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Environmental And Health Implications of Waste Disposal Sites In The Lesotho Lowlands

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Abstract: Many Southern African countries, including Lesotho, face severe health and environmental issues attributed to waste disposal. The purpose of this study is to assess the environmental and health impacts on residents living in proximity to disposal sites in the lowlands of Lesotho. A descriptive cross-sectional design was employed, using a semi-structured questionnaire and observation method. A mapping device was used, and photographs were taken to validate the findings. Descriptive statistics and the Chi-square test (χ^2) were employed to analyze the data. Results indicate that in Lesotho, some landfill sites are located as close as 50 meters from residential areas, and most (60%) received hazardous mixed waste streams. Waste burning and backyard dumping were the most frequently used disposal methods by residents. Several perceived health outcomes and environmental issues were noted, with respiratory and gastrointestinal health issues being the most prevalent. There was a statistically significant association between waste burning and respiratory diseases ($P < 0.010$) and between backyard dumping and gastrointestinal diseases ($P < 0.003$). The study concludes that regulatory instruments need to be revised and enforced, requiring hazardous waste producers to take responsibility for end-of-life waste and banning the entry of such waste into disposal sites. The application of waste management strategies to initiate other preferable end-of-life waste procedures, such as recycling of WEEE and waste-to-energy technologies for organic waste in Lesotho, could improve the quality of health for residents and their environment.

Keywords: Lesotho Urban Councils, Waste Disposal, Waste Burning, Dumpsites, Environment Impacts, Health Impacts, Social Impacts

1. Introduction

Municipal Solid Waste (MSW) management in African cities is characterized by poor collection coverage and inadequate disposal (Godfrey et al., 2019). While waste generation is inevitable, especially in the modern age of industrialization, rural-urban migration, and urbanization, waste collection faces significant constraints (Odonkor & Sallar, 2021). Due to the steady rise in technological advancement, waste in urban areas of Lesotho is more diversified in quantity and composition compared to rural areas (Oguneye & Uzoma, 2018; Senekane et al., 2021). Most developing countries allocate about 80–95% of their waste management budgets to collecting and transporting waste, yet collection coverage remains below 50% (Masoabi, 2020). Lesotho has implemented an integrated waste management strategy to address current and future waste management challenges and opportunities; however, poor waste disposal practices continue to hinder progress toward integrated solid waste management for households (United Nations Development Programme [UNDP], 2022; Fadhullah et al., 2022).

Globally, a significant gap exists in waste management from source to final destination, as most countries rely on landfilling as a primary or sole waste management method, regardless of their development status (Siddiqui et al., 2022). Lesotho currently lacks a sanitary landfill; the Ts'osane site, labeled as a landfill, functions more as an open dump. Other districts have at least one dumpsite designated as an official disposal site by local authorities, but these sites are poorly developed, inadequately managed, and unprotected, often selected with little consideration for site selection indicators, such as distance from natural resources, infrastructure, residential areas, or end-of-life planning (Mavropoulos & Newman, 2015; Abubakar et al., 2022). In low-income countries, approximately 93% of waste is openly dumped and burned, posing significant threats to the environment, public health, and the socioeconomic well-being of communities (Kaza *et al*., 2018) (Kaza et al., 2021).

The location of disposal sites affects the socio-economic stability and safety of local communities. In Maseru, for instance, residents have lost properties and businesses due to spontaneous fires at the Ts'osane landfill (Mokoka, 2022). Residential areas near disposal sites often experience issues such as methane (CH_4)

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gas accumulation and property destruction (Siddiqui et al., 2022). The effects of landfills on building conditions may not be immediate, with impact varying based on the distance from and size of landfill sites (Akinrogunde et al., 2019). Community members renting out rooms face financial losses as tenants frequently vacate due to unbearable living conditions (e.g., odor, smoke, rodents, and pests), leaving rooms unoccupied for extended periods (Mokoka, 2022). Waste burning impacts residents' quality of life, limiting outdoor activities, causing sleep disturbances due to air pollution, and prompting relocation during fire outbreaks. Many studies report that residents opt to relocate to mitigate health risks associated with nearby open burning (Phelan et al., 2020; Ofori, 2021; Owusu-Sekyere, 2022). In Maseru's Ts'osane landfill, residents have complained that friends and family avoid visiting them due to the intolerable living conditions (Mokoka, 2022). Poor sanitation and living conditions not only affect residents' physical well-being but also stigmatize the community in the eyes of others.

