

Environmental and health effects of solid waste dumpsites in Wadajir District, Mogadishu, Somalia

Daud Ahmed Mohamed^{1,*}, Magda Elhadi Ahmed Yousif² and Abdalla Ibrahim Abdalla¹

¹ Department of Environmental Health, Gezira University, Wad Madani, Al Jazeera State, Sudan.

² Department of Community Medicine, Gezira University, Wad Madani, Al Jazeera State, Sudan.

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Abstract

Solid waste dumpsites are areas where waste is thrown away, stored, and disposed of. Improper solid waste dumpsites pose a major risk to both human health and the environment. The objective of this paper is to study the environmental and health effects of a solid waste dumpsite in Wadajir District, Mogadishu, Somalia. The study utilized a prospective case-control analytic approach as well as a cross-sectional study to assess the impact of these dumpsites on the environment. The findings of the study revealed that in Wadajir district, the majority of people believed that improper solid waste management leads to water and air pollution; similarly, in Dharkeynley district, the majority of respondents believed that improper solid waste management leads to water and air pollution. The study has also revealed in Wadajir district that the majority of the population was affected by malaria during the last six weeks, while in Dharkeynley district, the majority of the population was also affected by this disease, showing that there is a significant association between improper waste disposal and the transmission of malaria. These findings demonstrate that solid waste management is a crucial issue that affects both the environment and human health in the district. The study paper recommends protecting public and environmental health by reducing risks caused by improper solid waste management. It suggests opening landfills in remote areas without habitation and proper monitoring to minimize the impact on nearby residents.

Keywords: Solid waste dumpsite; Wadajir district wastes; Municipal Waste; Environmental pollution; Open dumping

1. Introduction

Solid waste can be described as any unwanted solid materials originating from residential, industrial, medical, construction, agricultural, commercial, and institutional sources [1]. Improper disposal of solid refuse causes contamination of air, soil, and water; on the other hand, when waste is dumped carelessly, it pollutes both ground and surface water sources. Solid waste clogs drain in urban areas, generating stagnant water for insect breeding and flooding during the rainy season [2].

Solid waste management has become a major problem in most cities, especially in the developing world [3]. African nations are currently dealing with massive amounts of MSW, which directly affects environment, and human health. The rapid growth in population and urbanization in many African towns is responsible for the rising volume of solid waste [4]. and Wadajir District in Mogadishu, Somalia, is no exception. Mogadishu, the capital city of Somalia, is home to over two million people and produces about 2,500 tons of waste every day. But up until recently, it lacked an appropriate disposal site or a facility for recycling waste. Instead, garbage has been dumped into the Indian Ocean or along the coast by residents. In urban areas, rubbish can be seen everywhere, even in and around public institutions of higher learning and healthcare facilities.

* Corresponding author: Daud Ahmed Mohamed

The solid waste problem in Mogadishu, Somalia, is a serious issue that requires immediate attention. Of particular concern is the dumpsite in Wadajir District, which has become a source of serious environmental and health concerns. The indiscriminate dumping of waste in this area has led to the contamination of soil, water, and air. This, in turn, can cause a wide range of health problems for the residents, including respiratory illnesses, skin diseases, and other infections. The dumpsite has also become a breeding ground for disease-carrying vectors such as flies and rodents, which can further exacerbate the health risks faced by the local population. The situation is made worse by the fact that the dumpsite is located in a densely populated area with many people living in close proximity to it. This means that the health risks associated with the dumpsite are not limited to those who live directly adjacent to it, but also affect a much wider population. The image below illustrates a solid waste dumpsite situated near residential areas in Wadajir district.



Figure 1 Solid waste dumpsite close to residential areas

1.1. Characteristics and Types of Solid Waste

Solid waste can be broadly categorized based on its various characteristics, which are crucial to understand for effective waste management. These key parameters include their sources, the types of wastes produced, and generation rates and composition. Accurate information in these areas is essential for properly monitoring and controlling existing waste management systems as well as making informed regulatory, financial, and institutional decisions [5].

