies, 10 studies compared the impacts that landfills have on informal waste pickers in relation to age, gender, education, and working experience. Gender-related impacts were reported in six studies. Age related impacts were documented in two studies. The influence of educational level and working experience each were reported in one study. Additionally, one study went a step further and compared their socioeconomic statuses as well.

4.1.16. Psychological impacts of landfills

Figure 4.14 shows psychological impacts of landfills on informal waste pickers as documented in the reviewed studies conducted in Africa relating to landfill impacts on informal waste pickers. To determine the type as well as the mostly reported impact during the period of the studies.

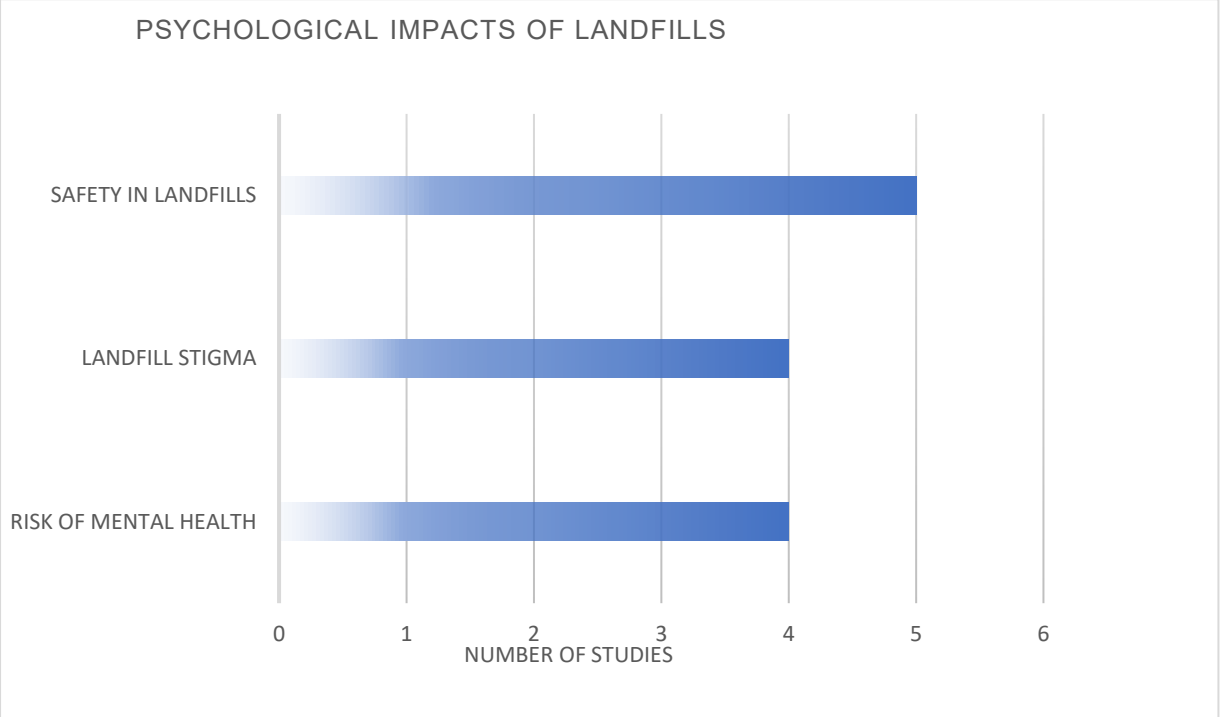


Figure 4.14: Psychological impacts of landfills

Out of the 20 studies reviewed, nine reported on the psychological effects experienced by informal waste pickers in landfills. Safety concerns within landfills were reported in five studies. Landfill-related stigma and mental health risks were highlighted in four studies each.

4.1.17. Awareness levels of occupational hazards

Figure 4.15 represents the level of informal waste pickers' awareness with regards to occupational hazards as reported by the reviewed studies conducted in Africa relating to landfill impacts on informal waste pickers. These studies highlighted the level of waste pickers awareness on the risks related to their occupation.

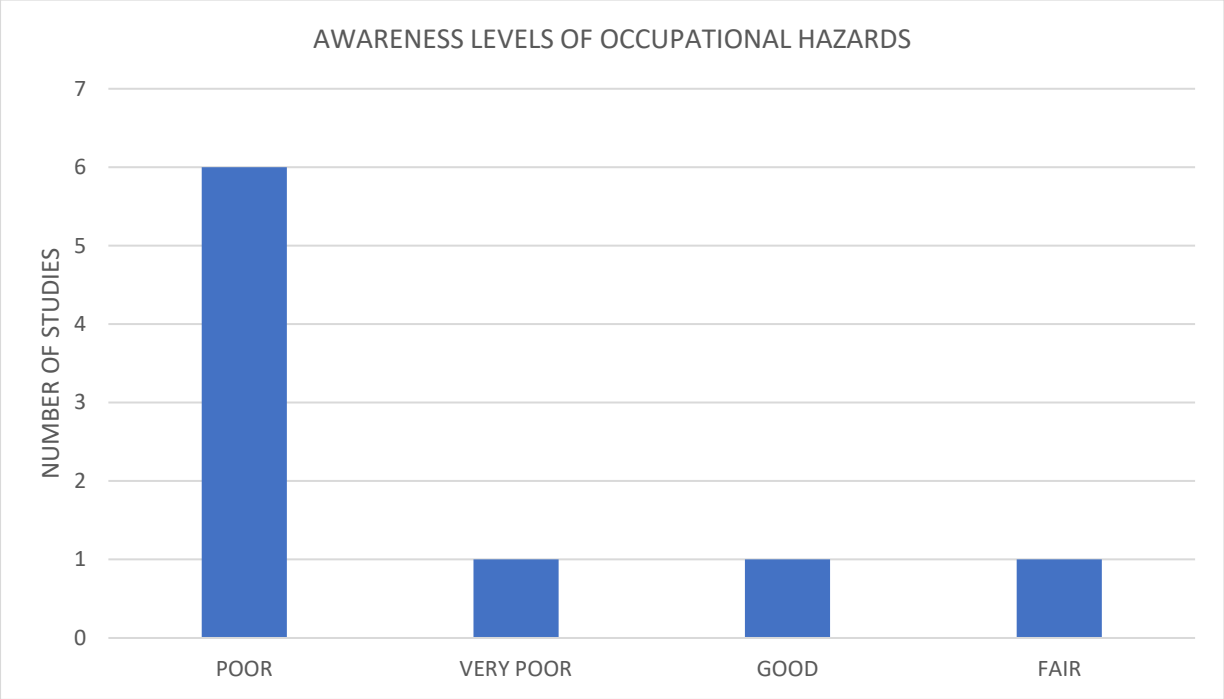


Figure 4.15: Awareness levels of occupational hazards

From the 20 reviewed studies, nine analysed the level of informal waste pickers occupational hazards awareness. Poor levels of awareness were reported and documented in six studies, while, very poor, fair, and good were documented in one study each.

4.1.18. Landfill hazards that were not exclusively studied

None of the 20 reviewed studies exclusively explored the chemical and biological effects of landfills on informal waste pickers. Of the reviewed studies, six documented that informal waste pickers are exposed to chemical hazards in landfills. With regards to biological hazards, four studies indicated that picking waste in landfills is associated with exposure to biological hazards.

4.1.19. Recommendations from reviewed studies

Figure 4.16 represents recommendations made in studies conducted on health impacts of landfills on informal waste pickers in Africa. To determine what recommendations were made and which ones were mostly recommended.

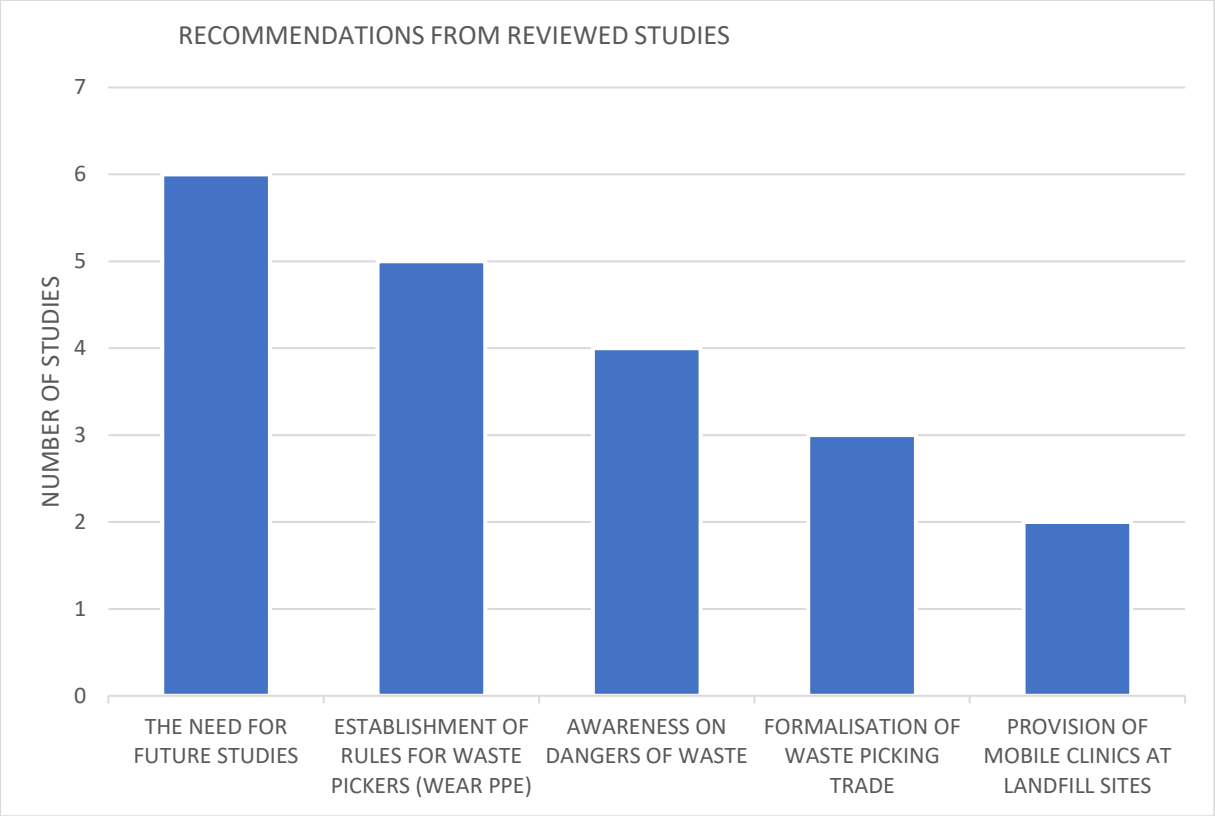


Figure 4.16: Recommendations from reviewed studies

The need for further research was recommended and emphasised in six studies. The establishment of rules for waste pickers, with a particular emphasis on the importance of wearing personal protective equipment was documented in five studies. Enhancing awareness concerning the hazards linked to waste picking was proposed in four studies. Moreover, formalising the waste-picking trade was recommended in three studies, and establishing mobile clinics at landfill sites was suggested in two studies.

4.1.20. Study areas that need more attention

Further research is warranted in the following areas. These areas need further studies because, from the 20 reviewed studies, each area was addressed only once.

1 Mental health among informal waste pickers.

2 Prevalence of hypertension among informal waste pickers.

3 Cardiovascular disease rates among informal waste pickers.

4 Biological and chemical impacts of landfills on informal waste pickers - these two areas were not solely investigated.

4.2. Reviewed studies on surrounding communities

A total of 37 studies were identified and screened for exclusion or inclusion. Of these, 16 studies were excluded from this review because they concentrated on landfill impacts on the environment only. Studies included on this review relating to the impacts of landfills on surrounding communities were 21.

These studies chose heads of households or the oldest person in the house as the respondent. Majority of respondents were males. The average age of respondents was between 21 and 40 years. Most of the respondents from the reviewed studies had attained secondary education, were self-employed, and married. Proximity to the landfill was 100 m to 10 km, however, a study by Suleman (2016) calculated the distance by means of minutes travelled to the landfill (10 - 15 minutes). The studies reported that most of the respondents have stayed close to the landfill for five to 10 years. The studies compared the impact of landfill to those who stay close by and far away. It is important to note that one study reviewed the impacts of landfills on both informal waste pickers and surrounding communities (Mugo *et al., 2022).*

4.2.1. Studies conducted in African countries

Figure 4.17 represents the number of studies published per country in Africa relating to the impacts of landfills on surrounding communities. To determine where the most research was done on this topic during the studies period.

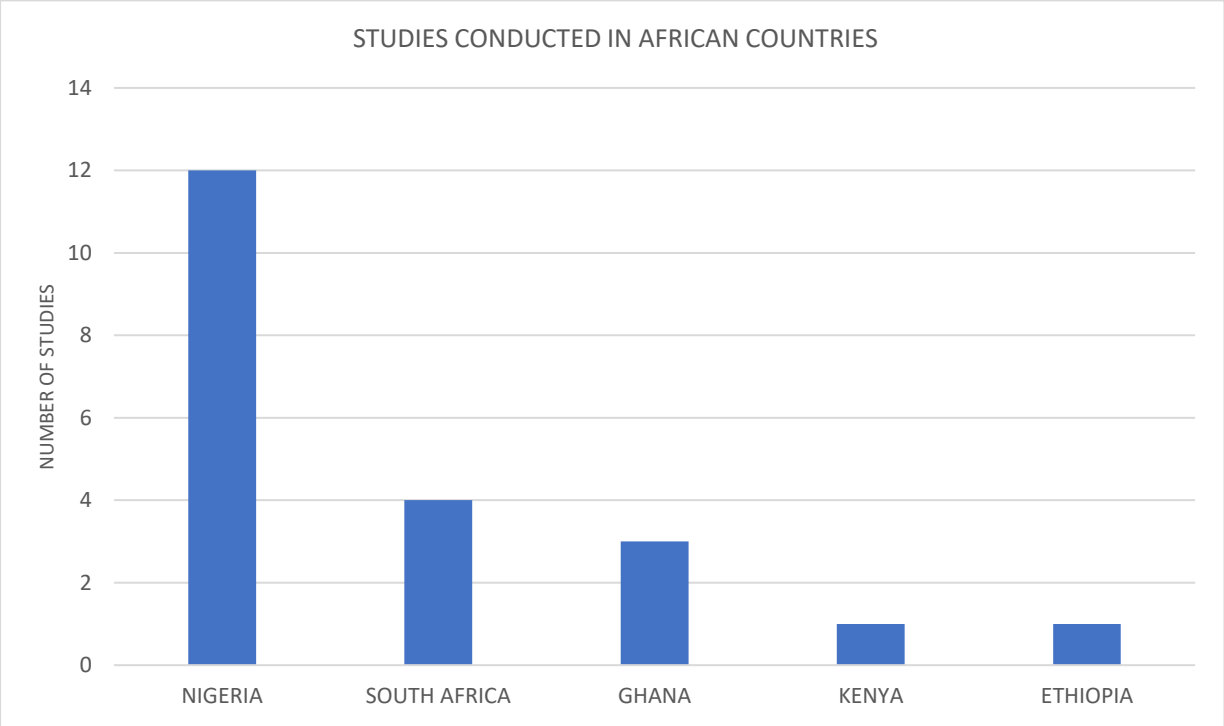


Figure 4.17: Studies conducted in African countries

Out of the reviewed studies, Nigeria had 12 studies published, with South Africa having four studies, followed by Ghana with three studies published. Kenya and Ethiopia each had one study published.

4.2.2. Studies published per year

Figure 4.18 represents the number of studies published per year between 2015 and 2022 on the impacts of landfills on surrounding communities in Africa. To determine when the most research was published on this topic within the studies period.

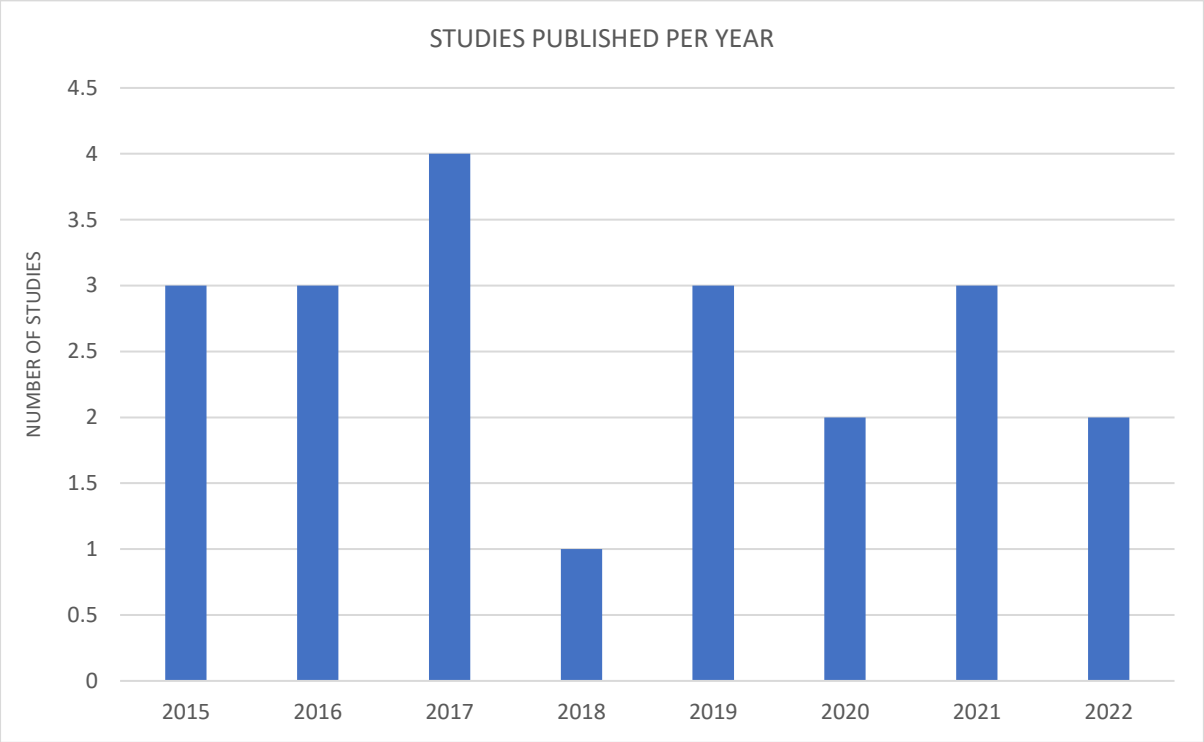


Figure 4.18: Studies published per year

In the year 2017, four studies were published. The years 2015, 2016, 2019, and 2021, published three studies each. In 2020 and 2022, 2 studies each were published. Only one study was published in the year 2018.