Poorly managed disposal sites also harm the environment and the health of nearby residents (UNDP, 2022). Improper solid waste disposal introduces hazardous pollutants into the air, soil, and water systems, contaminating surface and groundwater supplies (Tsheleza et al., 2018; Fadhullah et al., 2022; Phan et al., 2022; Etea et al., 2021; Turyahabwe et al., 2022). Fumes and vapors from open burning and greenhouse gas emissions contribute to environmental risks, such as global warming, land and vegetation degradation, wildlife depletion, and decreased property values (United Nations [UN], 2022). Landfill leachate often contains high concentrations of heavy metals, nutrients (e.g., nitrates and phosphates), ammonia, and chlorides, which can impede soil and water movement and harm aquatic life (Danthurebandara et al., 2013; Gwibi et al., 2020; Owusu-Sekyere, 2022). Open dumpsites also attract rodents and pests, degrading sanitation and aesthetics in nearby areas (Turyahabwe et al., 2022; Kumar & Prakash, 2020; Omang et al., 2021). Human exposure to pollutants occurs through inhalation, skin contact, or ingestion (Machete & Shale, 2015; Turyahabwe et al., 2022). Standing water in waste piles attracts mosquitoes and other insects, spreading vector-borne diseases. Diseases such as malaria, dengue fever, typhoid, tetanus, cholera, eczema, and dysentery are transmitted by these vectors (Babs-Shomoye & Kabir, 2016; Turyahabwe et al., 2022). Non-communicable diseases account for 62% of environmentally related deaths in East Asia, with major causes of mortality including heart attacks, stroke, chronic obstructive pulmonary disease, and lung cancer linked to air pollution. Residents living near landfills often sustain injuries from contact with waste, such as needle pricks and cuts (World Health Organization, 2019). Given Lesotho's high prevalence of HIV/AIDS and tuberculosis (TB), the country cannot afford additional health burdens (World Bank, 2018). Effective waste management is essential for protecting human health, conserving natural resources, and safeguarding the environment (Cervantes et al., 2018).

Thus, this study aims to assess the impact of waste disposal sites on the environment and health of residents living in close proximity to disposal sites in the lowlands of Lesotho.

2. Methodology

2.1 Description of the study area

The Kingdom of Lesotho is a small, mountainous country covering 30,555 km². It is completely landlocked by the Republic of South Africa (UNDP, 2015). Less than 10% of this territory is arable (Government of Lesotho, 2018). The topographical variability and climatological influences define the ecological zones of the country: the Lowlands (17%), Foothills (15%), Mountains (59%), and Senqu River Valley (9%) (UNDP, 2022). The country is divided into ten districts with ten district councils, 65 community councils, and eleven urban councils, along with one municipal (or city) council, which forms the local government (UNDP, 2022). The study focused on the Lowlands of Lesotho, specifically on the Northern Lowland districts of Botha-Bothe, Leribe, and Berea, each with one official disposal site per district. Only Maseru represented the Southern Lowlands. Therefore, the perceptions and results of this study may not fully reflect all urban areas in the country, and the findings cannot be generalized to the entire Kingdom of Lesotho. The study included one city council and four urban councils: Maseru City Council, Berea Urban Council, Maputsoe Urban Council, Hlotse Urban Council, and Botha-Bothe Urban Council. The sample of five councils represented 45.5% of the total 11 city and/or urban councils.

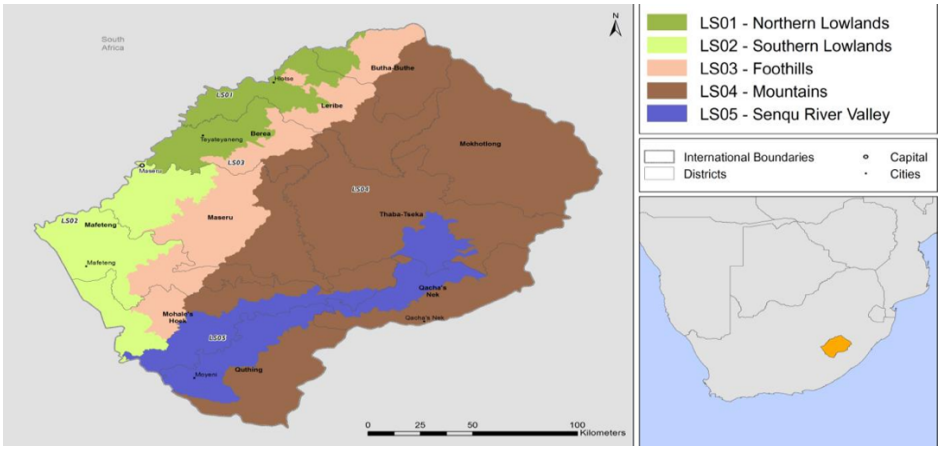

Figure 1: Map of Lesotho's administrative districts and livelihood zones Source: Famine Early Warning Systems Network, 2011.

2.2. Research approach and design

A descriptive cross-sectional study approach was adopted for this study. Cross-sectional studies provide a snapshot of what is happening within a group at a particular time. They are more manageable, cost-effective, and time-efficient, making them a popular choice for health professionals as large amounts of data can be collected at once, providing quick results (Zheng, 2015). In clinical or health research, cross-sectional studies are typically used to understand the prevalence of a disease or the association between exposure and outcomes in a population. Descriptive cross-sectional studies portray the prevalence of one or multiple health outcomes in a specific population, while analytical cross-sectional studies collect data on both exposures and outcomes simultaneously to compare differences between exposed and unexposed individuals (Wang & Chen, 2020). Given the temporal nature of cross-sectional studies, revisiting the same setting to verify collected information in the future may not be feasible.