There are several types of solid waste that can be distinguished from one another due to their distinct traits. These types include municipal solid waste (generated by households and commercial establishments), industrial waste (resulting from manufacturing processes), institutional waste (produced by schools, hospitals, and government organizations), agricultural waste (originating from farming activities), hazardous waste (dangerous to public health or environment), and more. Each type possesses unique properties that require specialized handling and disposal methods [6].

By understanding these categories and their characteristics, we can develop an optimized approach for managing solid waste in various sectors.

1.2. Environmental and Health Effects of Solid Waste Disposal

The inadequate collection and improper disposal of solid waste are major contributors to air, water, and land pollution and pose a threat to both human health and the environment. Globalization, fast urbanization, industrialization, and economic expansion in developing nations all have the potential to worsen this scenario over the coming decades [7]. Solid waste disposal has several negative effects on the environment, including tourism, ethics recreation, Visual Pollution, and Water Pollution [8].

The disposal of solid waste poses a significant threat to human health and the environment. Inadequate management of waste can lead to various health issues, ranging from minor to severe.

The growth and spread of bacteria, insects, and rodents are all considerably aided by the piling of waste in neighborhoods and cities. Waste offers these carriers the perfect habitat because of its nutrient-rich makeup and moisture content. As a result, there is a greater risk of spreading diseases like cholera, TB, the plague, and anthrax, which may all be carried by flies, as well as amoebic and bacillus diarrhea, trachoma, typhoid and paratyphoid fever, and others [9].

2. Methodology

2.1. Study area

The study area of this research focuses on Wadajir district, which serves as the case study, and Dharkeynley district, which acts as the control study, both among the seventeen districts in Banadir region, Somalia. Wadajir is a district situated in the south-central Banadir region of Somalia, bordering Jazeera (lower Shebelle) to the south, Hodan to the west, Waberi to the north, and Dharkenley to the east. Dharkeynley district lies in the southeastern Banadir region of Somalia, adjacent to Wadajir district. Both districts have notable populations: approximately 91,760 residents inhabit Wadajir District, while Dharkeynley District is home to around 75,047 individuals. This makes them two of the largest and most densely populated districts in Somalia. Mogadishu, the capital of Somalia, is located in the Banadir region and serves as its most populous city. With a thriving community of over two million residents, the city boasts a rich cultural heritage and a diverse populace within its boundaries.

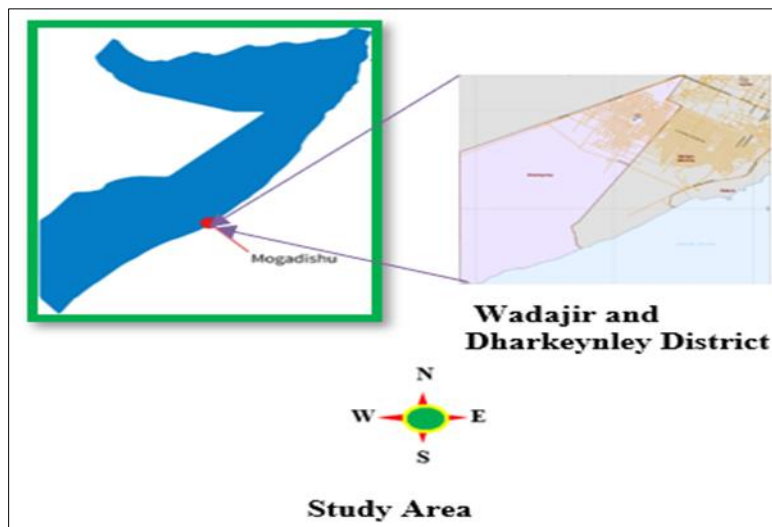


Figure 2 Depicts the study area located in the southern part of Somalia, specifically in the Banadir region. The map highlights the research location, with arrows pointing to key points of interest within Mogadishu, Somalia.