4.2.3. Research design used on reviewed studies

Figure 4.19 illustrates the research designs utilised in studies done in Africa relating to the impacts of landfills on surrounding communities, to determine the mostly preferred design during the studies period.

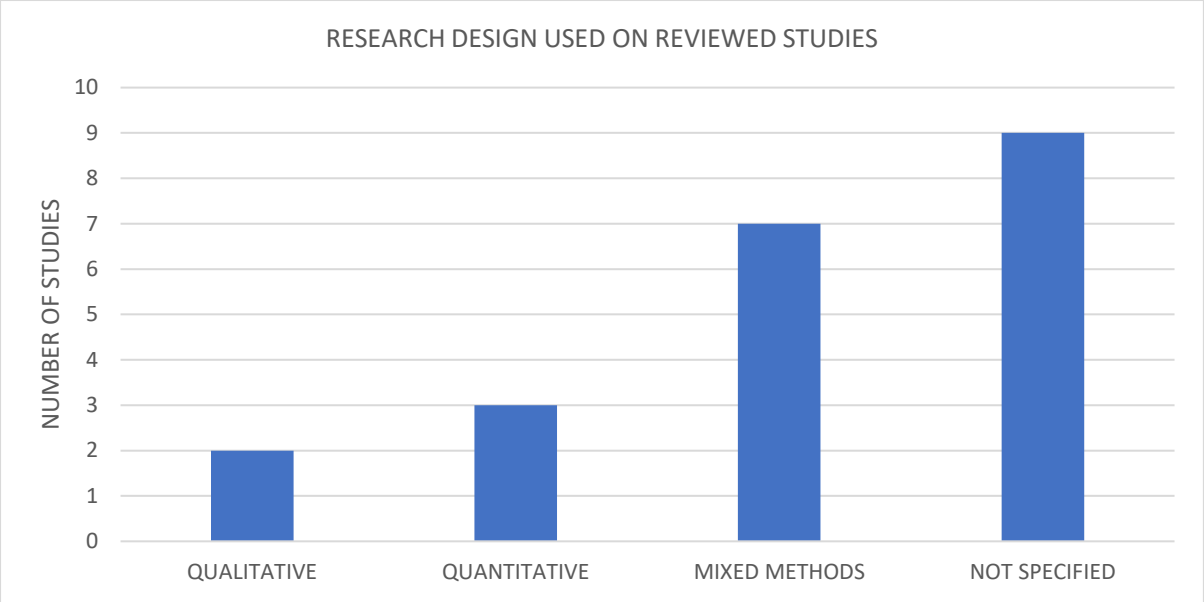


Figure 4.19: Research design used on reviewed studies

Mixed methods were used in seven studies. Quantitative methods were utilised in three studies, while qualitative methods were used in two studies. Of the reviewed studies, nine did not specify their research design.

4.2.4. Research methods used on reviewed studies

Figure 4.20 represents research methods used on studies conducted in Africa relating to landfill impacts on surrounding communities. Aiming to highlight the method that was mostly preferred during the studies period.

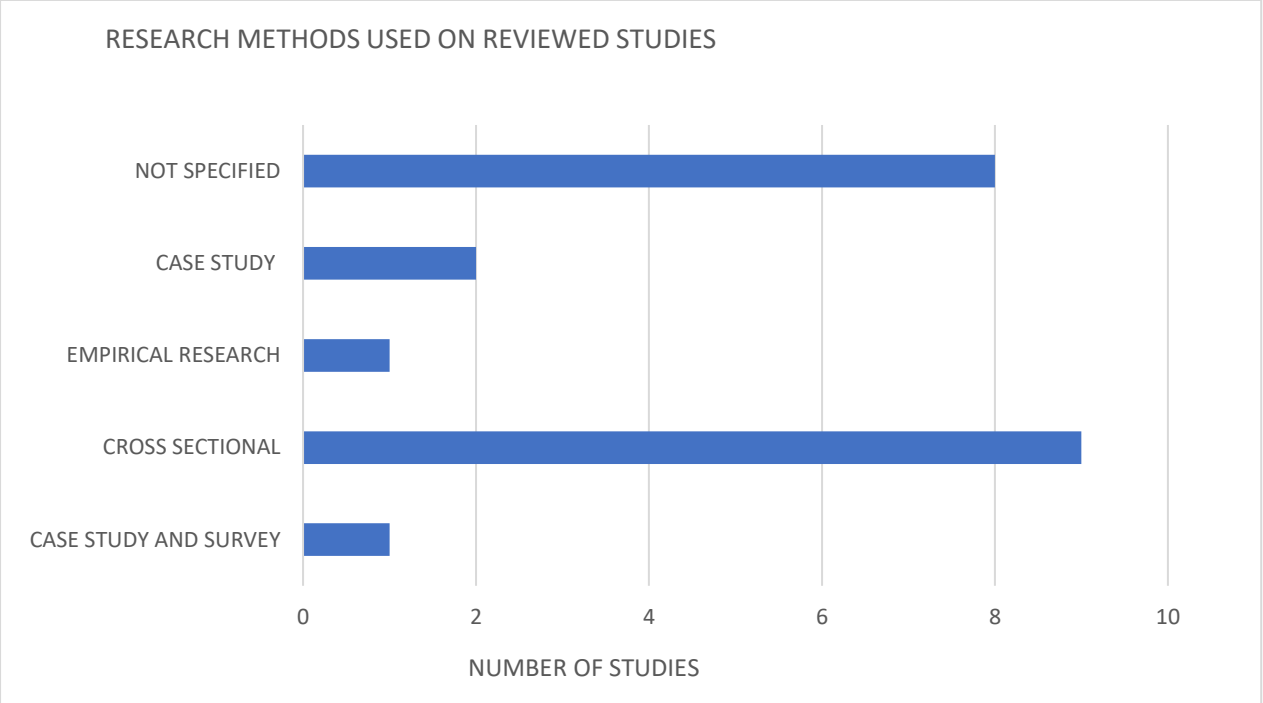


Figure 4.20: Research methods used on reviewed studies

Among the 21 studies examined, nine studies used cross-sectional method. Case study was employed in two studies. The combination of case study and survey, as well as empirical research were each utilised in only one study. Additionally, eight studies did not specify their research methods.

4.2.5. Sampling methods used on reviewed studies

Figure 4.21 illustrates the sampling methods used by studies published in Africa relating to the impacts of landfills on surrounding communities. To highlight the frequently used sampling method by the reviewed studies.

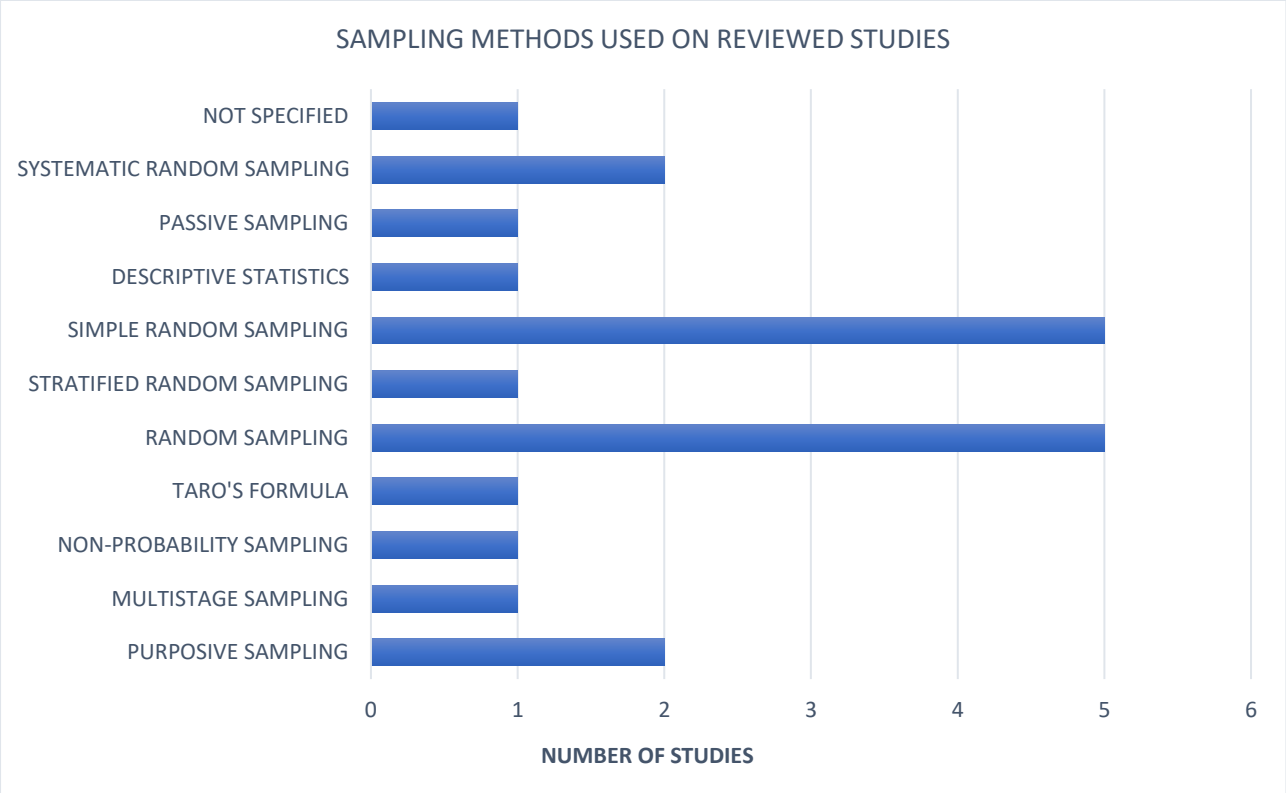


Figure 4.21: Sampling methods used on reviewed studies

Random and simple random sampling were used in five studies each. Purposive sampling and systematic random sampling were sampling methods each utilised in two studies. Sampling methods that were used in one study each were multistage sampling, non-probability sampling, stratified random sampling, descriptive statistics, Tarro's formula and passive sampling. Out of the 21 reviewed studies, one did not mention the sampling method employed.

4.2.6. Data collection used by reviewed studies

Figure 4.22 represents data collection method used by studies conducted in Africa relating to impacts of landfills on surrounding communities. To determine which method of data collection was mostly used on these studies.

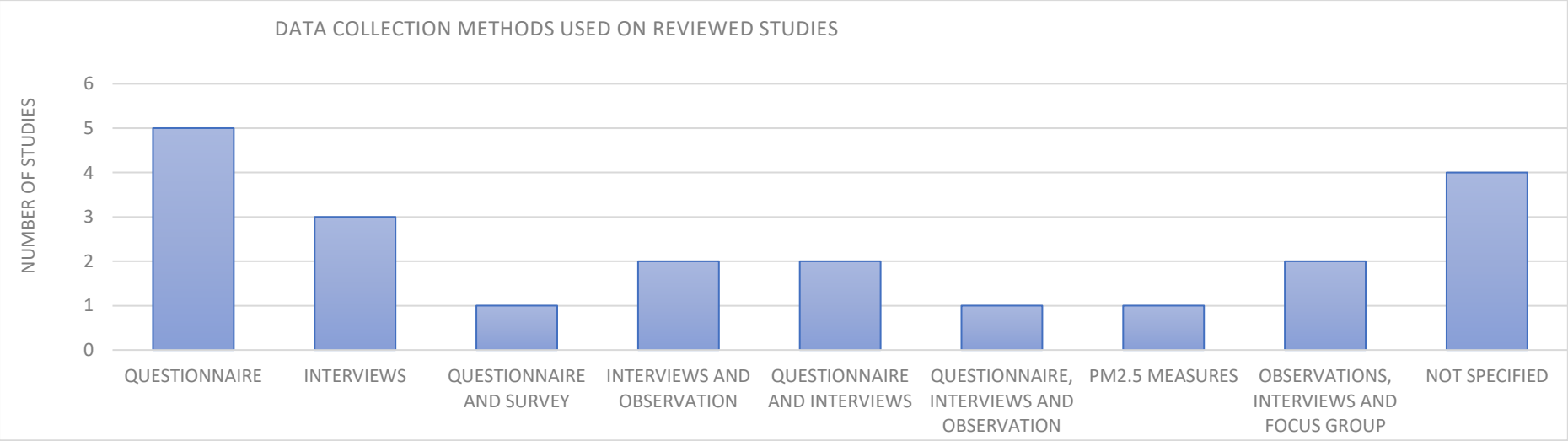


Figure 4.22: Data collection methods used on reviewed studies

Of the reviewed studies, questionnaire was used in a total of five studies. The interview method was utilised in three studies. The combination of observation, interview, and focus group as well as questionnaire and interview were employed in two studies each. Interview and observation, this combination was used in one study. Particulate Matter ($PM_{2.5}$) measurements and questionnaire with survey were methods also used in one study each for data collection. The number of studies that failed to disclose their data collection methods amounted to four.

4.2.7. Environmental hazards from landfills

Figure 4.23 represents landfill-reported environmental hazards faced by communities who resides close to landfills as documented by the reviewed studies. To determine the kind of environmental hazards that surrounding communities are exposed to from landfills. To also identify the most reported hazards.

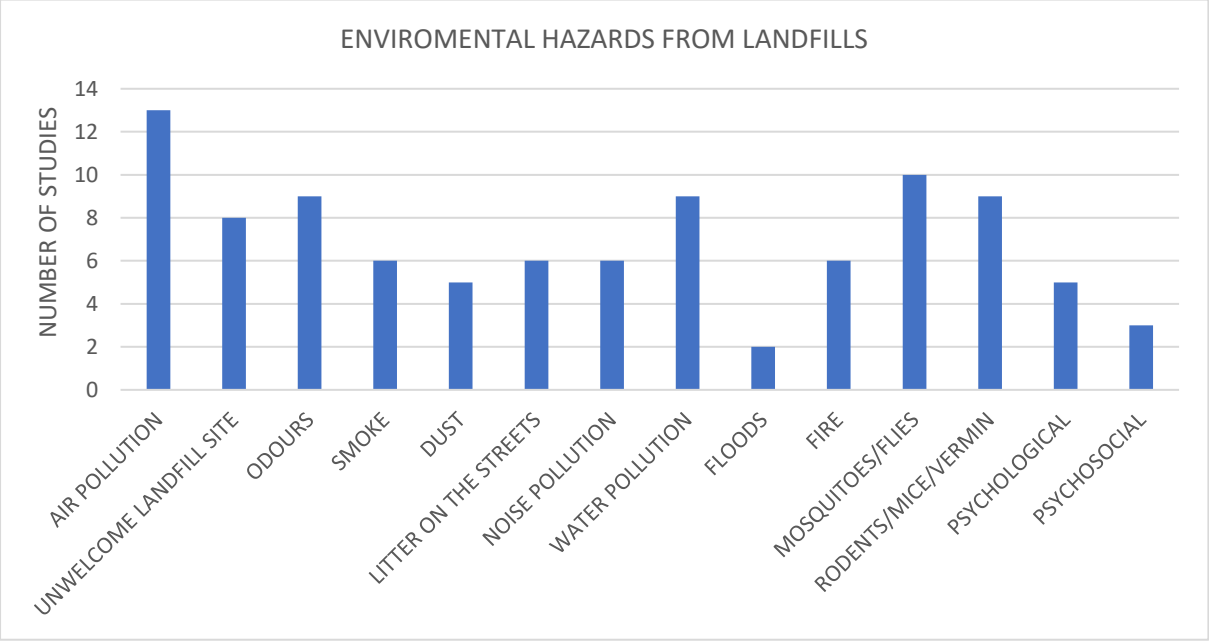


Figure 4.23*:* Environmental hazards from landfills

From the reviewed studies,15 studies detailed the specific environmental hazards communities encounter when residing in proximity to landfills. Some of the studies documented more than one hazard. In 13 studies, air pollution was reported. Mosquitoes or fly invasions were documented in 10 studies. Rodent infestation, odorous conditions and water pollution were documented as challenges in nine studies. The unwelcome landfill site was reported in eight studies. Additionally, street litter, smoke, fires, and noise pollution were each reported in six studies. Psychological issues and dust were documented in five studies. Psychosocial and flood-related problems were mentioned in three and two studies respectively.

4.2.8. Landfill impacts by various factors

The proximity of residential areas to landfills and the duration of exposure are critical factors in evaluating the severity of consequences experienced by communities. Figure 4.24 illustrates the relative impacts of landfills on nearby communities, considering variables such as distance, socio-demographic factors, and seasonal changes. To highlight the frequently documented variable during the period of the studies.