2.3. Study Population and Selection Techniques

The target population consisted of residents and urban council officials. One hundred and fifty participants (thirty per council) living near disposal sites were conveniently selected. One representative official (preferably a waste management official or town clerk) was purposively sampled from each city and/or urban council.

2.4. Data Collection Instruments and Techniques

Structured questionnaires and checklists were used for this study. Questionnaires allow for the collection of large amounts of data from a sizable sample and help obtain more objective answers (Taherdoost, 2021). Predetermined standard questions were used to collect data numerically for statistical analysis. Two questionnaires were created in English and translated into Sesotho (the first language of the Basotho people). The Sesotho questionnaire was then back-translated into English to ensure consistency in understanding. The questionnaire was peer-reviewed by professionals (supervisors and experts in waste management) and submitted to a biostatistician for approval to ensure validity and reliability. Reliability is defined as the consistency or repeatability of results, while validity refers to the degree of accuracy in reflecting what is being measured (Eldridge, 2015).

The close-ended questions included nominal, ordinal, interval, and Likert-scale types to offset the limitations of structured questionnaires. Questions offered options like “very strong,” “strong,” “fair,” “weak,” and “very weak.” Multiple-choice and network-type questions were also included, depending on the question type and desired responses. Open-ended questions allowed participants to elaborate on their thoughts, such as: "What initiatives did you take to minimize the risks you are exposed to?"

Observations were documented using a checklist during site walkthroughs, and photographs were taken. Direct observation refers to data collection where the researcher notes participants' actions without altering their environment. The checklist was developed using standardized instruments from previous waste landfill projects. Observations aimed to gather data on the characteristics of the disposal sites.

2.5. Ethical Clearance and Consent

The study was approved by the Health Science Research Ethics Committee (HSREC) of the University of the Free State (UFS-HSD2018/0730/2509), South Africa, and by the Ministry of Health’s Research Coordinating Unit for Ethical Clearance in Lesotho (REF: ID102-2018), following guidelines for personal information protection before the study commenced.

2.6. Data Collection Procedure

For residents, local gatekeepers (chiefs, ward councillors, or town clerks) were approached to inform them about the research taking place in their area and to build rapport and ensure security. A convenient sample of 150 residents living near waste disposal sites was selected. A door-to-door approach was used, with the researcher distributing questionnaires in person. The purpose of the study was explained to participants to emphasize the value of their participation. Confidentiality was assured, and consent forms were signed by those willing to participate. Since self-administered questionnaires can yield low response rates, the researcher’s presence allowed participants to ask questions for clarification, and forms were collected immediately after completion (Ezeah & Roberts, 2012; Cassim & Du Plessis, 2021). Participants were encouraged to respond in the language they preferred, and assistance was provided if needed, especially for those with limited formal education. Only one participant per household aged 18 and above was allowed to avoid redundant responses.

For urban council officials, permission was obtained from the municipal management of Maseru City Council and the town clerks of other urban councils. Purposive sampling was used to select urban council representatives, specifically waste management officials and town clerks, based on the researcher’s judgment of their expertise in waste management. To mitigate the Hawthorne Effect (where participants alter their behavior when they feel observed), the study’s purpose and the importance of honest responses were emphasized (Cassim & Du Plessis, 2021). Confidentiality was assured, and participants were informed of their right to withdraw without repercussions. Appointments were scheduled to facilitate data collection, and consent forms were collected immediately after completion. The questionnaires were identified by numeric values rather than names or easily identifiable details (e.g., Town 1 or T1).

Observational data was also collected to record site conditions. Human behavior and activities, as well as environmental features at the sites, were documented using a checklist with three sections: site location information, landfill/dumpsite features, and operation/maintenance activities. The checklist guided observations, and photographs of the sites were taken for visual reference.

Geographical mapping was also used as a data collection method. This involved taking field trips to selected disposal sites with a Garmin Global Positioning System (GPS) device (Etrex 10 model). The device was calibrated for 10 minutes, and waypoints were recorded every 90 minutes as recommended in the user manual. The distances between human settlements, natural resources, and disposal sites within a 1-kilometer radius were measured and recorded.

2.7. Data analysis

Data from the two questionnaires were first validated, coded, and then entered into Microsoft Excel by the researcher. Descriptive statistics were conducted by a statistician using SAS Version 9.2. Frequencies and percentages were calculated for categorical data, while means, standard deviations, and percentiles were calculated for numerical data. Percentages were used to present the results and determine the number of respondents. An inferential statistical test, namely the Chi-Square test, was used to find associations between certain categorical variables using an online social science statistical package (https://www.socstatistics.com). This test was used to establish associations between the most preferred disposal method and the most prevalent health outcomes. The significance level was set at 0.05, meaning results were considered significant if the p-value was less than 0.05.

3. Results and discussion

3.1. Waste types, collection coverage, disposal methods, and dumpsite operation in the urban councils

This section presents the coverage of existing waste collection services, the types of waste generated, and the various disposal methods in residential areas. It also covers the types of general and hazardous waste permitted in disposal sites across the five councils. The data reflects the responses of the surveyed residents and urban council officials.