2.2. Study design

The research employed a case study method, combining qualitative and quantitative data for a robust analysis of waste disposal practices in Wadajir district, Bandari Region. Quantitative techniques, including surveys and questionnaires, collected numerical evidence on the prevalence of disposal practices. Qualitative methods contributed to a deeper understanding of the broader context and impact. The study utilized both prospective case-control analytic studies and cross-sectional methodologies. Prospective analyses examined causative factors influencing waste management practices by comparing affected and unaffected cases. A cross-sectional analysis assessed the environmental implications and distribution patterns of waste disposal practices at one point in time across various locations within the district. The integrated approach allowed for a comprehensive understanding of waste disposal trends and contextual factors in Wadajir district.

2.3. Study population

The study focused on the residents of Wadajir district as its target population, which has a total of 91,760 inhabitants. Additionally, the research encompassed the residents of Dharkeynley district, using it as a control village. This district is home to 75,047 individuals. Both districts were integral to understanding the subject matter at hand and providing meaningful comparisons and insights.

2.4. Sample size determinants

The sample size for this study was calculated using the following formula:

$$n = (N \times p(1-p)) / ((N-1) \times (d^2/z^2)) + p(1-p)$$

Where:

n: sample size

N: population size

Z: value of the selected α level of 0.95 in each tail (1.96=2)

P: prevalence rate (proportion) = 0.5 (unknown prevalence)

d: margin of error = 0.05

By plugging these values into the formula, we can determine the required sample size for this study:

$$n = (91,760 \times 0.5 \times (1 - 0.5)) / (((91,760 - 1) \times (0.05^2 / 1.96^2) + 0.5 \times (1 - 0.5))$$

$$n \approx 383$$

Using the given values, the formula yields a sample size of 383 participants. The inclusion criteria comprised residents in Wadjir and Dharkeynley districts who had completed at least one year of study in those areas. Exclusion criteria applied to individuals not currently in the study year and those residing in other districts. Simple random sampling was employed as the sampling technique.

2.5. Data collection and data acquisition

During the first quarter of 2021, a systematic process of data collection and acquisition commenced to collect relevant information on several environmental factors. This process involved various methods, including direct observations, survey questionnaires distributed to households, structured interviews with authorities, and laboratory analyses to assess contamination in water, air, and soil samples. In addition, field surveys were carried out in the target research area, with visits to solid waste dumpsites documented as evidence.

Furthermore, secondary data was obtained from a wide array of sources. These included books, published and unpublished written materials, thesis papers, dissertations, journal articles, and reports on related topics.

The combination of primary data collection through field work and secondary data from existing sources has allowed for a comprehensive understanding of the issue at hand while ensuring data reliability and validity. As a result, researchers can utilize this information to develop informed solutions and strategies targeting environmental challenges.

2.6. Data analysis

Data was analyzed utilizing the widely-used spreadsheet software, Microsoft Excel, for enhanced organization and ease of access. In order to conduct a more in-depth analysis of the acquired data, we employed the Statistical Package for the Social Sciences (SPSS) software, specifically tailored to interpret and scrutinize complex data sets. Upon completion of the analysis, we generated easy-to-comprehend summary tables and graphs for visually representing the results. These visual aids effectively communicated crucial findings.

3. Results

In the Wadajir district, a majority of 55.35% of respondents were female, while 44.65% were male. On the other hand, in the Dharkeynley district, 59.79% were male and 40.21% were female (figure 3). Regarding age distribution in Wadajir district, 31.07% were aged between (26-35), 25.85% in the range of (15-25), another 25.85% between (36-45) years old, and finally, 17.23% were aged (46 and above). In contrast, Dharkeynley's age distribution showed that 36.04% belonged to the age group of (46 and above), followed by 24.54% (36-45), 24.28% (26-35), and lastly, 15.14% (15-25). In terms of educational attainment in Wadajir district, the majority had a university level of 36.8%, followed by secondary level at 19.3%, basic level at 17.2%, illiterate at 10.4%, postgraduate at 9.4%, and khalwa at a proportion of 6.9%. Meanwhile, in Dharkeynley district, the majority of respondents had a university degree with a percentage of 31.59%, followed by Khalwa level making up 18.02%, basic level at 16.71%, secondary level at 15.14%, illiterate at 12.01%, and postgraduate level with a percentage of 6.53%. Regarding occupational distribution in Wadajir district, it was found that 32.38% were engaged in various businesses, 28.98% were employees, 19.84% were housewives, 14.36% were students, and 4.44% were jobless. In contrast, Dharkeynley district revealed a different picture, with 48.56% involved in other occupations, 22.19% as employees, 15.67% as housewives, 7.57% as students, and 6.01% being jobless. In terms of social status in Wadajir district, the majority of the population was married (61.36%), followed by singles (31.85%), divorced individuals (4.18%), and widows (2.61%). Meanwhile, in Dharkeynley district, there was a higher percentage of married individuals (67.62%), with singles accounting for only 15.93%, divorcees at 8.62%, and