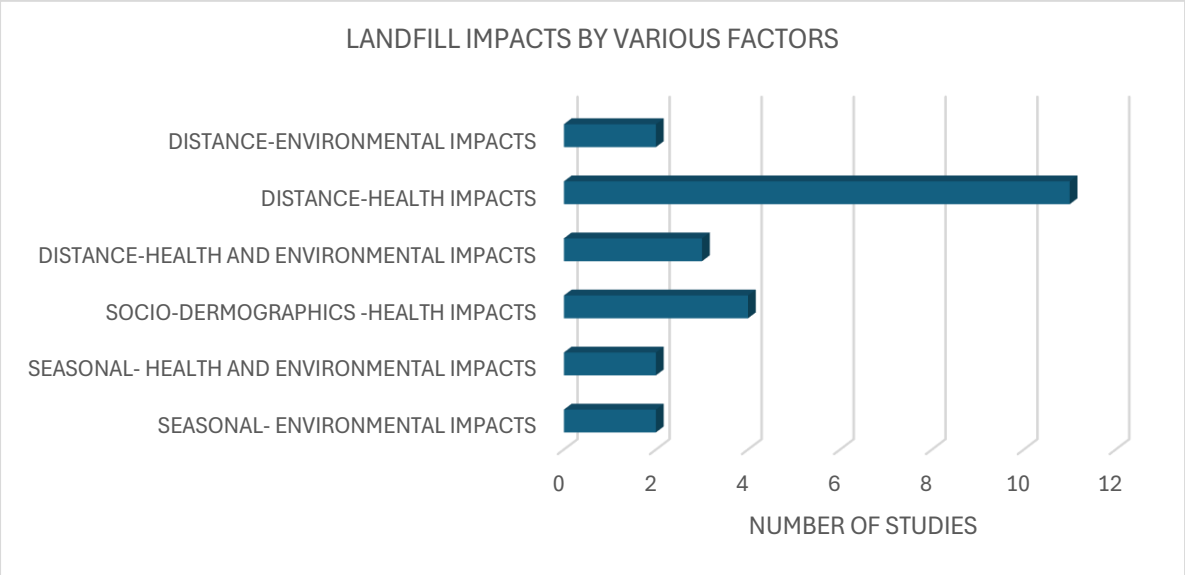


Figure 4.24: Landfill impacts by various factors

Among these comparisons, the analysis of health impacts based on distance was documented in 11 studies. Following this, four studies examined the correlation between socio-demographic factors and landfill impacts. Additionally, three studies focused on the combined assessment of health and environmental impacts based on distance. Seasonal variations in health and environmental impacts, distance-related environmental impacts, and the difference in seasonal environmental impacts were each investigated and reported in two studies. Notably, some of the studies analysed more than one factor.

4.2.9. Landfill psychosocial impacts

In addition to health and environmental repercussions, landfills can also cause psychosocial impacts on nearby communities (Figure 4.25). This figure demonstrates the psychosocial impacts of landfills on nearby communities. To determine the kinds of psychosocial impacts on surrounding communities from landfills and to also highlight which impacts were mostly reported by the reviewed studies.

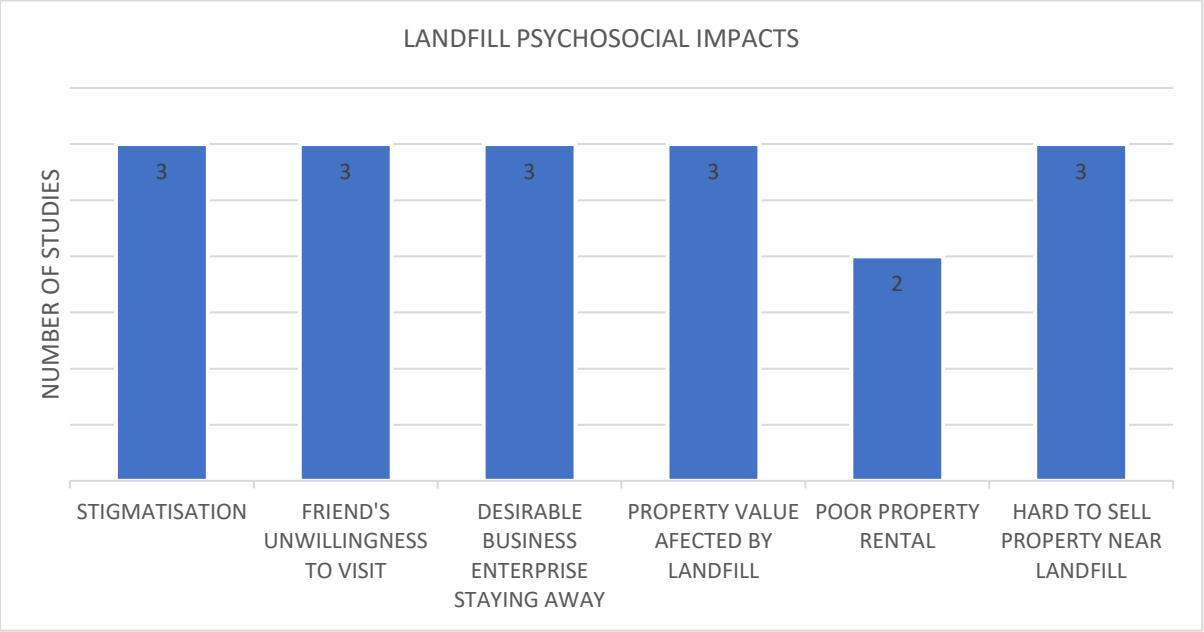


Figure 4.25: Landfill Psychosocial impacts

Landfill external factors or psychosocial impacts were analysed in three of the 21 reviewed studies. Some of the studies reported on more than one of these psychosocial impacts. These impacts include various challenges such as reluctance of friends to visit, avoidance of desired commercial enterprises due to the landfill's presence, stigma associated with living near landfills, and difficulties in selling properties which were each highlighted in three studies. Poor property rental was reported in two studies.

4.2.10. Landfill psychological impacts

Figure 4.26 illustrates studies that analysed the psychological effects of exposure to landfill hazards on nearby communities. These studies will assist in identifying those impacts as well as highlighting the most or least frequently examined and reported during the period of the studies.

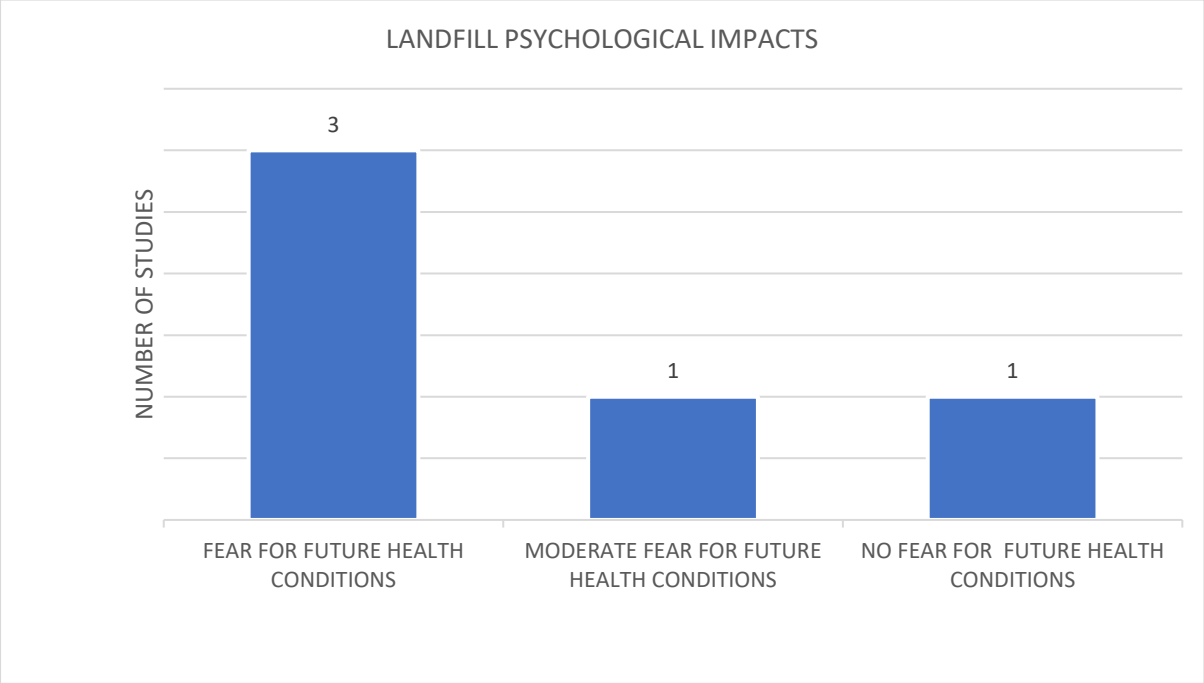


Figure 4.26: Landfill psychological impacts

Out of the 21 studies analysed, five investigated psychological effects of exposure to landfill hazards on nearby communities. Among these, three studies reported on the fear of potential future health conditions. In one study each, moderate concerns and no fears regarding future health conditions were documented.

4.2.11. Health impacts of landfill

Table 5 illustrates various adverse health effects experienced by residents living in close proximity to landfills as documented in the reviewed studies relating to the impacts of landfills on surrounding communities in Africa. Only studies encompassing any form of health impact on nearby communities resulting from landfills were included in the table. Each row on the table represents a different study, while the columns indicate different health outcomes. For each study, "X" mark indicates the presence of a particular health outcome. For instance, in study one, there are occurrences of cancer, kidney problems, malaria, cholera, hepatitis, Headache, pneumonia, common cold, reoccurring flu, coughing/TB, sore throat, wheezing/sneezing, fever, typhoid, respiratory problems, and nose irritation. Not all health outcomes are present in every study, indicating variability across cases.

Table 5: Negative health outcomes

Study name	Health Outcomes																																			
	Cancer	Lung infection	Fungi infection	Kidney problems	Ocular allergies	Malaria	Cholera	Hepatitis	Headache	pneumonia	common cold	Recurring flue	coughing/TB	Sore throat	Wheezing/ Sneezing	Fever	Typhoid	Asthma	Respiratory problems	Skin disorder	Eye irritation	Nose irritation	Hearing problems	Vomiting/nausea	Intestinal worms//Gastro-	Diarrhoea	Dysentery	Tetanus	Back pains	Chest pains	Abdominal pains	Body weakness	Pregnancy abortion	Premature birth	Birth defects	Regular health challenges
Njoku *et al*. (2019)	X								X			X	X					X		X	X		X		X				X			X				
Addo *et al*. (2015)	X					X		X					X			X	X		X	X						X				X						
Roffe *et al*. (2017)									X									X		X	X	X									X						
Nnamdi *et al*. (2017)						X	X							X		X				X	X			X	X	X					X						X
Aliu (2021)						X	X										X										X										
Ndukwe *et al*. (2019)						X	X													X	X	X			X	X				X							
Abiola *et al*. (2021)											X	X	X		X	X			X	X																	
Machete (2017)	X			X															X						X	X									X		
Suleman (2016)						X	X										X			X																	
Gumede and Savage (2017)																			X																		
Babs-Shomoye and Kabir (2016)						X	X													X					X	X				X							
Dada (2020)						X	X		X			X	X			X	X		X	X	X		X	X	X	X	X					X					X
Peprah *et al*. (2022)					X																																
Sindama *et al*. (2017)						X				X			X				X	X			X				X	X	X	X		X							
Etea *et al*. (2021)						X					X		X	X	X			X	X	X	X	X															X
Ozabor and Obaro (2016)						X														X					X	X	X										
Adetona *et al*. (2020)						X					X	X	X	X				X	X	X	X	X	X						X	X		X					
Oyedele and Oyedele (2017)	X	X	X			X	X													X				X	X	X	X	X			X		X	X	X		
Ahmed *et al*. (2017)						x											x									x	x										

Of the reviewed studies, 19 focused and reported on the impacts of landfill on the health of surrounding communities. Malaria and skin disorders were each reported in 13 studies, followed by diarrhoea, which was reported in 10 studies. Intestinal worms and gastrointestinal disorders were the subject of nine studies, while eye irritation was investigated in eight studies. Cholera, coughing/tuberculosis, and respiratory problems were examined in seven studies each. Chest pains, typhoid, and dysentery were addressed in six studies each. Asthma was discussed in five studies. Fever, recurring flu, nasal irritation, and cancer were explored in four studies each. Regular health issues, weakness, headaches, sore throat, the common cold, hearing problems, and vomiting were each reported in three studies. Birth defects, abdominal and back pain, tetanus, wheezing/sneezing, lung and fungal infections, hepatitis, ocular allergies, pregnancy complications leading to abortions and premature births, pneumonia, and kidney problems were each documented in only one study.

4.2.12. Residents' level of risk perception on landfill impacts

Figure 4.27 illustrates residents' perception levels regarding the risks associated with landfill hazards. These studies were used to ascertain the levels of knowledge that communities have with regard to landfill hazards.

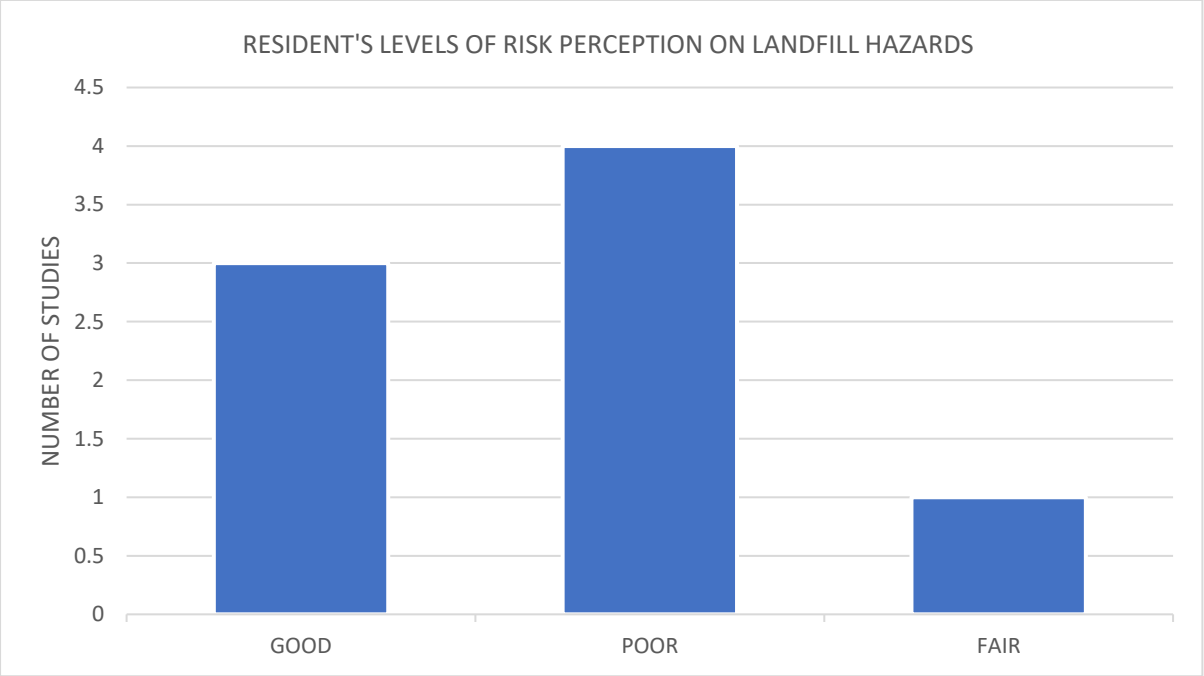


Figure 4.27: Resident's levels of risk perceptions on landfill hazards

From the 21 reviewed studies, eight examined resident's level of risk perception on landfill hazard. Poor levels of awareness were reported in four studies. Fair and good levels were reported in three and one studies each.

4.2.13. Recommendations from reviewed studies

Figure 4.28 shows recommendations from studies conducted in Africa relating to the impacts of landfills on surrounding communities from landfills. To determine what recommendations were made and which were mostly recommended.

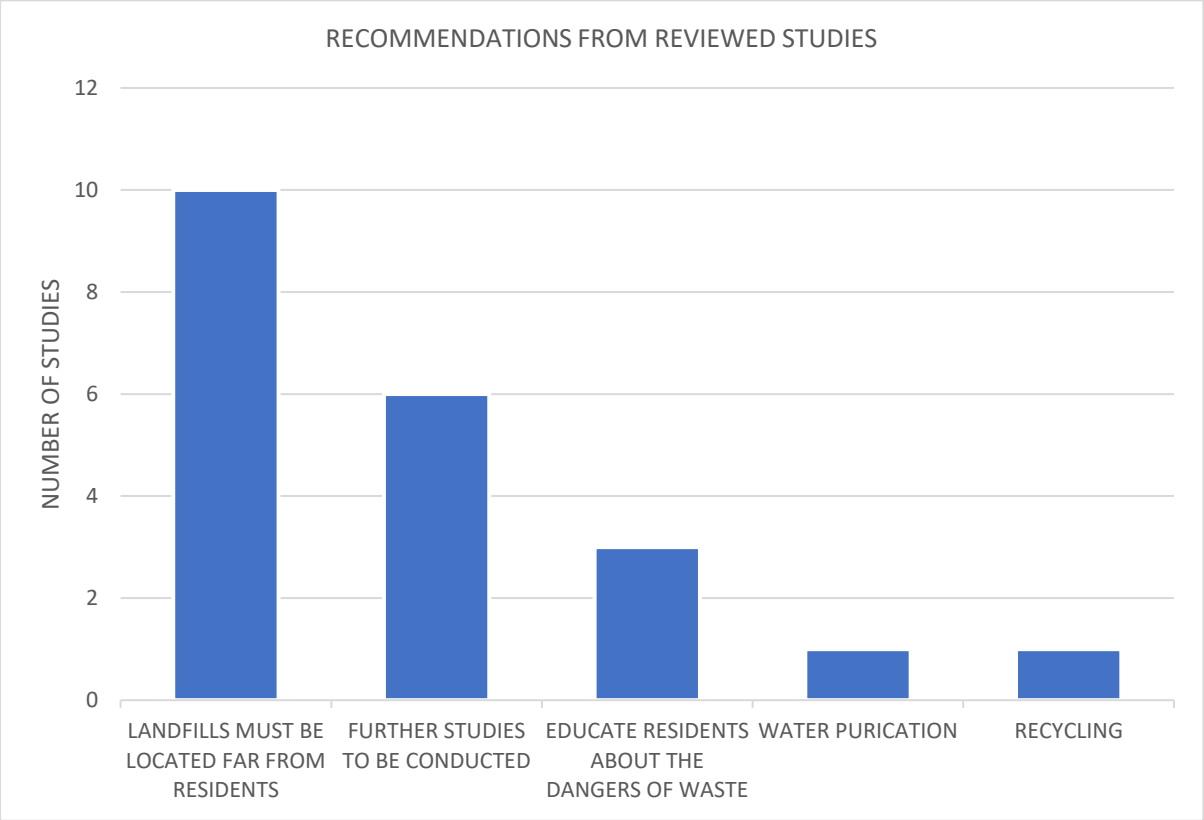


Figure 4.28: Recommendations from reviewed studies

From the reviewed studies examining the impacts of landfills on surrounding communities, several recommendations were made. Relocation of landfill sites was recommended in 10 of the studies. The need for conducting additional studies was advocated in six studies, whereas educating residents about the hazards of waste was a recommendation in three studies. Water purification and recycling were mentioned in one study each.