Waste collection duty in Lesotho is assigned to urban councils, with an annual budget decentralized through the Ministry of Local Government and Chieftaincy. Approximately 60% of residents in the areas studied, across three councils, did not receive any waste collection services, while only 40% of the councils provided waste collection services, as shown in Figure 2.

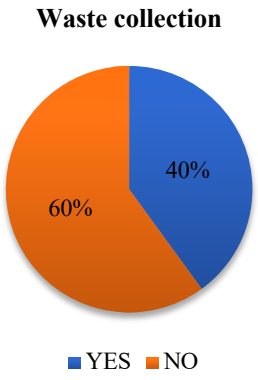

Figure 2: Waste collection in the councils under study

Figure 3 shows that waste burning was the most frequently used solid waste disposal method, with more than half (61.3%) of residents burning their waste in open spaces. A smaller percentage of residents (20%) burned and buried their waste in their backyards, and only 4.7% carried their waste to the landfill or dumpsite.

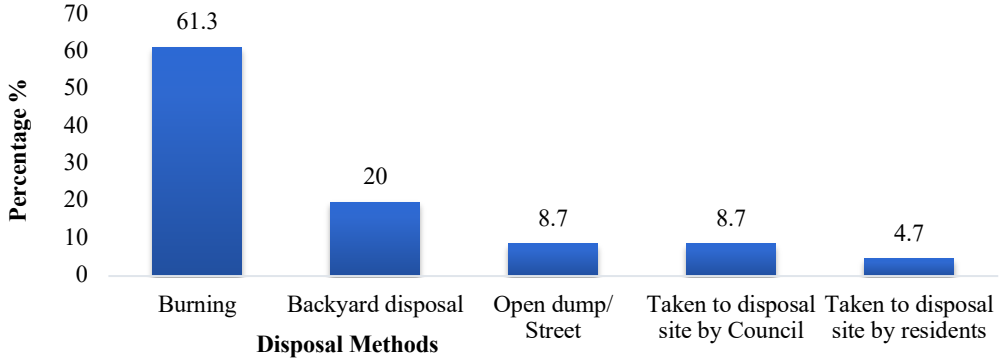

Figure 3: Disposal methods used by residents in the five council areas under study.

The high percentage of residents without access to waste collection services rely on unsafe disposal practices, which are harmful to health and the environment, such as open burning, backyard disposal, and open dumping. Many studies conducted in developing countries align with this study, noting that burning and open dumping are the most dominant waste disposal practices, even in areas where waste collection services are available (Akinrogunde et al., 2019; Mahai et al., 2019; Omang et al., 2021; Turyahabwe et al., 2022; Phelan et al., 2020; Fadhullah et al., 2022). For instance, a case study conducted in Neam County, Romania, revealed that open burning and backyard dumping remained high even when waste collection services were only partially available, especially in poor and marginalized communities not covered by local council budgets (Mahai et al., 2019). This study did not investigate the reasons behind residents' choice of disposal methods but calls for councils and the Bureau of Statistics in Lesotho to prioritize waste data to understand the underlying factors influencing these choices.

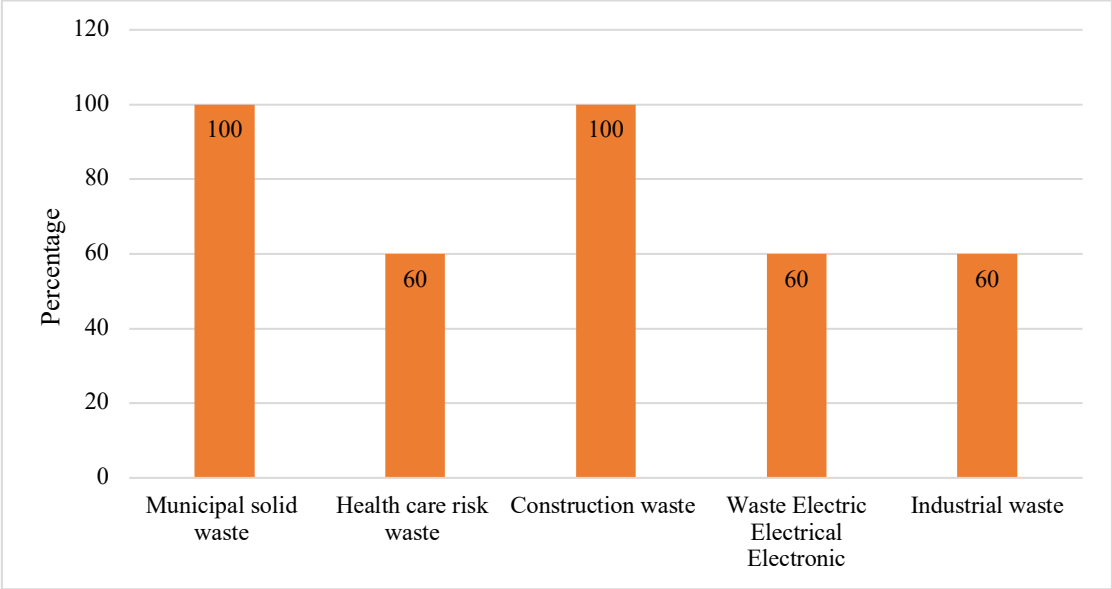

Figure 4: The general and hazardous waste categories received in the disposal sites under this study