widows at 7.83%. Income levels also varied between these two districts. In Wadajir district, most people fell into the low-income category (47.52%) or the middle-income category (46.21%), leaving only a small proportion (6.27%) with high incomes. On the other hand, Dharkeynley district had a more even distribution, with a larger part of its population holding middle-income positions (56.14%), followed by low-income earners (39.94%), and a slightly higher proportion earning high incomes at 3.92%.

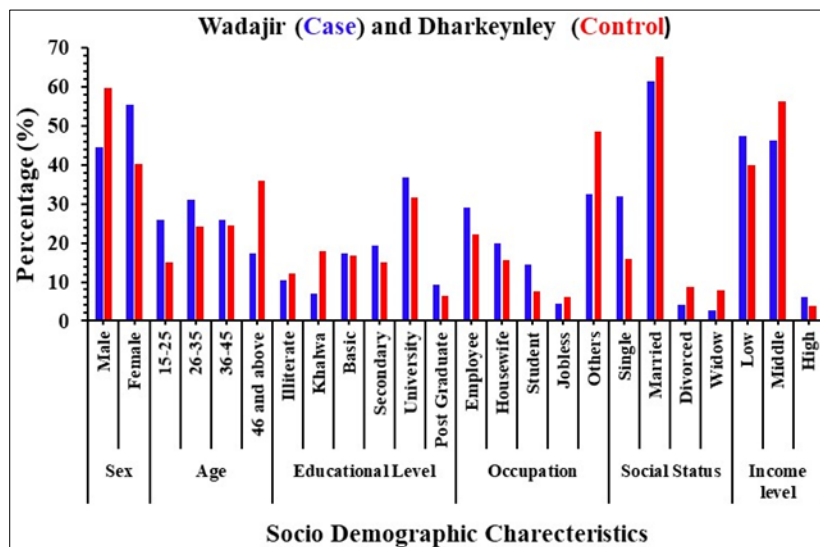


Figure 3 Respondents' socio-demographic characteristics

In the Wadajir district, survey results showed that 68.15% of respondents self-dispose of their solid waste, while the remaining 31.85% do not. Similarly, in the Dharkeynley district, 64.23% of respondents indicated that they self-dispose of their solid waste, whereas 35.77% do not dispose of it themselves, as illustrated in Figure 4.

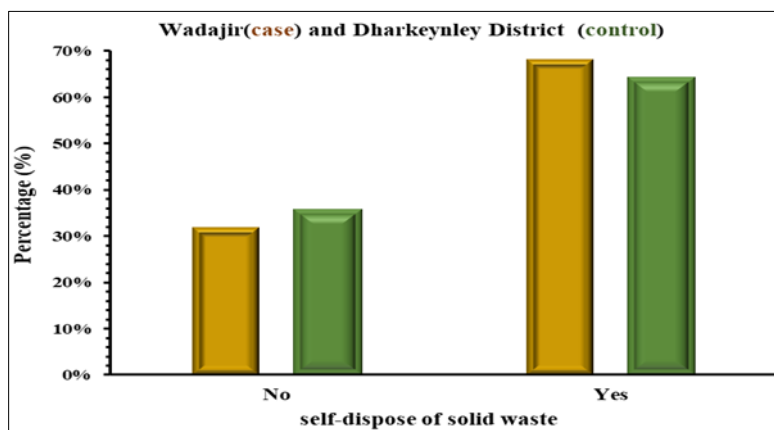


Figure 4 Self disposal of solid waste

In the Wadajir district, 78.85% of respondents indicated that improper solid waste management leads to water and air pollution, while 21.15% did not agree with this statement. Similarly, in the Dharkeynley district, 80.94% of respondents expressed that improper solid waste management results in water and air pollution, whereas 19.06% did not share this view, as shown in figure 5.