4.2.14. Study areas that need more attention

Additional studies are warranted in the following areas, which were only published once each, among the 21 studies conducted between 2015 and 2022 concerning the impacts of landfills on surrounding communities in Africa:

1. The health hazards faced by communities residing in proximity to landfills in connection with electronic waste (e-waste).

2. The duration of exposure and its correlation with health risks.

3. The well-being of children in affected areas.

4. Health hazards faced by surrounding communities in relation to landfill gas emission.

4.3. Impacts on waste pickers and nearby communities

Out of the reviewed studies, one study investigated the impacts of landfills on both informal waste pickers and surrounding communities.

A study by Mugo *et al*. (2022) evaluated the safety and health hazards at existing dumpsites in Kenya. The research employed a case study method, utilising a combination of questionnaires, interviews, and observations for data collection. The findings revealed that majority of informal waste pickers had only completed primary education.

The study documented several occupational risks faced by informal waste pickers, including noise-induced hearing loss, hand-arm vibration issues, manual handling concerns, and exposure to airborne contaminants *(*Mugo *et al., 2022*). Health issues resulting from exposure to landfill hazards included respiratory problems, as well as skin and ear issues (Mugo *et al*., 2022). It was also reported that these waste pickers did not use any form of PPE while working (Mugo *et al.,* 2022).

With regards to surrounding communities, majority of residents staying closer to the landfill complained about its location as well as the smelly conditions *(*Mugo *et al*., 2022). The study also established that residents used water from nearby streams to bath and to also wash their clothes, this may potentially enhance the risk of being exposed to chemicals *(*Mugo *et al*., 2022).

4.4. Conclusion

This chapter revealed that landfills significantly impact the health and environment of both informal waste pickers and nearby communities. The waste pickers face various health risks, injuries, and psychological distress due to their exposure to hazardous materials and challenging working conditions. Surrounding communities also experience negative health outcomes, environmental pollution, and psychosocial impacts due to the proximity of landfills.

5. Chapter 5: Discussion

5.1. Introduction

This chapter explored how the findings relate to the research objectives and how the research questions were answered. It also discusses the analysis done in Chapter 4, connecting the findings with theories and literature discussed earlier.

5.2. Synthesis

Objective 1: To identify research trends as well as research gaps from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

The objective was achieved through a systematic reviewal of relevant studies relating to landfill impacts on informal waste pickers and surrounding communities conducted in Africa. Systematic literature reviews conducted by Chan and Hsu (2016) and Bozkurt *et al.* (2015) in Section 2.5, revealed research trends and gaps in a specific discipline. By following the same research method, this study also identified research trends and gaps in the current literature.

Objective 2: To identify the impacts of landfills on informal waste pickers and surrounding communities from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

The objective was achieved through the initial identification of relevant studies. The reviewal process resulted in the achievement of this objective. Various impacts which were subsequently grouped together according to their similarities were identified as landfill impacts.

Objective 3: To determine the causes of landfill impacts on informal waste pickers and surrounding communities from studies conducted in Africa relating to landfill impacts on informal waste pickers and surrounding communities published between 2015 and 2022.

To achieve Objective 3, a comprehensive analysis of all included studies was conducted. The causes of impacts of landfills were identified. The sources of hazards which are now known includes sharp objects, food or organic waste, metals, vehicles, and hazardous substances. Yang *et al*. (2018) in Section 2.3.1 also identified sharp objects as a source of hazard faced by informal waste pickers.

Objective 4: To identify factors that influence the impacts of landfills on informal waste pickers and surrounding communities from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

Objective 4 was accomplished through a comprehensive analysis of different included studies. The thorough analysis enabled the identification and the grouping together of similar influential factors of landfill impacts on informal waste pickers and surrounding communities. Factors which influence the impacts of landfills on both informal waste pickers and surrounding communities are now known, these include distance, season, age, gender and educational level. In Section 2.4.1, Salah *et al*. (2019) reported on landfill impacts on surrounding communities by distance, while Limoli *et al*. (2019) focused on age.

Objective 5: To make recommendations based on the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities.

After the analysis of different studies**,** this objective was reached. A set of recommendations from the reviewed studies were identified. Recommendations made by the reviewed studies included relocation of landfills away from residential areas, teaching people about the dangers of landfill hazards, and establishment of rules for informal waste pickers and a need for further studies. By conducting a systematic

literature review, Chan and Hsu (2016) in section 2.5 also recommended more studies to be conducted.

Research question 1: What research trends and gaps were seen from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

This research question was answered in Figures 4.1 to 4.6 and in Figures 4.17 to 4.22. These figures illustrated the number of studies conducted on Africa, the number of studies published per year, research design, research method, sampling, and data collection methods used on the reviewed studies. It was observed that in both informal waste pickers and surrounding communities, most studies addressing the research question used mixed methods as their study design. Quantitative was the second most used, while qualitative was the least utilised, this can be seen in Figures 4.3 and 4.19. It is important to note that in the studies on surrounding communities, majority failed to reveal the research design used. Another trend is illustrated in Figures 4.4, and 4.20 which highlights that cross-sectional studies were the most frequently used research method, whereas cross-sectional surveys, case studies, and empirical research were the least used methods for informal waste pickers. In both informal waste pickers and surrounding communities, the most frequently used method was cross-sectional, followed by case studies. In the case of surrounding communities, the least utilised research methods were empirical and the combination of case study and survey. Of the reviewed studies, a quarter in the case of informal waste pickers and almost half in the case of surrounding communities did not mention their research methods. Bozkurt *et al.* (2015) in Section 2.5 reported findings indicating a trend on the studies they analysed, their results revealed that qualitative was the least used study design from the reviews they analysed.

Additionally, Figures 4.5 and 4.6 as well as Figures 4.21 and 4.22 highlight significant trends in sampling and data collection methods. The analysis revealed in Figure 4.5 that, in studies on informal waste pickers, convenience sampling was the most frequently employed method. In contrast, stratified random, accidental, random, purposive, non-probability, and multi-stage sampling were used the least. It is important to note that a quarter of these studies did not disclose the sampling method

they used. In terms of surrounding communities, Figure 4.21 shows that random and simple random sampling were the most frequently utilised methods, followed by purposive sampling and systematic random sampling as the second most common methods used. The least used sampling methods included multistage sampling, non-probability sampling, stratified random sampling, descriptive statistics, Tarro's formula, and passive sampling. Notably only a fraction of the studies did not specify the sampling method used. In Section 2.5, Gaur and Kumar (2018) also identified a trend in the studies they reviewed; they established that most studies used inductive approach.

Figures 4.6 and 4.22 which represents data collection methods used by the reviewed studies revealed that for both informal waste pickers and surrounding communities, majority of the reviewed studies used questionnaires as their method of data collection. For informal waste pickers, this was followed by using both questionnaires and interviews. The least utilised methods were the combinations of questionnaires and risk assessments, questionnaires and surveys, interviews, surveys, and questionnaires as well as questionnaires with interviews and observations. A small fraction of the studies failed to reveal the data collection method employed. In the case of surrounding communities, the second mostly used method was interviews. $PM_{2.5}$ measurements, along with questionnaires supplemented by surveys were the least used. Almost a quarter of the studies did not specify their method of data collection. This review underscores a notable gap in the existing studies concerning the impacts of landfills on informal waste pickers and surrounding communities across other African nations as prior studies have predominantly focused on South Africa and Nigeria as shown in Figures 4.1 and 4.17. Moreover, Figure 4.2 shows that the years 2020 had the most published studies followed by 2021 in the case of informal waste pickers. Notably, the years 2015 and 2017 did not have any studies published. When it comes to studies on surrounding communities in Figure 4.18, the year 2017 had the most published studies, while 2015, 2016, 2019, and 2021 had the second most studies published.

Research gaps were also identified in underexplored areas that require further attention as discussed in Sections 4.1.20 and 4.2.14. Regarding the impacts of landfills on informal waste pickers, the study highlights several neglected areas of investigation

detailed in Section 4.1.20. These areas include the overall hygiene status of informal waste pickers working within landfills, the prevalence of mental health issues, biological and chemical impacts from landfills, and the frequency of hypertension and cardiovascular diseases among these workers.

Furthermore, the study highlights the importance of further research into the effects of landfills on nearby communities as discussed in Section 4.2.14. These includes evaluating health risks from e-waste, gas emissions, exposure duration, and the well-being of children living near landfills. Research gaps were identified in Section 2.5 by Chan and Hsu (2016), the review highlighted the need for further studies on areas including green marketing, environmental reporting, environmental technology which were underexplored.

Research question 2: What were the impacts of landfills on informal waste pickers and surrounding communities identified from the studies reviewed conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

The presence of landfills can have various impacts on both informal waste pickers and surrounding communities as demonstrated in Figures 4.11 and 4.23. Figure 4.11 illustrates occupational hazards encountered by informal waste pickers. These impacts can be categorised into different areas, ergonomics, physical health, psychosocial well-being, chemical and biological hazard. The most frequently reported hazard was health hazards associated with waste picking, closely followed by ergonomics, psychological, and physical hazards in descending order. While some attention was also given to chemical hazards, psychosocial and biological hazards received the least priority.

Figure 4.12 demonstrates occupational injuries suffered by informal waste pickers on landfill sites. Out of the studies reviewed, cuts emerged as the most documented occupational injury, followed by animal or rodent bites, punches, and wounds, each mentioned in multiple studies. Burns, on the other hand, were less frequently reported. The findings by Ali and Yusuf (2021), which indicated that cuts were the most frequently reported occupational injuries among waste pickers, are consistent with

those of Nyathi *et al*. (2018), Nuripuoh *et al*. (2022), and Uhunamure *et al*. (2021). These studies all concluded that the predominant type of occupational injury involved being pierced by sharp objects. However, these results contrast with those from Naicker *et al*. (2019), who documented that the most common occupational injury reported by informal waste pickers at landfills was being bitten by rodents. Additionally, according to Mothiba (2016), respondents engaged in waste picking at landfills reported no injuries from cuts. Using PPE and having a long waste picking experience was closely linked to decreased chances of injuries (Byonanebye *et al*., 2022). It was also established that people who felt to be at risk were 13 times more likely to be injured than those who perceived themselves as not being at risk (Byonanebye *et al*., 2022). The results from this study which indicate that cuts were the most reported occupational injury amongst informal waste pickers correlate with those recorded on Section 2.3.1 (Yang *et al*., 2018; Cruvinel *et al.*, 2019).

Figure 4.14 shows psychological impacts of landfills on informal waste pickers. The most frequently reported psychological impact was safety concerns within landfills. Landfill-related stigma and mental health risks were the second most reported. The odds of having symptoms of common mental health disorder were reported to be lower among participants who reported life enjoyment and a good quality of life (Makhubele, 2019). Findings by Nuripuoh *et al*. (2022) indicates that discrimination and abuse for being an informal waste picker was significantly linked to their mental health problems. Even though waste picking improved socioeconomic conditions of waste pickers, Isaac *et al*., (2020), the social and interpersonal aspects of their working environments posed the greatest threat to their health and safety (Schenck *et al*., 2019).

While Nyathi *et al*. (2018); Naicker *et al*. (2019); Wilson *et al*. (2021); Uhunamure *et al*. (2021); Patrick *et al*. (2022) did not exclusively concentrate on investigating mental health disorders among informal waste pickers, they did however, address the topic of informal waste pickers mental health. They reported that informal waste pickers did not feel safe in landfills. Naicker *et al*. (2019) further stipulated that waste pickers did not feel safe due to interpersonal violence amongst each other. In addition to feeling unsafe, Nyathi *et al*. (2018) reported that informal waste pickers were in danger of experiencing work environment induced stress. Nuripuoh *et al*. (2022) documented

that contributing factors to psychological health risks for most informal waste pickers included discrimination and physical abuse.

In studies conducted by Makhubele (2019) and Uhunamure *et al*. (2021), the feeling of vulnerability regarding mental health was expressed by participants. A different conclusion was arrived at by Wilson *et al*. (2021) who reported that participants in their study did not perceive themselves as being at any risk of mental health conditions. Because of their occupation, it was reported that informal waste pickers were subjected to stigmatisation (Mothiba, 2016; Nuripuoh *et al*., 2021).

With regards to surrounding communities, Figure 4.23 represents landfill-reported environmental hazards faced by communities who resides close to landfills as documented in the reviewed studies (Babs-Shomoye and Kabir, 2016; Suleman, 2016; Gumede and Savage, 2017; Roffe *et al*., 2017; Sindama *et al*., 2017; Oladejo and Otene, 2018; Amugsi *et al*., 2019; Ndukwe *et al*., 2019; Njoku *et al*., 2019; Adetona *et al*., 2020, Dada, 2020; Etea *et al*., 2021; Aliu, 2021; Abiola *et al*., 2022; Mnamndi *et al*., 2022).

Air pollution was identified as the primary environmental hazard for people living near landfills. Additional challenges include rodent infestations, unpleasant odours, mosquito and fly infestations, and poorly situated landfills. Concerns also extend to water pollution and street litter. Studies reported concerns about smoke, fires, and noise pollution, as well as psychological problems and dust. Psychosocial and flood-related issues were mentioned less frequently.

Research question 2 was further addressed in Tables 3, 4 and 5. Tables 3 and 4 addresses the health as well as ergonomics impacts of landfills on informal waste pickers. Skin problems were the most cited health issue, followed by respiratory problems and eye ailments. The less frequently reported health issues documented were hepatitis, cholera, cancer, lung problems, diabetes, dysentery, conjunctivitis, and impetigo as reported in table 3.

Health outcomes as a result of waste picking included epidermal, communicable, and noncommunicable diseases, respiratory and musculoskeletal problems (Tlotleng *et al*., 2019, Wilson *et al*., 2021, Patrick *et al*., 2022; Byonanebye *et al*., 2022). The reviewed studies reported that landfill poses a risk on the health of waste pickers in one way or the other. This notion was concurred by Magaji and Osigbemhe (2018) because of the difference they observed in the health status of informal waste pickers before and after joining the trade.

Tlotleng *et al*. (2019) focused on the prevalence of respiratory symptoms on waste pickers. Majority of the respondents reported being exposed to dust and chemicals, hence a statistically significant association between inhaling chemicals and respiratory problems was established (Tlotleng *et al*., 2019). Current and previous smokers showed a marginally significant association with respiratory problems (Tlotleng *et al*., 2019). The findings from Tlotleng *et al*. (2019) are different from Uhunamure *et al*. (2021) who found no statistical significance between landfills and respiratory symptoms but concluded that respiratory symptoms on informal waste pickers might have been as a result of smoking. Mothiba (2016) concluded differently and documented that exposure to dust in landfills was credited to be the reason behind respiratory problems by most informal waste pickers. Coughing was a respiratory symptom that was most dominant amongst informal waste pickers as compared with other self-reported symptoms such as wheezing, shortness, and rapid breathing (Tlotleng *et al*., 2019). Colds, flu, coughs, diarrhoea, headaches, skin rashes, shortness of breath were identified as sickness related to landfill pollution which several informal waste pickers suffer from (Nyathi *et al*., 2018). Nuripuoh *et al*. (2021) concurred with these results and reported that headache, cough, skin problems, diarrhoea, fever, malaria, vomiting, shortness of breath and typhoid were dominant health concerns among informal waste pickers. Mugo *et al*. (2022) also documented that health issues resulting from exposure to landfill hazards included respiratory problems, as well as skin and ear issues. Uhunamure *et al.* (2021) reported an association between ears, eyes, and skin irritation with exposure to landfill hazards. Contrary to these results, informal waste pickers' trend of bathing with unclean water from the landfill was attributed to their skin irritation concerns by Mothiba (2016).

Table 4 illustrates musculoskeletal problems suffered by informal waste pickers. Back pain was the most mentioned musculoskeletal issue followed by chest pain, joint pain, slip and fall incidents, swelling or numbness of limbs, and tiredness or weakness. Additionally, neck pain, shoulder pain, tetanus, and cramps were the least addressed.