Figure 4 shows that all disposal sites received Municipal Solid Waste (MSW) and construction waste. Due to the absence of a hazardous waste landfill, Health Care Risk Waste (HCRW), e-waste, and industrial waste were disposed of in most (60%) council disposal sites. Waste was received in a mixed state at all disposal sites, and due to limited monitoring and the absence of weighbridges, waste quantities are still roughly estimated. The lack of accurate data on the density of different waste types limits the ability to estimate the required capacity for disposal sites and to classify the types of disposal sites in Lesotho (Cline, 2020; Senekane et al., 2021). These findings align with a study in South Africa, which showed that unregulated landfills lack waste separation, with commercial and healthcare activities as major contributors to hazardous waste streams (Machete & Shale, 2015). Many healthcare facilities rely on onsite incineration kilns for HCRW waste, but the three disposal sites in this study confirmed that some HCRW items (e.g., needles, swabs, soiled bandages, and biological waste) still end up in disposal sites due to poor waste segregation and limited training in these facilities (Turyahabwe et al., 2022). This finding raises questions about the availability and compliance of HCRW management strategies in Lesotho's healthcare facilities. Understanding what is disposed of at each site determines the site's toxicity level, potential impacts, and future remediation needs, making the classification of unregulated disposal sites in these urban councils a pressing issue.

The Mokota-koti dumpsite in the Maputsoe Urban Council and the Ts'osane landfill in Maseru City Council were notable for containing large quantities of industrial waste and e-waste, including chemical containers, apparel cut-offs, wires, car parts, electronic appliances, and waste tyres. Studies in Maseru have reported a significant increase in e-waste disposal in recent years due to short product life cycles and limited repair options. In the absence of e-waste legislation, public awareness, recycling infrastructure, and an extended producer responsibility (EPR) framework, e-waste is often disposed of alongside general waste in landfills or ends up being burned or dumped in open spaces (Masoabi, 2020). E-waste has a high market value (Thakholi, 2022), presenting a potential recycling opportunity and a case for promoting e-waste recycling markets.

Studies have suggested possible solutions for managing general and hazardous waste at disposal sites in Lesotho. Sechoola (2019) indicated that most MSW in developing countries, including Lesotho, is organic. Lesotho, which currently underproduces electricity and imports energy from Mozambique and Eskom, could explore biological methods of waste conversion to generate energy from waste. This would not only reduce electricity costs but also introduce clean energy solutions to address socio-economic inequalities in Lesotho. Some residents burn textile off-cuts as a wood substitute for heating, exposing themselves to health risks and environmental pollution. A study by Hapazari (2015) revealed that some persistent waste types in Lesotho, including textile, brewery, and soft drink industries' waste, along with polystyrene, could be valuable resources for the brick industry. Transitioning from traditional manufacturing methods to waste-based projects like clay and waste bricks could create business opportunities and positively impact residents' health and the environment.

Figure 5: Air pollution by spontaneous fires at Tsosane landfill in the Maseru City Council area

Waste was dumped without treatment in most disposal sites under study. It was only at the Tsosane landfill where waste was partially leveled, covered with a soil layer, and compacted due to the availability of equipment (excavator, forklift, and compactor) on site, which was complemented by a contractor serving on behalf of the city council during visitation (Jan-Feb 2019). Waste was burned at all disposal sites to reduce volumes by residents and, in some councils, by council workers. In some instances, as at the Tsosane landfill, waste burned spontaneously. Installations for the control of landfill gas, particularly methane, were observed; however, in the same year, October saw spontaneous fires, and the landfill burned continuously, with smoke hovering over and around the site for over a month (see Figure 5). The fire was reported to the Maseru City Council by the operating site contractor, but no action was taken to contain the situation.

Higher concentrations of particulate matter harm human health and the environment. Landfill gas is generally controlled by installing vertical or horizontal wells within the landfill. These wells are either vented to the atmosphere or connected to a central blower system that directs the gas to a flare or treatment process (Danthurebandara et al., 2013). This raises questions about the effectiveness of the city council in monitoring landfill gas emissions to protect citizens from adverse effects. The maturity of the site may be a contributing factor, as most disposal sites are projected to reach maximum capacity within a decade. The Ts'osane landfill, however, has been operating for over 40 years, with plans to relocate it to Ts'oeneng, Rothe in rural Maseru, only recently announced without specific timelines by the Minister of Local Government and Chieftainship in May 2024 (Abubakar, 2022; Lesotho News Agency [LENA], 2024). Many countries, including Lesotho, have committed to protecting the environment from air pollutants via international agreements, such as the United Nations Sustainable Development Goals (SDGs) and the Stockholm Convention on Persistent Organic Pollutants (POPs). These conventions require countries to manage their waste in ways that do not harm human health or the environment, and they also require signatories to report on their implementation efforts (Mahai et al., 2019). This is challenging for countries like Lesotho, which lack adequate data to measure progress toward these targets.