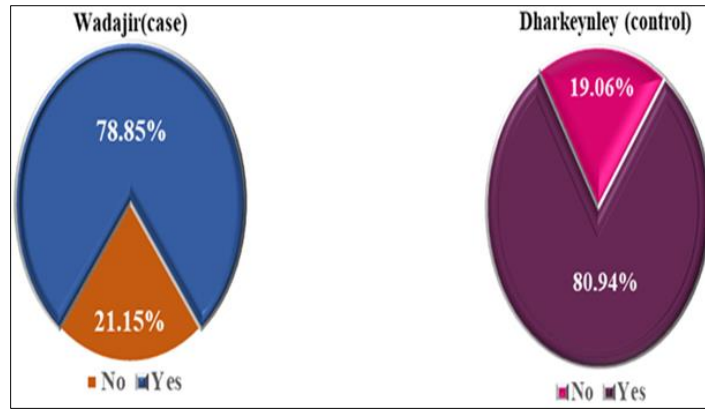


Figure 5 Consequences of Inadequate Solid Waste Management

In the Wadajir district, 81.72% of the respondents indicated that the presence of solid waste dumpsites near their village had an effect on the community's health status, while 18.28% reported no impact. Similarly, in the Dharkeynley district, 85.64% believed that such dumpsites affected their community's health status, while 14.36% perceived no effect, as illustrated in Figure 6.

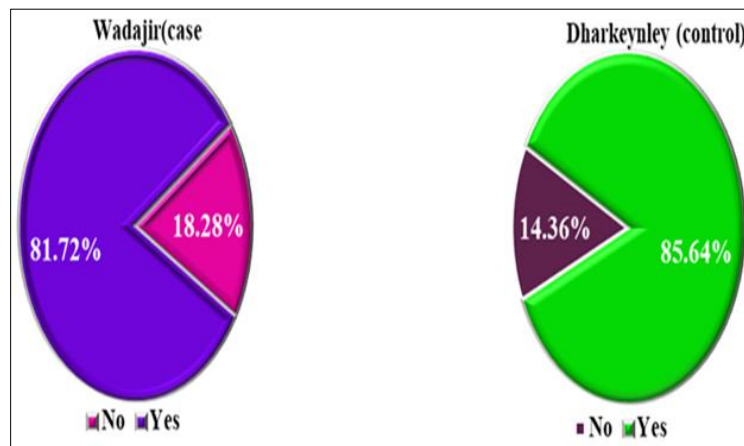


Figure 6 Effect of a solid waste dumpsite near the village on community health

The data shows that in Wadajir district, 57.44% of the respondents did not have regular garbage collection in their area, while 42.56% did. Similarly, in the Dharkeynley District, 59.79% of respondents confirmed that they lacked regular garbage collection services, with only 40.21% receiving this service, as demonstrated in Figure 7.