In relations to surrounding communities, Table 5 represent the negative health outcomes suffered by residents residing close to landfills. Studies most frequently documented illnesses such as, malaria and skin disorders. These were followed by diarrhoea which was commonly reported. Intestinal worms and gastrointestinal disorders were also significant concerns, while eye irritation was frequently investigated. Cholera, coughing/tuberculosis, and respiratory problems were examined regularly. Chest pains, typhoid, and dysentery were also notable, with asthma being discussed less frequently. Fever, recurring flu, nasal irritation, and cancer were explored in several studies. Regular health issues, weakness, headaches, sore throat, common cold, hearing problems, and vomiting were commonly reported. The least documented illnesses included birth defects, abdominal and back pain, tetanus, wheezing and/or sneezing, lung and fungal infections, hepatitis, ocular allergies, pregnancy complications leading to abortions and premature births, pneumonia, and kidney problems.

Figure 4.25 illustrates landfill psychosocial impacts on surrounding communities as reported by the reviewed studies. The effects frequently highlighted as significant concerns were reluctance of friends to visit, avoidance of desired commercial enterprises due to the landfill's presence, stigma associated with living near landfills, and difficulties in selling properties (Oladejo and Otene, 2018). Additionally, the inability to rent out properties near landfills was least documented. However, respondents living further away from the landfill were generally less affected by these external factors, except for experiencing stigma (Dada, 2020). The external factors reported on this study are similar to those reported in Section 2. Olawoye *et al.* (2019) reported that living close to landfills can lower property values, make the area to look unattractive and has the potential to reduce people’s quality of life.

Figure 4.26 indicates landfill psychological impacts on surrounding communities. The most frequently reported psychological impact because of residing close to landfill was the fear of potential future health conditions (Roffe *et al*., 2017; Dada, 2020; Etea *et al*., 2021). The least reported landfill psychological impact were moderate concerns regarding future health issues (Nnamdi *et al*., 2022). Respondents in a study by Njoku *et al*. (2019) reported that living close to a landfill does not make them fear any future health conditions.

Research question 3: What were the causes of landfill impacts on informal waste pickers and surrounding communities reported by the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

Research question 3 was addressed in studies by Nyathi *et al*. (2018); Vasina (2018); Schenck *et al*. (2019); Tlotleng *et al*. (2019); Hashim *et al*, (2020); Ali and Yusuf (2021); Uhunamure *et al*. (2021); Nuripuoh *et al*. (2022); Patrick *et al*. (2022). Figure 4.8 indicates the sources of hazards faced by informal waste pickers in landfills. The commonly reported sources of hazards were sharp objects with food or organic waste, metals, plastics, landfill surfaces, vehicles, and hazardous substances following closely behind. Wood, dust, and papers were also identified as sources of risk. Additionally, less frequently mentioned were electronic waste (e-waste), lifting heavy bags, exposure to toxins from decomposing waste faecal matter, batteries, rubber, and aluminium as well as, encounters with insects, rats, and snakes. Majority of the reviewed studies did not report the specific sources of hazards encountered by informal waste pickers within landfills.

Figure 4.23 further address research question 3. Concerns about air pollution were frequently reported. Numerous studies noted rat infections, foul smell, water pollution and problems with flies and mosquitoes. Additionally, street litter, smoke, fires, and noise pollution were also reported. Psychosocial and flood-related problems were least reported. In Section 2.4.1, it was also recorded that landfills are contributors to air pollution faced by surrounding communities (Khoiron *et al*., 2020).

Research question 4: Which factors influenced the impact of landfills on informal waste pickers and surrounding communities from the studies reviewed conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

Research question 4 was answered in Figure 4.13, which represents landfill impacts on informal waste pickers by socio-demographics. Gender-based impacts were frequently reported. Age based were the second most documented impacts. Educational level and working experience-based impacts were the least reported. Wilson *et al*. (2021) went a step further and compared informal waste pickers socioeconomic statuses as well.

Age, education and working experience were significant parameters to the prevalence of injuries among waste pickers (Ali and Yusuf, 2021). Naicker *et al*. (2019); Ali and Yusuf (2021); Patrick *et al*. (2022) studied the prevalence of injuries on waste pickers and found a significant association between being a male and being over the age of 34 with waste picker's occupational injuries. Ali and Yusuf (2021) further concluded that the probability of accidents among waste pickers was significantly influenced by age, education, and job experience. As these factors decreased, the rate of injuries demonstrated a corresponding increase (Ali and Yusuf, 2021). Age and working experience comparisons highlighted concerns about age-related impacts on musculoskeletal fitness. Mugo *et al*. (2022) reported on the development of age-related arthritis, and deterioration in hearing and vision among workers who had an average age of about 50 years and around 10 years of waste picking experience. A significant relationship between occupational health of informal waste pickers and exposure to landfills hazards, the number of days worked, age, and infectious as well as chronic diseases was established (Uhunamure *et al*., 2021). The more days and the longer the hours worked, the higher the chances of exposure. Health issues were found to vary by activity and age, such as, noise and age induced hearing loss as well as age-related arthritis (Byonanebye *et al*., 2022).

Made *et al*. (2020b) conducted a study and recognised a strong relationship between hypertension among informal waste pickers with age, weight, and injuries. For each year increase in the age of an informal waste picker, the odds of developing

hypertension also increased by 5% (Made *et al*., 2020b). The number of women who had hypertension was higher than that of men (Made *et al*., 2020b). When comparing their mental health, the chances of suffering from a common mental health disorder was two times higher in women waste pickers than in men (Makhubele *et al*., 2019).

The ten-year risk of fatal cardiovascular disease (CVD) and its connection to metabolic risk factors among informal waste pickers was studied in South Africa by Made *et al*. (2021). The results indicated that the odds of suffering from the ten-year risk of fatal CVD was higher in females as compared to their male counterparts. A strong link between age and the ten-year risk of fatal CVD was established in both males and females (Made *et al*., 2021). The results also indicated that normal-weight participants displayed a higher mean ten-year CVD risk contrasted to those who were underweight, overweight, or obese (Made *et al*., 2021).

Both men and women informal waste pickers socioeconomic as well as health statuses were compared in a study by Wilson *et al*. (2021). Poorer chronic health outcomes and symptoms of chronic illness were seen mostly in women (Wilson *et al*. 2021). The likelihood to suffer from hearing loss was more possible for men than women (Wilson *et al*., 2021). Overall reporting of perceived health by gender did not significantly differ (Wilson *et al*., 2021). Although there was a clear difference on why males and females ended up as informal waste pickers, both genders reported not feeling safe in landfills (Wilson *et al*., 2021). In terms of materials collected from the landfills, men collected more valuable items such as electronics, metals, and cans, while women collected items which were less valuable: glass, plastics, and paper (Wilson *et al*., 2021). This is probably why women reported earning less from waste picking than men (Wilson *et al*., 2021).

Research question 4 was further addressed in Figure 4.9 which shows the type of PPE used by informal waste pickers in landfills. Safety boots and hand gloves were reported most frequently. Face masks and safety goggles were documented frequently. This was followed by using light during night-time activities as well as the use of coveralls, and helmets. Reflective vests were the least reported.

Waste pickers were reported to use surgical mask which did not protect them from inhaling toxins (Uhunamure *et al*., 2021). Nonetheless, there was no conclusive evidence indicating a reduction in respiratory complaints and cuts among waste pickers who used PPE compared to those who did not use it. Women were reported to use PPE more than men (Nyathi *et al*., 2018; Hashim *et al*., 2020). Mugo *et al*. (2022) reported that informal waste pickers did not use any form of PPE while working. Patrick *et al.* (2022) documented that only a few informal waste pickers used PPE. Nyathi *et al*. (2018) concluded that waste picker's lack of PPE use was due to lack of knowledge as well as financial constraints. In section 2.3.1, Yang *et al*. (2018) confirms that because of financial limitations, and lack of risk awareness, informal waste pickers reported that they do not use Personal Protective Equipment. PPE that was used by a very few of the informal waste pickers was picked from landfills (Nyathi *et al*., 2018; Nuripuoh *et al*., 2022). Limited knowledge regarding occupational health hazards exposed informal waste pickers to various illnesses (Hashim *et al*., 2020). If informal waste pickers had worn gloves or safety boots while working, many of the sustained injuries could have been prevented (Nyathi *et al*., 2018).

Figure 4.15 illustrates the levels of informal waste pickers awareness on occupational hazards. Majority of the reviewed studies that examined levels of informal waste picker's awareness of occupational hazards reported poor levels of awareness. The least documented levels were very poor, fair, and good.

Hashim *et al*. (2020) reported that there were significant relations determined between the level of risk awareness and occupational hazards. A study by Mugo *et al*. (2022*)* concluded that informal waste pickers had poor levels of risk awareness. Majority of informal waste pickers did not know the importance of using PPE, neither did they know that hazardous waste in landfills can cause pathogens and vectors (Nuripuoh *et al*., 2022). Vasina (2018) however, concluded that waste pickers generally viewed their work as dangerous and filled with risks, but they often prioritised the immediate dangers such as accidents with landfill vehicles or getting cut by glass, rather than considering the long-term health risks associated with environmental pollution.

Furthermore, Figure 4.24 demonstrate landfill impacts on surrounding communities by different factors. The analysis of health impacts based on distance received the most attention. The second most examined correlation was socio-demographic factors and landfill impacts. This was followed by the assessment of health and environmental impacts based on distance. The least reported comparison were investigations on seasonal variations in health and environmental impacts, distance-related environmental impacts, and the difference in seasonal environmental impacts.

In terms of landfill impacts on surrounding communities by socio demographics. A study in Ghana concluded that age, marital status, educational attainment, and length of stay were important sociodemographic factors associated with symptomatic ocular allergies (Babs-Shomoye and Kabir, 2016). These findings were confirmed by Peprah *et al*. (2022). However, gender, ethnicity, religion, employment, or primary occupation did not relate with symptoms of ocular allergy (Peprah *et al*., 2022). Children and elderly people were believed to be more at risk from landfill hazardous exposures (Amugsi *et al*., 2019). These results were refuted by Etea *et al*. (2021) who reported that most respondents believed that all age groups and both genders were equally affected by the landfill.

With regards to landfill impacts on surrounding communities by distance. Roffe *et al*. (2017) conducted a study in South Africa focusing on the impact of gas emissions from benzene, toluene, ethylbenzene, and xylenes (BTEX) on individuals residing in proximity to a landfill site. Health concerns were mostly reported by residents residing closer to the landfill, which echoes the notion that there is a relationship between distance to the landfill, number of years lived in the area, and exposure to environmental issues (Adetona *et al*., 2020). Even though residents reported that BTEX from the landfill caused sicknesses, they were however, potentially exposed to this gas from different other sources within and outside of their residential area other than the landfill (Roffe *et al*., 2017).

In another study in South Africa, the health risks related to e-waste were assessed. Significant relationship was established between the distance to the landfill and exposure to, lead, arsenic, mercury, and cadmium from the landfill (Machete 2017). Residents near the landfill were more exposed to these components than those

residing further away (Machete, 2017). Ahmed *et al*. (2017) confirmed that proximity to landfill sites was a significant factor in determining the level of exposure to leachate, thus affecting the occurrence of waterborne diseases. As a result of landfill leachate, majority of residents have in their lifetime experienced different types of sicknesses with dysentery, malaria, and diarrhoea being the most prevalent (Ahmed *et al*., 2017). These findings were confirmed by Mugo *et al*. (2022) who reported that communities living close to landfills attributed their frustrations to its impact on their health.

In Durban, South Africa, Gumede and Savage (2017) studied the impacts of indoor particulate matter ($PM_{2.5}$) on children living close to landfills. Impaired lung function was found to be a condition majority of children living close to the landfill were suffering from (Gumede and Savage, 2017). The intensified air pollution levels around the landfills were attributed to the probability of children in their vicinity developing respiratory problems compared to those living far away (Gumede and Savage, 2017).

From a study by Abiola *et al*. (2021) in Nigeria, respiratory and skin disorders between residents living near and far from a landfill were compared. It was documented that contrasted to those staying far, individuals residing closer to landfills have a higher chance of suffering from respiratory and skin problems (Abiola *et al*., 2021).

The probability of long-term harm on different body organs due to exposure to emissions from landfill fires was investigated by Adetona *et al.* (2020). Toxins released from burning waste has the potential to heighten the risk of exposure among people living or working close to landfills. This exposure also increases the chances of suffering from respiratory, neurological, and musculoskeletal problems which were experienced more frequently by those who lived or worked close to landfills for a longer period as opposed to those who were exposed for a shorter amount of time (Adetona *et al*., 2020). Distance to the landfill and the number of affected people demonstrated strong correlations, an increase in the distance resulted in a decrease in the number of people affected (Ozabor and Obaro, 2016).

Due to exposure to waste from landfills, surrounding communities reported suffering from malaria, most frequently those living in their close proximity (Addo *et al*., 2015; Suleman, 2016, Ahmed *et al*., 2017, Ndukwe *et al*., 2019, Aliu, 2021, Nnamdi *et al*., 2022). These findings were refuted by Babs-Shomoye and Kabir (2016) who reported that there was no relationship between distance to the landfill and malaria, they documented that cases of malaria were more prevalent amongst those living far from the landfill.

Creatures which transport dieses including rats, cockroaches bed bugs have infested the environment, with flies and mosquitos causing most problems for both nearby and far away communities (Nnamdi *et al*., 2022). Landfills create an environment where these creatures thrive by serving as food and a breeding ground (Oladejo and Otene, 2018). As coping methods, Njoku *et al*. (2019) and Dada (2020) reported that residents stayed indoors for air pollution coping mechanism, would keep a clean house, close doors and windows as well as using insecticides and nets for flies. A link between distance and exposure to various environmental impacts was identified and it was documented that people living far from the landfill reported pollution as less problematic (Njoku *et al*., 2019; and Nnamdi *et al*., 2022).

Roffe *et al*. (2017); Njoku *et al*. (2019); Etea *et al*. (2021), Nnamdi *et al*. (2022) explored landfill impacts on nearby communities across different seasons and documented that a more pronounced smell was experienced during winter. Air and water pollution levels were worse during the rainy season; this was attributed to the foul odour and groundwater contamination (Sindama *et al*. 2017). Those staying far from the landfill were exposed to air pollution from smoke of burning waste mostly during the dry seasons (Sindama *et al*., 2017). The findings by Dada (2020), however, demonstrate that there was no seasonal trend in the environmental hazards and health problems experienced or perceived during either the dry or the wet seasons. In relations to health hazards, Dada (2020) reported that respondents experienced health issues throughout the year.

Figure 4.27 additionally answers Research question 4. The figure demonstrates the risk perception amongst residents who are staying close to landfills. Dominant levels of risk perception among residents concerning landfill hazards were classified as poor and good, with perceptions categorised as fair being reported least frequently. Contrary to Amugsi *et al*. (2019) who documented that resident reported fair levels of perception. Addo *et al*. (2015); Etea *et al*. (2021); Abiola *et al*. (2021), reported that residents had good perception about the negative impacts that landfills can cause. In studies by Suleman (2016); Ozabor and Obaro (2016); Roffe *et al*. (2017); and Ndukwe *et al*. (2019) it was documented that the perception levels of residents regarding the potential harm and severity resulting from exposure to landfill waste were poor. Majority of residents living near and far from the landfill reported knowing nothing about pollution, a small percentage of them reported that sicknesses were caused by pollution from landfills (Ndukwe *et al*., 2019).

Research question 5: Which recommendations were made by the reviewed studies conducted in Africa between 2015 and 2022 relating to the impacts from landfills on informal waste pickers and surrounding communities?

Figure 4.16 and 4.28 answers research question 5. These figures show recommendations made in the reviewed studies. In terms of studies on informal waste pickers, future research needs were predominantly recommended, with the second most frequent suggestion being the establishment of rules for waste pickers, particularly emphasising the importance of wearing personal protective equipment. Enhancing awareness about the hazards associated with waste picking was proposed. Additionally, the formalisation of the waste-picking trade was also advised. The suggestion to establish mobile clinics at landfill sites was the least recommended.

In the case of surrounding communities, Figure 4.28 shows that the most frequently suggested recommendation was the relocation of landfill sites. The need for conducting additional studies was the second most recommended, followed by educating residents about the hazards of waste. On the other hand, water purification and recycling were the least recommended. In Section 2.5.1, both Mussie *et al*. (2022) and Tlili *et al*. (2022), after conducting their respective reviews, similarly emphasised the necessity for further research.

5.3. Alignment to the literature review

Literature review highlighted the effects of landfills on informal waste pickers and nearby communities. The findings from this study showed strong alignment between the literature review and current results regarding the physical and mental health risks associated with landfill exposure. Studies from the literature review reported that health problems as a result of being exposed to landfill pollutants included skin diseases, respiratory infections, gastrointestinal disorders, and various infectious diseases (De and Debnath, 2016; Khoiron *et al*., 2020; Abiola *et al*., 2021), these results were corroborated by Makhubele *et al.* (2019); Njoku *et al*. (2019); Dada (2020); Nuripuoh *et al*. (2021); and Uhunamure. (2021*)* from this study. Yang *et al*. (2018) from the literature review and Nyathi *et al*. (2018) from this study reported that injuries, especially cuts from sharp objects were common and were made worse by the lack of PPE, often due to financial constraints and lack of risk awareness.

Both the literature review and the study findings also indicated that less experienced waste pickers were more prone to injuries and health issues (Yang *et al*. 2018; Ali and Yusuf, 2021). They also reported experiences of stigma, fear, and mental health issues (Naicker *et al*., 2019; Paul and Bhattacharjee, 2022). The literature review further found that female waste pickers, particularly those from disadvantaged backgrounds, faced poorer health outcomes and earned less (Chan *et al.* (2025). The findings from this study established that their lower earnings were primarily due to the type of materials they collected (Wilson *et al*., 2021).