Figure 6: Houses in danger zone of less than 50 metres from Tsosane landfill in Maseru City.

Households in most councils (4, 80%) were located within a danger zone radius of fewer than 250 meters from disposal sites, with the Tsosane landfill being the closest, at less than 50 meters away (see Figure 5). Various sources documented the lived experiences and complaints of those residing near disposal sites in Lesotho, particularly at the Ts'osane landfill. Studies and reports on the Ts'osane landfill revealed that residents complained of an unsanitary environment linked to various diseases, including continuous headaches, burning eyes, and chest pains. The site also contributes to contamination for children due to the proliferation of flies and mice (LENA,

2017; Mokoka, 2022). It should be noted that these reports on the Ts'osane landfill cannot be generalized to other urban councils due to limited data on the impacts of waste and disposal sites in the country. Other studies confirm that community members living 500m to 1km from dumping sites are more likely to have health problems than those maintaining a safer distance (Phan et al., 2021; Machete, 2019). Findings in these reports align with a cross-sectional study conducted in Vietnam, which used the WHO Quality of Life (QoL) assessment scale. This study revealed that only 22.6% of participants living near a waste facility had an overall good QoL, with significant negative impacts on health and environmental status compared to those living 2km away (Phan et al., 2021).

This study did not assess the overall satisfaction level of residents living near disposal sites. However, similar studies could determine stressors related to existing reports in the country. A South African study comparing the impacts of waste disposal sites based on distance revealed that 78% of residents living near landfills found the sites unsuitable for their area, while 90% of those living 2km away agreed (Njoku et al., 2019). Two studies conducted in Ghana revealed social disruptions and consequences of living near disposal sites. In some cases, community members had to send family members to stay with relatives due to unbearable living conditions when the dump was burning. The value of rental properties near disposal sites was lower, while rent prices increased with distance from the dump site (Ofori, 2021), which aligns with the findings of Mokoka (2022) in Lesotho.

3.2. Environmental and public health impacts associated with the treatment of waste disposal sites

This section describes the general conditions of the disposal sites, as well as the risk exposure and lived experiences of residents living near disposal sites.

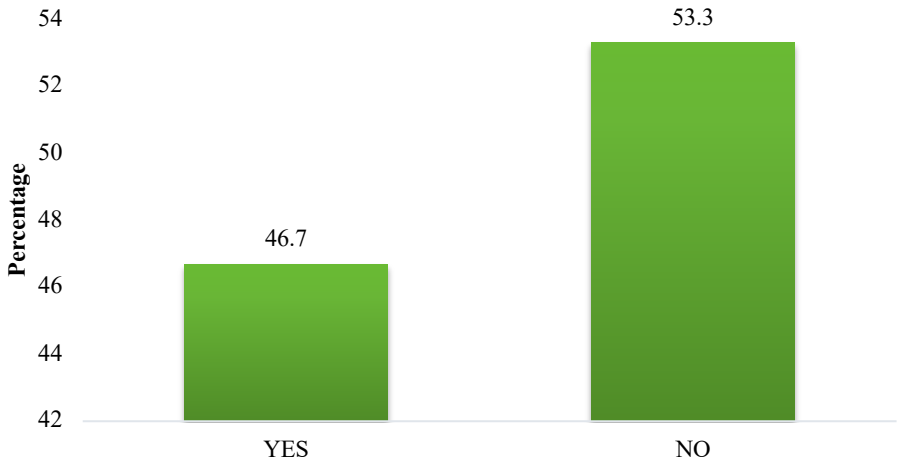

Figure 6: Waste Risk Exposure to Residents in the Councils Under Study

Figure 6 presents residents' perceptions of the risks they are exposed to: 46.7% felt vulnerable to health and environmental risks associated with living near landfills or dumpsites, while a slightly larger percentage (53.3%) felt safe. Although some participants shared recommendations for mitigating these risks, the rate of positive recommendations was low. This may be due to uninformed communities who have become accustomed to existing conditions without questioning potential hazards. A study of waste pickers conducted by Uhunamure et al. (2021) in northern South Africa found that about 50% of participants rated their health as good. However, waste pickers may underreport health issues due to fears of expulsion from work; similarly, residents in this study might fear eviction if they disclose their true health status or conditions.