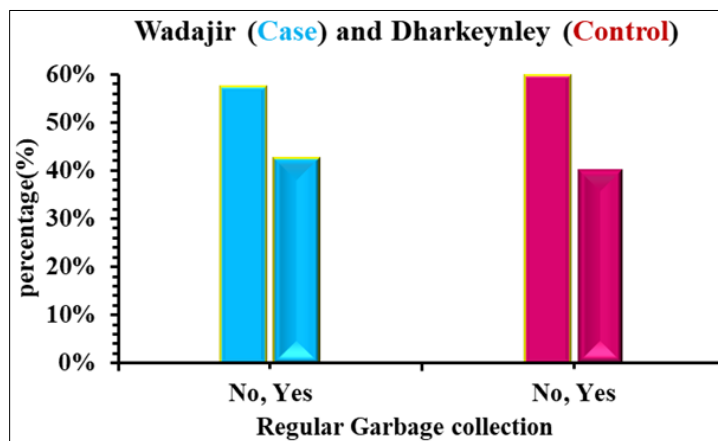


Figure 7 Consistent Garbage Collection Services

In Wadajir district, the survey revealed that 64.49% of respondents reported odor problems, 20.63% experienced rat problems, 8.10% had issues with flies, 3.39% encountered other problems, and 3.39% did not face any issues. In contrast, the Dharkeynley district results showed a higher prevalence of odor problems at 74.41%, with 13.84% reporting rat problems, 7.31% facing fly infestations, 2.87% having other issues, and only 1.57% without any problems (Figure 8).

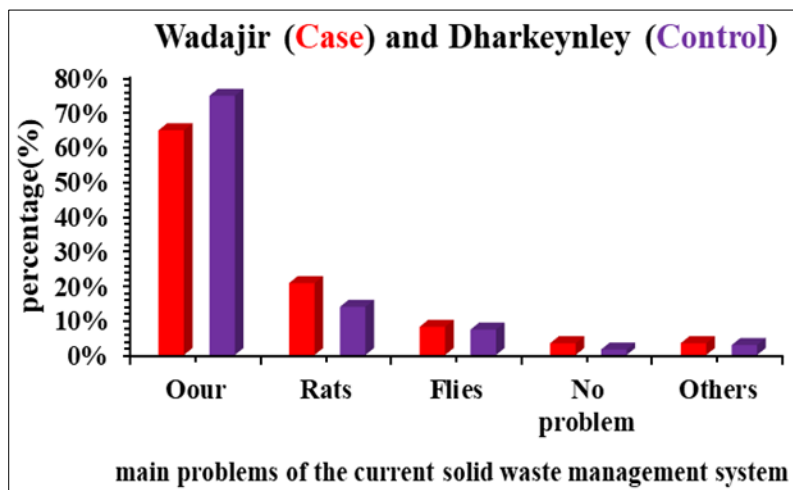


Figure 8 Main challenges in the current solid waste management system

The data from the two districts reveals a concerning trend in public health. In Wadajir district, it was found that 72.06% of the population suffered from a disease during the last six months, while 27.94% did not. Similarly, in Dharkeynley district, 79.37% of people experienced a disease in the same time period, with only 20.63% remaining unaffected, as illustrated in figure 9.

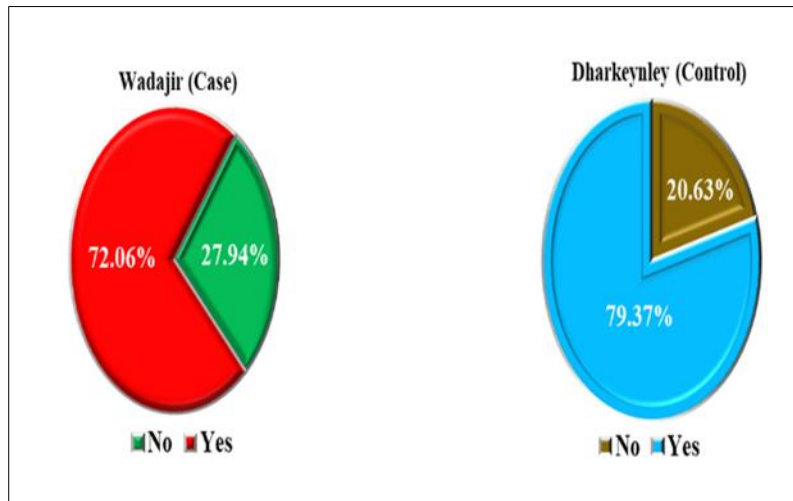


Figure 9 Household members affected by diseases in the last six months

A study conducted in Wadajir district revealed the following prevalence rates for various illnesses: 31.27% malaria, 18.18% diarrhea, 13.45% cholera, 12.01% typhoid, 11.64% dysentery, 11.27% asthma, 1.45% skin diseases, and 0.73% other diseases (Fig. 8). In comparison, the Dharkeynley district reported these rates: 23.61% malaria, 18.03% cholera, 12.46% diarrhea, 12.46% typhoid, 11.15% dysentery, 7.54% other diseases, 7.54% skin diseases, and 7.21% asthma (Fig.10).