Exposure to toxic substances and air pollution were identified as significant impacts on the literature review by Khoiron *et al*. (2020), these exposures were also identified by Njoku *et al*. (2019) and Dada (2020) from this study. Both Salah *et al*., 2019 from the literature review and Namdi *et al*., 2022 from this study documented that rodents and insects were contributors to the spread of diseases. From the literature review Limoli *et al*. (2019) reported that children and the elderly were reported as being particularly at risk from exposure to landfill pollutants, a finding that was confirmed by Amugsi *et al*. (2019) on this study.

While Limoli *et a*l. (2019); Ojekunle *et al*. (2022); and Chan *et al.* (2025) discussed the effects of landfills across different demographic groups, sources from studies by Roffe *et al.* (2017); Njoku *et al*. (2019); Etea *et al*. (2021), and Nnamdi *et al*. (2022) further identified seasonal variations in how these impacts are experienced.

5.4. Limitation of the final study

The exclusion of studies published in other languages may have resulted in some valuable information being left out. The exclusion of literature published before 2015 could have potentially led to overlooking crucial information which could have helped to establish long-term trends as well as revealing how exposure has progressed over the years. Further elimination of studies published after 2022 may have caused an omission of important data that the chosen timeline could not reveal. Grey literature and government documents were excluded, and only peer-reviewed literature was used. This excluded literature may potentially contain data or case studies not covered in the peer-reviewed studies. The excluded data may have possibly established new developments and emerging trends which could significantly alter the context in which this study's findings were interpreted. These limitations may have led to conclusions that are less relevant to the present-day situation.

5.5. Recommendations

The aim of this study was to review the impacts that landfill has on informal waste pickers and surrounding communities. The findings of this study suggest future research to be conducted focusing on topics such as chemical and biological impacts of landfills, duration of exposure, and its correlation with health risks. The health hazards faced by communities residing in proximity to landfills in connection with electronic waste (E-waste), the well-being of children in affected areas and the health hazards faced by surrounding communities in relation to landfill gas emission. Studies focusing exclusively on factors that influences the impacts of landfills on both informal waste pickers and surrounding communities are also recommended.

These comparative studies might provide a comprehensive understanding because analysing the impacts of landfills on informal waste pickers through the lens of age

and gender is vital for understanding how different age groups and genders within this population are affected. Investigating these impacts focusing on working experience is also important because experienced informal waste pickers may have acquired coping methods which may if identified can be passed down to the new ones thereby limiting the odds of accidents and injuries. Furthermore, impacts as influenced by educational levels are also important to investigate, this might shed light on how formal education enhances the understanding of occupational risks linked to waste picking and how this might help mitigate certain risks.

The findings also revealed that most studies were conducted in South Africa and Nigeria, this justifies the need for more studies to be conducted in other various African countries.

5.6. Significance and importance of the study

This study is a contributor towards the current body of knowledge with the presentation of landfill impacts on informal waste pickers and surrounding communities in Africa. This study provided insight into how landfills affect informal waste pickers as well as people who are living or working in their close proximity. This study is unique in the sense that, by the time it was conducted, no study could be found that systematically reviewed the impacts of landfills on informal waste pickers and surrounding communities in Africa between 2015 and 2022. The results of this study could be valuable to a wide range of audiences involved in environmental management such as academics, past and prospective researchers, policymakers, and public servants.

Additionally, this study presented an understanding of the content nature of landfill impacts in different parts of the African continent. If this study was not conducted, research trends, gaps and recommendations from the reviewed studies would have remained unknown. This study can also assist future researchers in closing the research gaps identified. The results from this study may enable policymakers and public servants to develop policies and interventions that may reduce the negative impacts of landfills on informal waste pickers and potentially improve the well-being of affected communities.

5.7. Conclusion

This study started with the notion that the trends, causes, influencing factors, gaps, and recommendations from research conducted on Africa relating to the impacts of landfills were not known. This study achieved what it set out to do and filled a gap in the existing literature.

The results identified trends such as the frequent use of mixed methods and cross-sectional as study designs and methods. A further trend was established indicating that majority of the studies investigated health impacts of landfills on informal waste pickers and surrounding communities.

Age, gender, levels of education, and working experience are factors which influenced the impacts of exposure to landfill hazards on informal waste pickers. Concerns about the impacts varied depending on the age and the specific task being performed. Respiratory diseases such as asthma and pneumonia were noted as some of the sicknesses that waste pickers contract while working in the landfills. The study highlighted that age, educational levels and working experience were factors which influenced the likelihood of accidents in landfills, as these factors decreased, the probability increased. Failure to use PPE coupled with the lack of knowledge concerning hazards associated with their occupation enhanced the vulnerability of informal waste pickers to sicknesses and injuries.

All the reviewed studies on the impacts of landfills on informal waste pickers highlighted the occupational risks that waste pickers are faced with. Similarities in findings includes the lack of PPE usage which worsened occupational injuries, respiratory problems and exposure to hazardous materials. South African studies revealed physical health issues suffered by informal waste pickers, mental health and gender-based inequality. Studies in Nigeria focused more on occupational injuries, and health issues while Kenya and Uganda uncovered a low safety awareness and use of PPE. Senegal and Ghana highlighted the potential of financial constrains causing a gap between risk awareness and safe behaviour.

With regards to surrounding communities, factors which influenced how people living close to landfills were impacted included, distance, socio-demographics seasons as well as percept ion levels on landfill hazards. The study established that those staying closer to landfills were at a higher risk of being negatively affected by exposure to landfill hazards such as air pollution, leachate, and groundwater contamination as compared to those living far away. Other landfill hazards included fire and smoke. Distance to the landfill did not only influence the probability of communities contracting various kinds of diseases but also their severity. Age influenced impacts indicated that children and the elderly were most likely to be affected by these hazardous exposures. The severity of landfill impacts also depended on seasons. The study furthermore identified a lack of knowledge with regards to dangers as a result of pollution from landfills. The relocation of landfill sites far from the communities as well as the need for further studies on landfill impacts is recommended.

Across all countries, studies reported on eye and skin irritation and an increase in vulnerability amongst children and the elderly. Similar factors included poor waste management and proximity to landfills. Another recurring theme was psychosocial stress which includes feeling fearful and anxiety. Nigeria revealed the widest range of health effects and South Africa focused on chemical exposure. Ghana studied ocular allergies while Ethiopia and Kenya highlighted on community perception and psychosocial risks of living close to landfills.

6. References

Abubakar, I.R., Maniruzzaman, K.M., Dano, U.L., AlShihri, F.S., AlShammari, M.S., Ahmed, S.M.S., Al-Gehlani, W.A.G., and Alrawaf, T.I. (2022). Environmental sustainability impacts of solid waste management practices in the global South. *International journal of environmental research and public health, 19(19),* pp.1-26.

Abdel-Shafy, H.I. and Mansour, M.S.M. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egyptian Journal of Petroleum*, *27(4),* pp.1275-1290.

Addy, R., Kalamdhad, A. and Goud, V.V. (2023). Insight on the prevalence of pathogens present in the municipal solid waste of sanitary landfills, dumpsites, and leachate. *In Fate of biological contaminants during recycling of organic wastes*. pp.279-295.

Adedara, M.L., Taiwo, R. and Bork, H.R. (2023). Municipal solid waste collection and coverage rates in Sub-Saharan African countries: A comprehensive systematic review and meta-analysis. In *Waste*, 1(2), pp.389-413).

Akomea-Frimpong, I., Adeabah, D., Ofosu, D. and Tenakwah, E. (2021). A review of studies on green finance of banks, research gaps and future directions. *Journal of Sustainable Finance and Investment*, pp.1-24.

Al-Ababneh, M.M. (2020) Linking ontology, epistemology and research methodology. *Science and Philosophy*, *8(1),* pp.75-91

Alharahsheh, H.H. and Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, *2(3),* pp.39-43.

Al-Hazmi, H.E., Hassan, G.K., Kurniawan, T.A., Śniatała, B., Joseph, T.M., Majtacz, J., Piechota, G., Li, X., El-Gohary, F.A., Saeb, M.R. and Mąkinia, J. (2024). Technological solutions to landfill management: towards recovery of biomethane and carbon neutrality. *Journal of Environmental Management*, *354*, pp.120414.

Andeobu, L., Wibowo, S. and Grandhi, S. (2022). Artificial intelligence applications for sustainable solid waste management practices in Australia: A systematic review. *Science of The Total Environment*, *834*, pp.155389.

Auler, F., Nakashima, A.T. and Cuman, R.K. (2014). Health conditions of recyclable waste pickers. *Journal of Community Health*, *39*, pp.17-22.

Baderna, D., Caloni, F. and Benfenati, E. (2019). Investigating landfill leachate toxicity in vitro: A review of cell models and endpoints. *Environment International*, *122*, pp.21-30.

Bihałowicz, J.S., Rogula-Kozłowska, W., Krasuski, A. and Salamonowicz, Z. (2021). The critical factors of landfill fire impact on air quality. *Environmental Research Letters*, *16*(10), pp.104026.

Bozkurt, A., Kumtepe, E., Kumtepe, A., Aydın, İ., Bozkaya, M. and Aydın, C. (2015). Research Trends in Turkish Distance Education: A Content Analysis of Dissertations, 1986-2014. *European Journal of Open, Distance and E-Learning, 18(2)*, pp.1-21.

Büchter, R.B., Rombey, T., Mathes, T., Khalil, H., Lunny, C., Pollock, D., Puljak, L., Tricco, A.C. and Pieper, D. (2023). Systematic reviewers used various approaches to data extraction and expressed several research needs: A survey. *Journal of Clinical Epidemiology*.

Büchter, R.B., Weise, A. and Pieper, D. (2020). Development, testing and use of data extraction forms in systematic reviews: A review of Methodological Guidance. *BMC Medical Research Methodology, 20(1).*

Bush, A.A. and Amechi, M.H. (2019). Conducting and presenting qualitative research in Pharmacy Education. *Currents in Pharmacy Teaching and Learning, 11(6)*, pp.638–650.

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D. and Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of research in Nursing, 25(8),* pp.652-661.

Chakravarty, P. and Kumar, M. (2019). Floral species in pollution remediation and augmentation of micrometeorological conditions and microclimate. *Phyto management of Polluted Sites,* pp.203–219.

Chan, E. and Hsu, C. (2016). Environmental management research in hospitality. *International Journal of Contemporary Hospitality Management, 28(5)*, pp.886-923.

Chan, S.M., Tang, Y.K., Xu, H., Zhang, J., Kwok, K., Tam, W.Y. and Tang, W.H. (2025). Unequal Burdens: Gendered and Socioeconomic Dimensions of Occupational Health Among Hong Kong's Informal Waste Pickers. In *Healthcare*, 13(6), pp.683.

Chavan, D., Lakshmikanthan, P., Manjunatha, G.S., Singh, D., Khati, S., Arya, S., Tardio, J., Eshtiaghi, N., Mandal, P., Kumar, S. and Kumar, R. (2022). Determination of risk of spontaneous waste ignition and leachate quality for open municipal solid waste dumpsite*. Waste Management*, 154, pp.272-282.

Chisholm, J.M., Zamani, R., Negm, A.M., Said, N., Abdel daiem, M.M., Dibaj, M. and Akrami, M. (2021). Sustainable waste management of medical waste in African developing countries: A narrative review. *Waste Management & Research*, *39*(9), pp.1149-1163.

Cruvinel, V.R.N., Marques, C.P., Cardoso, V., Novaes, M.R.C.G., Araújo, W.N., Angulo-Tuesta, A., Escalda, P.M.F., Galato, D., Brito, P. and Da Silva, E.N. (2019). Health conditions and occupational risks in a novel group: waste pickers in the largest open garbage dump in Latin America. *BMC public health*, 19, pp.1-15.

Dabrowska, D., Rykala, W. and Nourani, V. (2023). Causes, types and consequences of municipal waste landfill fires—Literature review. *Sustainability*, *15*(7), pp.5713.

Daniel, A.N., Ekeleme, I.K., Onuigbo, C.M., Ikpeazu, V.O. and Obiekezie, S.O. (2021). Review on effect of dumpsite leachate to the environmental and public health implication. *GSC Advanced Research and Reviews*, *7*(2), pp.051-060.

Da Silva, C.L., Weins, N. and Potinkara, M. (2019). Formalizing the informal? A perspective on informal waste management in the BRICS through the lens of institutional economics. *Waste Management*, *99*, pp.79-89.

De, S. and Debnath, B. (2016). Prevalence of health hazards associated with solid waste disposal-A case study of Kolkata, India. *Procedia Environmental Sciences*, 35, pp.201-208.

Dissanayaka, D.M.S.H. and Vasanthapriyan, S. (2020). Smart solid waste management: a scientific literature review. *Journal of solid waste technology and management*, 46 (4), pp.606-619.

DWAF. (1998). Minimum *Requirements for Waste Disposal by Landfill*. 2nd Edition. Waste Management Series.

Espuny, M., Faria Neto, A., da Motta Reis, J.S., dos Santos Neto, S.T., Nunhes, T.V. and de Oliveira, O.J. (2021). Building new paths for responsible solid waste management. *Environmental Monitoring and Assessment*, 193(7), pp.442.

Etikan, I. and Babtope, O. (2019). A basic approach in sampling methodology and sample size calculation. *Med Life Clin*, *1*(2), pp.1006.

Gaur, A. and Kumar, M. (2018). A systematic approach to conducting review studies: An Assessment of Content Analysis in 25 years of IB Research. *Journal of World Business.* 53(2), pp.280–289.

Godfrey, L., Ahmed, M.T., Gebremedhin, K.G., Katima, J.H., Oelofse, S., Osibanjo, O., Richter, U.H. and Yonli, A.H. (2019). Solid waste management in Africa: Governance failure or development opportunity. *Regional development in Africa*, pp.*235*.

Gonçalves, A., Moraes, F., Marques, G., Lima, J. and Lima, R. (2018). Urban solid waste challenges in the BRICS countries: a systematic literature review. *Ambiente e Agua - An Interdisciplinary Journal of Applied Science*, 13(2), pp.1.

Graue, C. (2015). Qualitative data analysis. *International Journal of Sales, Retailing and Marketing*, *4*(9).

Gutberlet, J. (2021). Grassroots waste picker organizations addressing the UN sustainable development goals. *World Development*, *138*, pp.105195.

Higgins, J.P.T., Thomas J., Chandler, J., Cumpston M., Li, T., Page, M.J., Welch, V.A. (2019). *Cochrane Handbook for Systematic Reviews of Interventions*. 2nd Edition. Chichester (UK): John Wiley and Sons.

Ihsanullah, I., Alam, G., Jamal, A. and Shaik, F. (2022). Recent advances in applications of artificial intelligence in solid waste management: A review. *Chemosphere*, *309*, pp.136631.

Iravanian, A. and Ravari, S.O. (2020). Types of contamination in landfills and effects on the environment: A review study. *IOP conference series: Earth and environmental science*. 614 (1), pp.012083.

Jones, S. (2022). Interpreting themes from qualitative data: Thematic analysis.

Karki, A., Karki, J., Joshi, S., Black, M.N., Rijal, B., Basnet, S., Makai, P., Fossier Heckmann, A., Baral, Y.R. and Lee, A. (2022). Mental health risks among informal waste workers in Kathmandu Valley, Nepal. *The Journal of Health Care Organization, Provision, and Financing*, *59*, pp.00469580221128419.

Kasinja, C. and Tilley, E. (2018). Formalization of informal waste pickers' cooperatives in Blantyre, Malawi: A feasibility assessment. *Sustainability*, *10(4),* pp.1149.

Khaustov, V.V., Bredikhin, V.V. and Khaustova, T.V. (2019). Treatment technology of liquid phase at industrial waste landfill. *IOP Conference Series: Materials Science and Engineering, 687(6)*, pp.066063.

Khoiron, K., Probandari, A.N., Setyaningsih, W., Kasjono, H.S., Setyobudi, R.H. and Anne, O. (2020). A review of environmental health impact from municipal solid waste (MSW) landfill. *Annals of tropical medicine and public health*, 23(3), pp.60-67.

Kitto, K., Manly, C.A., Ferguson, R. and Poquet, O. (2023) Towards more replicable content analysis for learning analytics. *In LAK23: 13th International Learning Analytics and Knowledge Conference*. pp.303-314.

Kivunja, C. and Kuyini, A.B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of higher education*, *6*(5), pp.26-41.

Kleinheksel, A.J., Rockich-Winston, N., Tawfik, H. and Wyatt, T.R. (2020). Demystifying content analysis. *American Journal of Pharmaceutical Education*, *84*(1), pp.7113.

Krippendorff, K. (2019). *Content Analysis: An Introduction to Its Methodology*. 4th Edition. Thousand Oaks, CA: SAGE Publications, Inc.

Limoli, A., Garzia, E., De Pretto, A. and De Muri, C. (2019). Illegal landfill in Italy (EU)—a multidisciplinary approach*. Environmental Forensics*, 20(1), pp.26-38.

Lindamulla, L., Nanayakkara, N., Othman, M., Jinadasa, S., Herath, G. and Jegatheesan, V. (2022). Municipal solid waste landfill leachate characteristics and their treatment options in tropical countries. *Current Pollution Reports*, *8*(3), pp.273-287.

Lindner, A. (2025). An example of sustainable development (in) action: The Case of Waste Pickers at a Buy-Back Centre in Johannesburg. *Journal of Environmental Law*, pp. eqaf004.

Littell, J.H., Corcoran, J. and Pillai, V. (2008). *Systematic reviews and meta-analysis*. Oxford University Press.