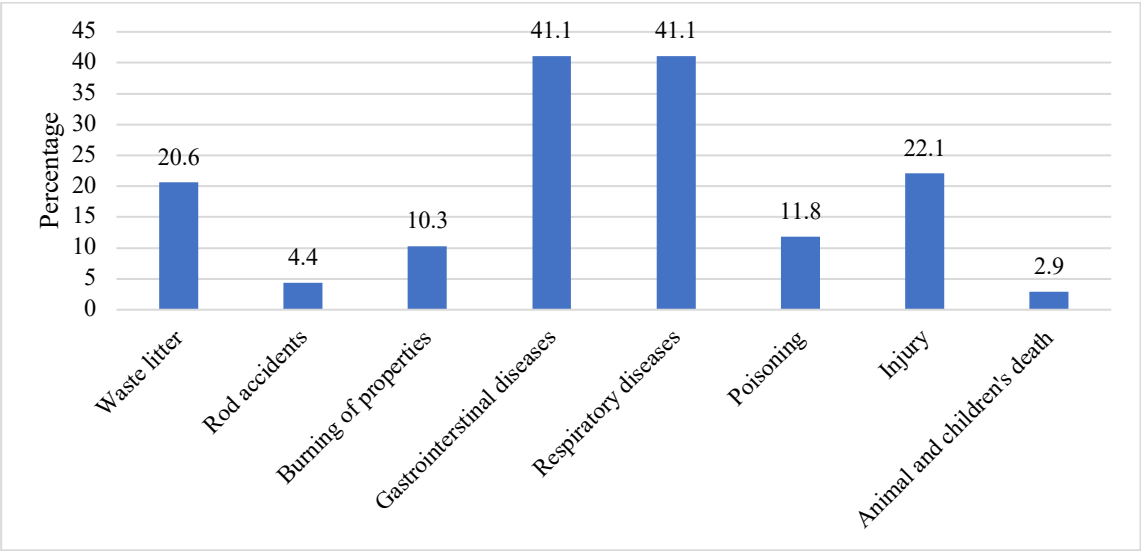

Figure 7: Environmental and Health Risks to Residents Attributed to Waste

The environmental and health risks perceived and experienced in the areas under study are shown in Figure 7. Gastrointestinal diseases and respiratory diseases were perceived to have the highest prevalence, at 44.1%, as indicated by the residents.

Table 1: The association between frequently used disposal methods and the two perceived health outcomes

Associated	**Waste burning**	**Respiratory diseases**	**Chi-square**	**P-value**
Yes	92 (83.18) [0.93]	30 (38.82) [2]	6.5955	0.010223
No	58 (66.82) [1.61]	40 (31.18) [2.49]		
Associated	**Backyard disposal**	**Gastrointestinal diseases**	**Chi-square**	**P-value**
Yes	30 (40.91) [2.91]	30 (19.09) [6.23]	12.5714	0.00392
No	120 (109.09) [1.09]	40 (50.91) [2.34]		

*Significant at $p < 0.05$

From a public health perspective, improper solid waste disposal and management can lead to air, soil, and water pollution that affects human health.

Table 1 shows the perceived association between frequently practiced disposal methods and prevalent health outcomes among residents. The association between waste burning and respiratory diseases was statistically significant, with $p < 0.010223$. Respiratory diseases associated with the constant inhalation of hazardous odorus and smoke were indicated by 44.1% of the residents. Various studies support the findings on respiratory diseases related to disposal sites and practices, noting conditions such as aggravated asthma, chronic obstructive pulmonary disease (COPD), and lung cancer caused by inhalation of particulate matter (PM) (Rim-Rukeh, 2014; Machete & Shale, 2015; Phan et al., 2019; Mahai et al., 2019). Other studies, such as one conducted in Ghana, found that dumpsites impact the microbial air load (both fungal and bacterial) and air quality in surrounding residences (Odonkor & Mahami, 2020). This can also contribute to diseases like tuberculosis, attributed to both microbial and fly ash inhalation. Tuberculosis is one of the major disease burdens in Lesotho (World Bank, 2018) and is generally prevalent in densely populated countries, such as India, which reported approximately 2.7 million cases in 2018 (World Health Organization [WHO], 2019). Factors like nutritional deficiencies, poor sanitation, limited healthcare access, and waste disposal practices increase vulnerability to disease in Sub-Saharan countries like Lesotho, even with a small population of 2.3 million (Das, 2021; Government of Lesotho, 2018). This does not overlook the high prevalence of tuberculosis in Lesotho, linked to the high rates of HIV and multidrug- and rifampicin-resistant tuberculosis infections (World Bank, 2018). While this study is descriptive and does not establish causation, it associates cumulative symptoms with certain diseases. A more analytical study is recommended in the future to identify specific diseases.

Improper solid waste management often attracts insect and rodent vectors, which facilitate the spread of gastrointestinal diseases (Omang et al., 2021). Residents (44.1%) identified gastrointestinal diseases attributed to living near disposal sites as a major cause of illness. A study conducted in Lagos, Nigeria, revealed that 30.5% of respondents reported that a household member or themselves had experienced gastrointestinal illnesses, with diseases like dysentery, cholera, and typhoid fever reported (Turyahabwe et al., 2022). The prevalence percentage was slightly lower, possibly due to a larger sample size used in that study. The association between backyard disposal and gastrointestinal disease was statistically significant, with $p < 0.00392$. These findings could assist in investigating the causation of diseases during outbreaks in the area. Although this study does not specify particular gastrointestinal diseases reported by residents, similar findings were seen in a cross-sectional study in Nigeria, which noted sanitation-related diseases like Lassa fever and cholera (Omang et al., 2021). While disease prevalence varies by region and climate, common symptoms include diarrhea, vomiting, abdominal pain, and fever (Kumar & Prakash, 2020; Omang et al., 2021; Akinrogunde et al., 2022; Turyahabwe et al., 2022).