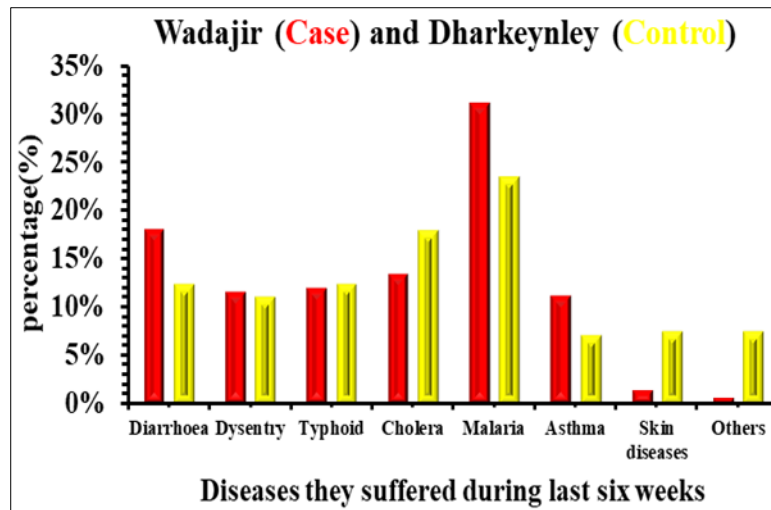


Figure 10 Illnesses experienced during the past six weeks

4. Discussion

Solid waste dumpsites pose serious environmental and health concerns in many areas, including Wadajir district. For years, this district has struggled with solid waste management, resulting in the creation of numerous landfill sites. These dumpsites contribute to pollution, negatively impacting both the surrounding environment and residents' well-being.

In our analysis of demographic characteristics in Wadajir and Dharkeynley districts, several interesting patterns emerged. One noticeable difference was the sex distribution across the two districts. While Wadajir district had a female majority (55.35%), Dharkeynley had a higher proportion of males (59.79%). Regarding age distribution, Wadajir district maintained relatively consistent percentages across all age groups studied, dominated by the younger cohorts aged 15-25 and 26-35. In contrast, Dharkeynley's population featured a significant concentration in the older age bracket (46 and above) at 36.04%, possibly hinting at different family structures or migration patterns for younger individuals. Educational attainment also demonstrated disparities between districts, as more respondents in both Wadajir and Dharkeynley had university degrees than any other education level. However, while Wadajir district maintained a graduate-majority population, Dharkeynley saw an intriguingly high proportion pursuing Al Khalwa education levels. The data on occupational distribution presented contrasting landscapes between Wadajir and Dharkeynley districts. Businesses constituted major employers in Wadajir district, while Dharkeynley observed a higher prevalence of other occupations with no specific sector dominating its labor force. Additionally, Dharkeynley district exhibited marginally higher percentages of housewives and jobless individuals when compared to Wadajir.

Finally, social status across both districts leaned towards married individuals, representing the largest group. However, Dharkeynley had a more substantial proportion of married persons relative to Wadajir district. Income levels also differed significantly; while most respondents in Wadajir identified as either low or middle-income earners, residents of Dharkeynley displayed a more balanced income distribution.

The findings from our study in Wadajir and Dharkeynley districts present a concerning situation regarding solid waste disposal practices. A significant majority of the respondents in each district self-dispose of their solid waste, with 68.15% in Wadajir district and 64.23% in Dharkeynley district. This trend of self-disposal demonstrates that proper solid waste management systems are lacking, leading to potential environmental hazards.