Ma, S., Zhou, C., Pan, J., Yang, G., Sun, C., Liu, Y., Chen, X. and Zhao, Z. (2022). Leachate from municipal solid waste landfills in a global perspective: Characteristics, influential factors and environmental risks. *Journal of Cleaner Production*, *333*, pp.130234.

Mancin, S., Sguanci, M., Andreoli, D., Soekeland, F., Anastasi, G., Piredda, M. and De Marinis, M.G. (2024). Systematic review of clinical practice guidelines and systematic reviews: a method for conducting comprehensive analysis. *MethodsX*, *12*, pp.102532.

Maphosa, V. and Maphosa, M. (2020). E-waste management in Sub-Saharan Africa: A systematic literature review. *Cogent Business and Management*, *7*(1), pp.1814503.

Mar, K.A., Unger, C., Walderdorff, L. and Butler, T. (2022). Beyond CO2 equivalence: The impacts of methane on climate, ecosystems, and health. *Environmental science and policy*, *134*, pp.127-136.

Mattiello, A., Chiodini, P., Bianco, E., Forgione, N., Flammia, I., Gallo, C., Pizzuti, R. and Panico, S. (2013). Health effects associated with the disposal of solid waste in landfills and incinerators in populations living in surrounding areas: a systematic review. *International Journal of Public Health, 58(5),* pp.725-735.

Mezmir, E.A. (2020). Qualitative data analysis: An overview of data reduction, data display, and interpretation. *Research on humanities and social sciences*, *10*(*21*), pp.15-27.

Milosevic, L.T., Mihajlovic, E.R., Djordjevic, A.V., Protic, M.Z. and Ristic, D.P. (2018). Identification of Fire Hazards Due to Landfill Gas Generation and Emission. *Polish Journal of Environmental Studies*, *27*(1).

Mishra, P., Singh, N., Shrama, C. and Pathak, A. (2020). Landfill Emissions and Their Impact on the Environment. *International Journal of Engineering Research and*, *9(08)*.

Mmereki, D., Baldwin, A. and Li, B. (2016). A comparative analysis of solid waste management in developed, developing and lesser developed countries. *Environmental Technology Reviews*, *5(1),* pp.120-141.

Morais, J., Corder, G., Golev, A., Lawson, L. and Ali, S. (2022). Global review of human waste-picking and its contribution to poverty alleviation and a circular economy. *Environmental Research Letters*, *17(6),* pp.063002.

Mngomezulu, N.P. and Senekane, M.F. (2023). Methodology to assess the perception of informal waste pickers on being integrated into the waste management system of the City of Ekurhuleni Municipality, Gauteng Province. *OIDA International Journal of Sustainable Development*, *16(12)*, pp.11-20.

Mussie, K.M., Setchell, J., Elger, B.S., Kaba, M., Memirie, S.T., Wangmo, T. (2022). Care of older persons in Eastern Africa: A scoping review of ethical issues. *Frontiers in Public Health. 10.* pp.1-14.

Nor Faiza, M.T., Hassan, N.A., Mohammad Farhan, R., Edre, M.A. and Rus, R.M. (2019). Solid waste: its implication for health and risk of vector borne diseases. *Journal of Wastes and Biomass Management (JWBM)*, *1(2),* pp.14-17.

Ogbuehi, N.C., Orji, M.C. and Afolabi, O.O. (2022). Health exposure and environmental challenges of households living nearby an open landfill system in Nigerian Urban Centre. *International Archives of Public Health and Community Medicine*, *6(3),* pp.1-7.

Oguntoyinbo, O.O. (2012). Informal waste management system in Nigeria and barriers to an inclusive modern waste management system: A review. *Public health*, *126*(5), pp.441-447.

Ojekunle, O.Z., Rasaki, A., Taiwo, A.M., Adegoke, K.A., Balogun, M.A., Ojekunle, O.O., Anumah, A.O., Ibrahim, A.O., Adeyemi, F. (2022). Health risk assessment of heavy metals in drinking water leaching through improperly managed dumpsite waste in Kurata, Ijoko, sango area of Ogun State, Nigeria. *Groundwater for Sustainable Development*. *18*. pp.100792.

Olawoye, A.O., Akinola Olusola, O. and Stephen, A.T. (2019). The socio-economic and environmental implications of residential buildings in proximate distance to landfill site. A case of Olusosun Landfill, Ojota Lagos. *Journal of Environmental and Earth Sciences*, *9(6),* pp.99-115.

Ozbay, G., Jones, M., Gadde, M., Isah, S. and Attarwala, T. (2021). Design and operation of effective landfills with minimal effects on the environment and human health. *Journal of environmental and public health*, *2021*(1), pp.6921607.

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E. and Chou, R. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International journal of surgery*, *88*, pp.105906.

Parvin, F. and Tareq, S. (2021). Impact of landfill leachate contamination on surface and groundwater of Bangladesh: a systematic review and possible public health risks assessment. *Applied Water Science*, *11(6)*, pp.100.

Paul, K. and Bhattacharjee, P. (2022). Livelihood status and health condition of waste pickers in Sylhet City Corporation: a study. *Space Culture India*, *9*(4), pp.16-27.

Rafiq, A., Rasheed, A., Arslan, C., Tallat, U. and Siddique, M. (2018). Estimation of greenhouse gas emissions from Muhammad wala open dumping site of Faisalabad, Pakistan. *Geology, Ecology, and Landscapes*, 2(1), pp.45-50.

Rincón, L.P.E and Canoles, O.D.A. (2021). P-246 Health and working conditions of waste pickers: Scoping review.

Rogers, E.R., Zalesny Jr, R.S. and Lin, C.H. (2021). A systematic approach for prioritizing landfill pollutants based on toxicity: Applications and opportunities. *Journal of Environmental Management*, 284, pp.112031

Rosyidah, E., Hermana, J. and Warmadewanthi, I.D.A.A. (2023), July. A Study of Waste Projection through Bibliometric Analysis. In *IOP Conference Series: Earth and Environmental Science*, 1211 (1), pp.012020.

Rovira, J., Domínguez-Morueco, N., Nadala, M., Schuhmacher, M., Domingo, J.L. (2018). Temporal trend in the levels of polycyclic aromatic hydrocarbons emitted in a big tire landfill fire in Spain: Risk assessment for human health. *Journal of Environmental Science and Health, Part A*, *53(3),* pp.222–229.

Salah, M.M., Al-Sari', M.I., Al-Khatib, I.A. and Kontogianni, S. (2020). Local residents' perception of landfill impacts in Palestine: the case of Zahrat Al-Finjan landfill. *Journal of Material Cycles and Waste Management*, *22*, pp.673-681.

Saunders, M.N.K., Lewis, P. and Thornhill, A. (2019). *Research methods for business students*. 8th Edition. Harlow: Pearson Education Limited.

Schenck, C.J., Blaauw, P.F., Viljoen, J.M. and Swart, E.C. (2019). Exploring the potential health risks faced by waste pickers on landfills in South Africa: A socio-ecological perspective. *International journal of environmental research and public health*, *16*(*11*), pp.2059.

Shen, S., Chen, Y., Zhan, L., Xie, H., Bouazza, A., He, F., Zuo, Z. (2018). Methane hotspot localization and visualization at a large-scale Xi'an landfill in China: Effective tool for Landfill Gas Management. *Journal of Environmental Management*, *225*, pp. 232–241.

Siddiqua, A., Hahladakis, J.N. and Al-Attiya, W.A. (2022). An overview of the environmental pollution and health effects associated with waste landfilling and open dumping. *Environmental Science and Pollution Research*, 29(*39*), pp.58514–58536.

Sileyew, K.J. (2019). Research Design and Methodology. In *Cyberspace*. IntechOpen.

Singh, S. and Chokhandre, P. (2015). Assessing the impact of waste picking on musculoskeletal disorders among waste pickers in Mumbai, India: a cross-sectional study. *BMJ open*, *5*(*9*), pp.e008474.

Simatele, D.M., Dlamini, S. and Kubanza, N.S. (2017). From informality to formality: Perspectives on the challenges of integrating solid waste management into the urban development and planning policy in Johannesburg, South Africa. *Habitat international*, *63*, pp.122-130.

Singh, S. and Chokhandre, P. (2015). Assessing the impact of waste picking on musculoskeletal disorders among waste pickers in Mumbai, India: a cross-sectional study. *BMJ open*, *5*(9), pp.e008474.

Singh, P., Milshina, Y., Tian, K., Borthakur, A., Verma, P. and Kumar, A. (2021). *Waste Management Policies and Practices in BRICS Nations*. CRC Press.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, pp.333-339.

Souza-Silva, G. and Mol, M.P.G. (2021). Hepatitis B or C prevalence in waste pickers from South America: a systematic review. *Journal of Public Health*, *43*(*4),* pp.e578-e583.

Sovacool, B.K., Axsen, J. and Sorrell, S. (2018). Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design. *Energy research and social science*, *45*, pp.12-42.

Surendra, K.C., Tomberlin, J.K., van Huis, A., Cammack, J.A., Heckmann, L.H.L. and Khanal, S.K. (2020). Rethinking organic wastes bioconversion: Evaluating the potential of the black soldier fly (Hermetia illucens (L.) (Diptera: Stratiomyidae) (BSF). *Waste Management*, *117*, pp.58-80.

Taherdoost, H. (2021). Data collection methods and tools for research; a step-by-step guide to choose data collection technique for academic and business research projects. *International Journal of Academic Research in Management (IJARM)*, *10*(*1*), pp.10-38.

Tamminen, K.A. and Poucher, Z.A. (2020). Research philosophies. In *The Routledge international encyclopedia of sport and exercise psychology*. pp.535-549.

Tellado, I., Lepori, B. and Morla-Folch, T. (2020). Communicative daily life stories to assess social impact in the lives of informal workers. *Qualitative Inquiry*, *26*(*8-9*), pp.962-969.

Teng, C., Zhou, K., Peng, C. and Chen, W. (2021). Characterization and treatment of landfill leachate: A review. *Water research*, *203*, pp.1-13.

The World Bank. (2012). *What a waste - A Global Review of Solid Waste Management*. Urban Development Series. Washington, DC: The World Bank, pp.1-33.

Tlili, A., Altinay, F., Huang, R., Altinay, Z., Olivier, J., Mishral, S., Jemni, M. and Burgos, D. (2022). Are we there yet? A systematic literature review of Open Educational Resources in Africa: A combined content and bibliometric analysis. *Plos One*, *17(1).*

Tomita, A., Cuadros, D., Burns, J., Tanser, F. and Slotow, R. (2020). Exposure to waste sites and their impact on health: a panel and geospatial analysis of nationally representative data from South Africa, 2008–2015. *The Lancet Planetary Health*, *4(6),* pp.e223-e234.

Torres-Carrión, P.V., González-González, C.S., Aciar, S. and Rodríguez-Morales, G. (2018). Methodology for systematic literature review applied to engineering and education. *IEEE Global Engineering Education Conference (EDUCON)*. pp.1364-1373.

Townsend, T.G. (2018). *Landfill bioreactor design and operation*. Routledge.

Uddin, S.M.N. and Gutberlet, J. (2018). Livelihoods and health status of informal recyclers in Mongolia. *Resources, conservation and recycling*, *134*, pp.1-9.

Uhunamure, S.E., Edokpayi, J.N. and Shale, K. (2021). Occupational health risk of waste pickers: A case study of the northern region of South Africa. *Journal of Environmental and Public Health*, *2021*, pp.1–12.

UNEP (2018). Africa Waste Management Outlook. *United Nations Environment Programme*. Nairobi. Kenya.

Valavanidis, A. (2023). Global Municipal Solid Waste (MSW) in Crisis. *Two billion tonnes of MSW every year, a worrying worldwide environmental problem*, *1*, pp.1-28.

Vallero, D.A. and Blight, G. (2019). The municipal landfill. In *Waste*, 2nd Edition. Academic Press, pp.235-258.

Vaverková, M. (2019). Landfill Impacts on the Environment—Review. *Geosciences*, *9(10),* pp.431.

Vears, D.F. and Gillam, L. (2022). Inductive content analysis: A guide for beginning qualitative researchers. *Focus on Health Professional Education: A Multi-Professional Journal*, *23(1),* pp.111–127.

Vidyavathy, K. (2018). A study on solid waste management and vector borne diseases (Dengue) control in polluted areas (Warangal City). *Pharma Innovat J*, *7*, pp.259-263.

Vierula, J., Stolt, M., Salminen, L., Leino-Kilpi, H. and Tuomi, J. (2016). Nursing education research in Finland—A review of doctoral dissertations. *Nurse Education Today*, *37*, pp.145-154.

Xiao, Y. and Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, *39*(*1*), pp.93-112.

Yang, H., Ma, M., Thompson, J.R. and Flower, R.J. (2018). Waste management, informal recycling, environmental pollution and public health. *J Epidemiol Community Health*, *72(3),* pp.237-243.

Yilmaz, M., Tinjum, J.M., Acker, C. and Marten, B. (2021). Transport mechanisms and emission of landfill gas through various cover soil configurations in an MSW landfill using a static flux chamber technique. *Journal of Environmental Management*, *280*, pp.111677.

Zhang, Z., Chen, Z., Zhang, J., Liu, Y., Chen, L., Yang, M., Osman, A.I., Farghali, M., Liu, E., Hassan, D. and Ihara, I. (2024). Municipal solid waste management challenges in developing regions: A comprehensive review and future perspectives for Asia and Africa. *Science of the Total Environment*, pp.172794.

Ziraba, A.K., Haregu, T.N. and Mberu, B. (2016). A review and framework for understanding the potential impact of poor solid waste management on health in developing countries. *Archives of Public Health*, *74(1)*.

Zolnikov, T.R., Furio, F., Cruvinel, V. and Richards, J. (2021). A systematic review on informal waste picking: Occupational hazards and health outcomes. *Waste Management*, *126*, pp.291-308.

7. Appendices

A - Data Set 1

1. Ali, A.F. and Yusuf, F.I. (2021). Prevalence of injuries among waste pickers. A case study in Nigeria. *Detritus*, *(17)*, pp.89–96.

2. Byonanebye, D.M., Nankya, J., Arinaitwe, I. and Bukenya, B. (2022). Occupational Injuries and use of personal protective equipment among casual municipal solid waste workers in the informal sector in Kampala: A cross-sectional study: Occupational injuries in informal waste workers. *Student's Journal of Health Research Africa*, *3(3),* pp.10-10.

3. Hashim, M., Njogu, P., Kinyua, R. and Korir, R. (2020). Awareness of scavenging waste pickers on occupational hazards in selected dumpsites in Nairobi metropolis, Kenya. *IOSR Journal of Humanities and Social Science*, *25(12),* pp.38-46.

4. Isaac, I., Habila, J., Salami, H., Increase, O. C., Olivia, O. N. (2020). Health impacts of informal solid waste scavenging in Minna, Nigeria. *International Journal of Scientific Research, 6(12),* pp.53-57.

5. Made, F., Ntlebi, V., Kootbodien, T., Wilson, K., Tlotleng, N., Mpume, N., Spo, K. and Naicker, N. (2019). Risk factors associated with self-reported health among waste pickers in landfill sites in Johannesburg municipality, South Africa. *Environmental Epidemiology*, *3*, pp.255.

6. Made, F., Ntlebi, V., Kootbodien, T., Wilson, K., Tlotleng, N., Mathee, A., Ndaba, M., Kgalamono, S. and Naicker, N. (2020a). Illness, self-rated health and access to medical care among waste pickers in landfill sites in Johannesburg, South Africa. *International Journal of Environmental Research and Public Health*, *17*(7), pp.2252.

7. Made, F., Wilson, K., Kootbodien, T., Tlotleng, N., Naicker, N., and Ntlebi, V. (2020b). Hypertension and associated risk factors among informal waste pickers in Johannesburg, South Africa. *Occupational Health Southern Africa*, *26(1),* pp.282-286.

8. Made, F., Nonterah, E.A., Tlotleng, N., Ntlebi, V. and Naicker, N. (2021). Ten-year risk of fatal cardiovascular disease and its association with metabolic risk factors among waste pickers in South Africa. *BMC Cardiovascular Disorders*, 21(1), pp.1-8.

9. Magaji, J. Y. and Osigbemhe, J. C. (2018). Occupational health risk associated with waste scavenging in Kuje Area council, Abuja, Nigeria, Ethiopian *Journal of Environmental Studies & Management, 11(3),* pp.360 – 375.

10. Makhubele, M., Ravhuhali, K., Kuonza, L., Mathee, A., Kgalamono, S., Made, F., Tlotleng, N., Kootbodien, T., Ntlebi, V., Wilson, K. and Naicker, N. (2019). Common mental health disorders among informal waste pickers in Johannesburg, South Africa 2018—A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, *16(14),* pp.2618.

11. Mothiba, M.P. (2016). *A study on working conditions and health status of waste pickers working at landfill sites in the city of Tshwane metropolitan municipality*, (Doctoral dissertation).

12. Mugo, K.K., Gichanga, J.M., Gatebe, E. and Njogu, P.M. (2022). Assessment of the safety and health hazards in existing dumpsites in Kenya. *In Proceedings of the Sustainable Research and Innovation Conference,* pp.46-49.

13. Naicker, N., Kootbodien, T., Ntlebi, V., Made, F., Tlotleng, N., Ndaba, M., Kgalamono, S., Du Preez, K., Mokone, M., Mathee, A., Wilson, K. (2020). Prevalence of non-fatal injuries in informal waste recyclers in landfill sites in Johannesburg, South Africa, *ISEE Conference Abstracts*, pp.0759.

14. Nuripuoh, J.G., Duwiejuah, A.B. and Bakobie, N. (2022). Awareness and health risk protection behaviours of scavengers in the Gbalahi landfill site, Ghana, in the era of sustainable development, *Discover Sustainability*, *3(1)*, pp.1.