Some residents (22.1%) reported injuries such as broken limbs, needle pricks, and cuts from surgical blades and other sharp-edged waste objects. Other African studies also associate injuries with disposal sites (Njoku et al., 2019; Uhunamure et al., 2021; Owusu-Sekye, 2021). In this study, injuries were exacerbated by uncontrolled access to disposal sites, where children were often found unmonitored. Road accidents (4.4%) were another risk, potentially linked to poorly maintained roads. The researcher observed that roads leading to disposal sites were often minor and partially paved with gravel, which became muddy and slippery in rainy seasons.

From an environmental perspective, pollution from disposal sites is not only unsightly but also interferes with agricultural activities and plant growth, compromising the aesthetics of the environment. Residents (20.6%) reported waste littering in fields near homesteads. Observations revealed that fencing at disposal sites varied, ranging from barbed cross-chain fences to cement pallets. Hlotse dumpsite was an exception, being merely an excavated pit, and most fencing was dilapidated and vandalized, rendering it ineffective. Only the fence at the Botha-Bothe dumpsite was found to be intact. When fencing is not litter-proof or well-maintained, it fails to serve its purpose. A qualitative study in Ginchi, Ethiopia, reported similar complaints about soil degradation and decreased soil fertility due to open dumping and burning practices, which also affected livestock health (Etea et al., 2021; Turyahabwe et al., 2022). Although statistical inferences were limited by a small sample size, the study's significance is notable for Lesotho, a country facing food insecurity where citizens often rely on their produce

(Chenene, 2020). Residents (2.9%) also mentioned associations with animal and child mortality. Additionally, 11.8% of residents mentioned the risk of chemical poisoning from direct ingestion of contaminated food, a concern also linked to food insecurity. Observations showed domestic animals (dogs, pigs, cattle, and goats) scavenging for food, highlighting potential risks for commercial farmers and unknown effects on agricultural produce.

Figure 8: Leachate trickling from waste at the Tsosane landfill of the Maseru City Council.

The prevalence of leachate was evident at the Tsosane landfill, and leachate is considered a major hazard contaminating urban water resources in Lesotho's lowlands. The Maqalika Reservoir, a drinking water source and fishery for Maseru residents, is threatened by pollution from landfills, industrial effluents, municipal waste, and agricultural runoff (LENA, 2017; Gwibi et al., 2020). Leachate from open dumpsites has impacted aquatic ecosystems, leading to habitat degradation and fish deaths (Turyahabwe et al., 2022). Assessing heavy metal levels in fish from the reservoir is essential to evaluate the health risks to residents. A study conducted at Maqalika Dam found that mercury (As) and lead (Pb) concentrations in the gills of *Cyprinus carpio*, harvested for consumption and sale, exceeded WHO permissible limits of 1 mg/kg and 0.2 mg/kg, respectively, suggesting significant health risks for residents consuming these metals (Gwibi et al., 2020). The WHO report indicates that landfill impact exposure through water pathways is typically limited to a 2 km radius, approximately the distance between Tsosane landfill and Maqalika Dam (WHO, 2000). Heavy metals, known for their toxicity, persistence, and accumulation in water and sediments, have been reported to cause organ mutations, immune system disturbances, and decreased disease resistance in humans (Kumar & Prakash, 2020). Aydamo (2023) believes that risks of various water-related diseases can be minimized through improved waste management systems, sanitation, and hygiene services.

4. Conclusions

This study concludes that residents living in the vicinity of unsanitary landfills are at an increased risk of severe health outcomes and environmental pollution. However, due to the smaller sample size used in this study and the focus on only five official disposal sites in the urban councils of the lowlands, the perceived health outcomes and environmental issues related to waste disposal practices cannot be generalized to represent the entire country. Nonetheless, the findings can serve as a pilot for more in-depth analytical studies.

The following recommendations are suggested for local governments, who serve as gatekeepers for all developmental initiatives in Lesotho, to address current waste disposal site issues and protect the health of citizens:

- Increase waste collection coverage in all councils to reduce the use of harmful waste disposal methods by residents. Promote waste separation through education, awareness campaigns, and informational reports, particularly on the implications of hazardous disposal methods.
- Revise and enforce regulatory measures to prohibit certain hazardous waste categories, such as healthcare waste, manufacturing off-cuts, WEEE (waste electrical and electronic equipment), and mixed waste, from being disposed of in general waste facilities.
- Classify existing waste disposal facilities to ensure that suitable rehabilitation methods can be applied upon their closure.
- Advocate for the rapid construction of appropriately located sanitary landfills in at least each council within the country. The conditions at Ts'osane landfill highlight the need for urgent intervention by local government to safeguard the environment and the lives of residents. Relocating the landfill site may be a proactive step forward.
- Require hazardous waste producers, such as healthcare facilities, industries, and WEEE repairers and users, to take responsibility for their waste.
- Implement waste management strategies that initiate other preferable end-of-life waste procedures with minimal health and environmental impact, such as WEEE recycling and waste-to-energy technologies for organic waste in Lesotho.

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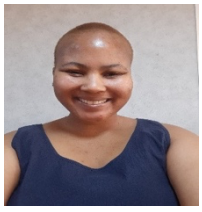

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