15. Nyathi, S., Olowoyo, J.O. and Oludare, A. (2018). Perception of scavengers and occupational health hazards associated with scavenging from a waste dumpsite in Pretoria, South Africa. *Journal of Environmental and Public Health*, *2018*, pp.1–7.

16. Patrick, N.O., Eyinna, D. and Stanley, K. (2022). Assessment of health and safety risk among waste scavengers in Enugu State, Nigeria. *Asian Research Journal of Arts and Social Sciences*, pp.23–37.

17. Schenck, C.J., Blaauw, P.F., Viljoen, J.M. and Swart, E.C. (2019). Exploring the potential health risks faced by waste pickers on landfills in South Africa: A socio-ecological perspective. *International Journal of Environmental Research and Public Health*, *16(11),* pp.2059.

18. Tlotleng, N., Kootbodien, T., Wilson, K., Made, F., Mathee, A., Ntlebi, V., Kgalamono, S., Mokone, M., Du Preez, K. and Naicker, N. (2019). Prevalence of respiratory health symptoms among landfill waste recyclers in the city of Johannesburg, South Africa. *International Journal of Environmental Research and Public Health*, *16(21),* pp.4277.

19. Uhunamure, S.E., Edokpayi, J.N. and Shale, K. (2021). Occupational health risk of waste pickers: A case study of the northern region of South Africa. *Journal of Environmental and Public Health*, *2021*, pp.1–12.

20. Vasina, M. (2018). Health-related practices and perceptions among waste pickers. The case of Mbeubeuss waste dump in Senegal [Masters dissertation]. Geneva: Graduate Institute of International and Development Studies.

21. Wilson, K.S., Kootbodien, T., Made, F., Mdleleni, S., Tlotleng, N., Ntlebi, V. and Naicker, N. (2021). Men and women waste pickers on landfills in Johannesburg, South Africa: Divergence in health, and socioeconomic status. *International archives of occupational and environmental health*, *95(2),* pp.351-363.

B - Data Set 2

1. Abiola, A.H.O., Fakolade, F.C., Akodu, B.A., Adejimi, A.A., Oyeleye, O.A., Sodamade, G.A. and Abdulkareem, A.T. (2021). Comparison of respiratory and skin disorders between residents living close to and far from Solous landfill site in Lagos State, Nigeria. *African Journal of Primary Health Care & Family Medicine*, *13(1)*, pp.1-7.

2. Adetona, O., Ozoh, O.B., Oluseyi, T., Uzoegwu, Q., Odei, J. and Lucas, M. (2020). An exploratory evaluation of the potential pulmonary, neurological and other health effects of chronic exposure to emissions from municipal solid waste fires at a large dumpsite in Olusosun, Lagos, Nigeria. *Environmental science and pollution research*, *27*, pp.30885-30892.

3. Addo, I.B., Adei, D. and Acheampong, E.O. (2015). Solid waste management and its health implications on the dwellers of Kumasi metropolis, Ghana. *Current Research Journal of Social Sciences*, *7(3),* pp.81–93.

4. Ahmed, Y.A., Aderonke, M. and Oyewo, S.O. (2017). Health impact of leachates from illegal dumpsites: Case study of Kubwa Abuja, Nigeria, *Ethiopian Journal of Environmental Studies and Management*, *10(1),* pp.125.

5. Aliu, I.R. (2021). Socio-environmental, residential and health effects of waste dumpsites in Igando-Alimoso area of Lagos, Nigeria. *Journal of Applied Sciences and Environmental Management*, *25(6),* pp.977–984.

6. Amugsi, D.A., Haregu, T.N. and Mberu, B.U. (2019). Levels and determinants of perceived health risk from solid wastes among communities living near to dumpsites in Kenya. *International Journal of Environmental Health Research*, *30(4),* pp.409–420.

7. Babs-Shomoye, F. and Kabir, R. (2016). Health effects of solid waste disposal at a dumpsite on the surrounding human settlements. *Journal of Public Health in Developing Countries*, *2(3),* pp.268-275.

8. Dada, O.T. (2020). Environmental and health hazards of residents domiciled around Africa's largest landfill. *Journal of Environmental Planning and Management*, *64(9),* pp.1642–1667.

9. Etea, T., Girma, E. and Mamo, K. (2021). Risk perceptions and experiences of residents living nearby municipal solid waste open dumpsite in Ginchi town, Ethiopia: A qualitative study. *Risk Management and Healthcare Policy*, *14*, pp.2035–2044.

10. Gumede, P.R. and Savage, M.J. (2017). Respiratory health effects associated with indoor particulate matter (PM2.5) in children residing near a landfill site in Durban, South Africa. *Air Quality, Atmosphere and Health*, *10(7),* pp.853–860.

11. Machete, F. (2017). Environmental health risks associated with e-waste exposure in Badplaas, Carolina and Elukwatini landfills, republic of South Africa. *African Journal of Science, Technology, Innovation and Development*, *9(6)*, pp.679–684.

12. Mugo, K.K., Gichanga, J.M., Gatebe, E. and Njogu, P.M. (2022). Assessment of the safety and health hazards in existing dumpsites in Kenya. In Proceedings of the Sustainable Research and Innovation Conference. pp.46-49.

13. Ndukwe, V.A., Uzoegbu, M.U., Ndukwe, O.S. and Agibe, A.N. (2019). Environmental and health impact of solid waste disposal in Umuahia and Environs, Southeast, Nigeria. *Journal of Applied Sciences and Environmental Management*, *23*(9), pp.1615-1620.

14. Njoku, P.O., Edokpayi, J.N. and Odiyo, J.O. (2019). Health and environmental risks of residents living close to a landfill: A case study of Thohoyandou landfill, Limpopo Province, South Africa. *International Journal of Environmental Research and Public Health*, *16(12),* pp.2125.

15. Nnamdi C, O., Maureen C, O. and Omobolaji O, A. (2022). Health exposure and environmental challenges of households living nearby an open landfill system in Nigerian Urban Centre. *International Archives of Public Health and Community Medicine, 6(3).* pp.87.

16. Oladejo, O.A. and Otene, I.J., (2018). Environmental hazards of dumpsites in Ibadan, Nigeria. *ASJ: International Journal of Health, Safety and Environments (IJHSE)*, *4(03),* pp.257-268.

17. Oyedele, O.A. and Oyedele, A.O. (2017). Impacts of waste dumps on the health of neighbours: a case study of Olusosun waste dump, Ojota, Lagos state, Nigeria. *Journal of Civil, Construction and Environmental Engineering*, *2(1),* pp.27-33.

18. Ozabor, F. and Obaro, H.N. (2016). Health effects of poor waste management in Nigeria: A case study of Abraka in Delta State. *International Journal of Environment and Waste Management*, *18(3),* pp.195.

19. Peprah, P., Kwarteng, M.A., Asiedu, K., Agyemang-Duah, W., Morgan, A.K. and Adjei Gyimah, A. (2022). Self-reported symptoms of ocular allergy and its comorbid factors among residents living near a landfill site in Ghana. *International Journal of Environmental Health Research*, *33(4),* pp.386-397.

20. Roffe, S., Moolla, R. And Grab, S. (2017). The influence of BTEX landfill gas emissions: a case study of residents in Roodepoort, Gauteng, South Africa. *WIT Transactions on Ecology and the Environment*, *211*, pp.149-159.

21. Sindama, A., Agere, H. and Ezeonu, C.S. (2017). Health risk tendencies of some municipal solid waste dumps in Otukpo, Benue State, Nigeria. *Journal of Environmental Toxicology and Public Health*, *2*, pp.1-6.

22. Suleman, Y. (2016). Solid waste disposal and community health implications in Ghana: Evidence from Sawaba, Asokore Mampong municipal assembly. *Journal of Civil and Environmental Engineering*, *5(6)*, pp.202.

C – Study Protocol

Study protocol

Title:
Review of landfills impacts on informal waste-pickers and surrounding communities in Africa (2015-2022)

Aim of the study

The aim of the study was to review research that has been conducted on Africa relating to impacts of landfills on informal waste pickers and surrounding communities between 2015 and 2022 found in Google Scholar, ScienceDirect, PubMed, Sabinet, Taylor and Francis, Sage Journals, MDPI, and ResearchGate.

Research questions

1. What research trends and gaps were seen from the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

2. What were the impacts of landfills on informal waste pickers and surrounding communities identified from the studies reviewed conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

3. What were the causes of landfill impacts on informal waste pickers and surrounding communities reported by the reviewed studies conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

4. Which factors influenced the impact of landfills on informal waste pickers and surrounding communities from the studies reviewed conducted in Africa published from 2015 - 2022 relating to the impacts of landfill on informal waste pickers and surrounding communities?

5. Which recommendations were made by the reviewed studies conducted in Africa between 2015 and 2022 relating to the impacts of landfills on informal waste pickers and surrounding communities?

Study Design- Qualitative

Method: This study employed a qualitative systematic literature review to examine the impacts of landfills on informal waste pickers and surrounding communities.

Sampling method- Census and purposive

Inclusion criteria

1 Quantitative, qualitative, and mixed research designs
2 Peer-reviewed articles published in English
3 Studies focusing on health impacts of landfills on informal waste pickers and surrounding communities in Africa
4 Studies that used alternative words such as scavengers, recyclers, and collectors.
5 Studies on regulated or unregulated landfills

Exclusion Criteria

1 Studies that focused on landfill health impacts on municipal, bin and street waste pickers
2 Studies that focused on landfill environmental impacts not addressing health impacts
3 Studies not published in English
4 Studies that were published before 2015 & after 2022

Data Sources

1. Electronic databases: Google Scholar, ScienceDirect, PubMed, Sabinet, Sage Journals, MDPI, Taylor and Francis, and ResearchGate databases.

Search Strategy

Keywords: landfills, waste, health impacts, surrounding communities, landfill waste management, causes, human health, perception, informal waste pickers, and Africa

Studies were also tracked using sources or references cited in former reviews as well as the use of forward and backward search

Data extraction

Title, authors, year of publication
Study design and methodology
Key findings on health impacts

Data Analysis

1. Data was analysed manually
2. Coding-inductive and iterative approach.
3. Summarising key findings

D - Condensing example

1. Exposure to hazardous materials and toxic chemicals in landfills for a long time severely impacts the health and well-being of informal waste pickers, causing respiratory issues, skin diseases, and other serious medical conditions. "Prolonged exposure to landfill hazard harms waste pickers”.

2. Informal waste pickers, who often work without proper protective gear or safety measures, are at a high risk of accidents like cuts, punctures, and injuries from sharp objects. “Waste pickers face accident risks without PPE”.

3. People staying in close proximity to landfills are more at risk of suffering from smoke and odorous conditions from such landfills. “Surrounding communities are more likely to experience air pollution”.

E - Coding process

Step 1- Read and familiarise **-** this step included reading the studies to understand the content of the dataset.

Step 2- First round of coding- developing subcategories and fine-grained codes.

Surrounding communities

Big picture/subcategories	Fine-grained codes
Demographic information	• Gender • Age • Educational background • Marital status • Distance from the landfill • Duration of stay
Influential factors	• Age • Gender • Season • Distance
Environmental hazards	• Air pollution (odor, smoke, and dust) • Water pollution • Soil pollution • Fire • Flood • Mice/rodents
Health concerns	• Cancer • Kidney problems • Hepatitis • Respiratory problems • Recurring flue • pneumonia • Asthma • coughing/TB • Headache • Malaria • Cholera • Typoid • Lung infection • Vomiting • Sore throat

Psychosocial	• Cannot sell the property • Poor renting property • Friends unwilling to visit • Desirable business enterprise staying away • Stigmatisation
Psychological	• Fear of future health conditions (not fearful/moderate fear)
Community perceptions	• Good • Fair • Poor

Informal waste pickers

Big picture/subcategories	Fine-grained codes
Demographic information	• Gender • Age • Marital status • Educational background • Work experience • Number of days worked per week • Seasonal working
Type of waste collected	• Cloth • Glass • Plastic • Papper • Metal • Electronics • Rubber • Cans • Car batteries • Wood • Other waste
Sources of hazards	• Hazardous waste • Sharp objects • Lifting of heavy bags • E-waste • Organic waste • Landfill surfaces • Landfill vehicles • Insects

Health	• Infectious diseases • Chronic diseases • Asthma • TB • Cancer • Hypertension Hepatitis • Cholera • Typoid • Dysentery • Tetanus • Diabetes • Lung problems • Eyes problems • Nasal irritation • Skin symptoms • Respiratory problems • Ears • Headache • Coughing • Gastrointestinal/Diarrhea • Vomiting • Impetigo • Conjunctivitis
Ergonomics	• Swelling/numbness of limbs • Tiredness/weakness • Cramp • Back/chest paints • Muscular • Joint pains • Slip and fall
Physical injuries	• Cuts • Wounds • Burns • Punch • Animal/rodents bites
Used PPE	• Safety boots • Face mask • Safety goggles • Helmets • Gloves • Reflective vest • Cover all • use of light at night

Psychological	• Safety in landfills • Risk of mental health • Stigma
Psychosocial	• Stigmatisation (Yes/ No)
Impacts by demographics	• Gender • Age • Education • Working experience
Informal waste pickers perception	• Good • Fair • Poor • Very poor
Self-rated health condition	• Health condition (good /fair)
Informal waste pickers hygiene	• Bath/intervals • Washing of clothes/intervals

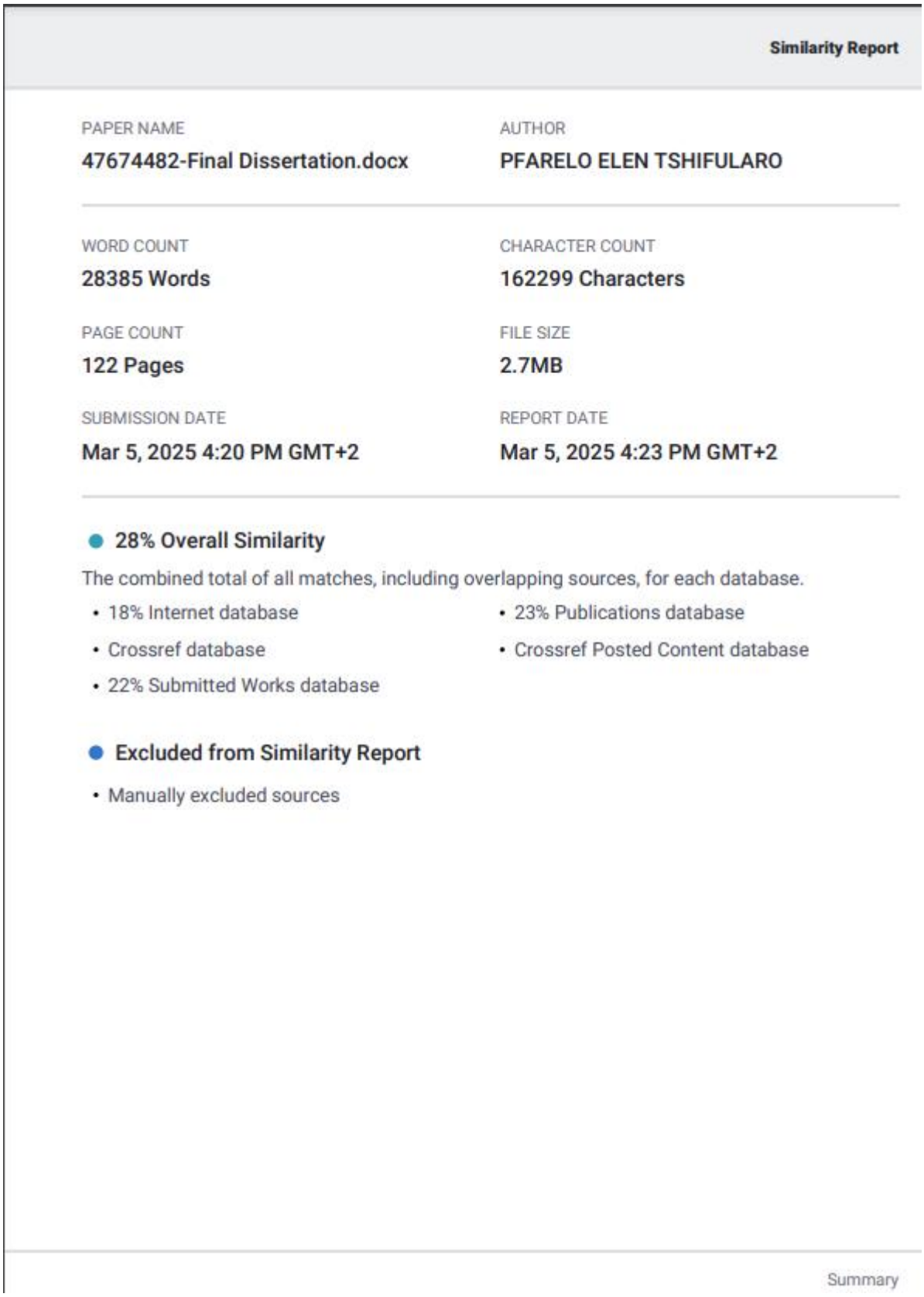
Step 3 - Refining the fine-grained codes/subcategories

The process of deciding on the final categories or themes included reviewing the subcategories and the fine-grained codes. It also involved splitting some of the fine-grained codes to ensure that the data set was represented accurately.

Example: smoke and fire (landfill impacts on surrounding communities)

Even though both smoke and fire are a source of air pollution and smoke can be as a result of fire, it was important to split them because smoke can come from other sources, such as emissions from vehicles within landfills.

F – Turn-it-in report



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Summary