Moreover, our study has also revealed a high level of awareness among the residents across both districts about the negative consequences of improper solid waste management. In Wadajir district, 78.85% of respondents recognized that mishandling of solid waste leads to water and air pollution. Similarly, 80.94% of respondents in Dharkeynley district shared this belief. The data analysis further supports this awareness as it displays a significant relationship between improper solid waste management and increased water and air pollution levels. As shown in Figure 4, the rise in solid waste mismanagement corresponds with the growth of pollution levels. These findings emphasize that authorities must take action to address the pressing issue of inadequate solid waste management practices in both districts. Initiatives such as enhancing waste collection services and raising public awareness about proper waste

disposal methods could help mitigate the risks associated with self-disposal and curb environmental damage from water and air pollution.

The studies conducted in Wadajir and Dharkeynley districts have revealed a concerning connection between solid waste dumpsites and community health. The majority of respondents from both districts (81.72%) in Wadajir and (85.64%) in Dharkeynley agreed that the presence of solid waste dumpsites near their villages has a detrimental impact on their well-being. Furthermore, a significant correlation was established between the proximity of solid waste dumpsites to homes and the health of community members. As depicted in Figure 5, inappropriate disposal of waste puts human health at risk due to exposure to toxic substances, air and water pollution, and the transmission of diseases. This harmful relationship is exacerbated by insufficient waste disposal methods and the vulnerability of those residing near such locations.

The research findings carried out in both Wadajir and Dharkeynley districts indicate that a majority of the population lacks consistent garbage collection services, with 57.44% and 59.79%, respectively. This issue has far-reaching implications for the environment, public health, and overall well-being of these communities. As depicted in Figure (6), there is a significant correlation between irregular garbage collection and environmental degradation. The absence of regular garbage collection can lead to an accumulation of solid waste in public spaces or water bodies, which consequently results in soil and water contamination, air pollution, and disease proliferation. Moreover, this inconsistency in waste management can negatively impact the economy by deterring tourism, lowering property values, and increasing solid waste management costs.

According to the study results, odor problems were identified as the primary concern related to the current solid waste management system in both districts. In Wadajir, 64.49% of respondents cited odor issues as their main complaint, while in Dharkeynley, this figure reached 74.41%.

The study conducted in Wadajir and Dharkeynley districts revealed that a significant majority of households recently faced health issues, with 72.06% in Wadajir and 79.37% in Dharkeynley experiencing diseases within the last six months. These results highlight the substantial health risks present in these communities, which can be attributed to several factors connected to waste, sanitation, and limited access to healthcare facilities. One primary cause of the prevalence of diseases in these districts is a lack of access to safe drinking water. Contaminated water sources pose a significant risk to people's health, leading to waterborne illnesses such as diarrhea, cholera, and dysentery. Furthermore, poor sanitation and hygiene practices contribute to disease transmission, especially when combined with the lack of proper waste management systems. Open defecation further exacerbates this problem as it increases environmental pollution and enhances disease spread.

In Wadajir district, it was found that the majority (31.27%) of the population had experienced malaria within the last six weeks. Similarly, in Dharkeynley district, a significant share (23.61%) of the population also reported suffering from this disease during the same period. These findings demonstrate that both districts are heavily affected by malaria. The high prevalence of malaria in Wadajir and Dharkeynley districts poses serious public health concerns. Malaria can result in severe health complications or even death, especially for young children, pregnant women, and people with compromised immune systems. Additionally, frequent bouts of malaria can have long-lasting socio-economic consequences by affecting people's ability to work and attend school.

5. Conclusion

The environmental and health impacts of solid waste dumpsites in Wadajir and Dharkeynley districts, Mogadishu, Somalia, are significantly concerning. Improper management of waste disposal sites has led to various potential hazards that directly threaten the well-being of residents and the surrounding environment. The existing state of solid waste management in these districts is insufficient, with most residents resorting to self-disposal practices that contribute to pollution and deteriorate living conditions.

Soil and groundwater contamination in areas near waste dump sites is particularly alarming. This contamination occurs due to the accumulation of hazardous materials such as heavy metals and toxic chemicals that leach into the soil over time. As these substances infiltrate underground water sources, they not only harm local ecosystems but also expose humans to risks through consumption or contact with polluted water. Contaminated water sources present severe public health threats, with waterborne diseases like diarrhea, cholera, and dysentery commonly resulting from unsanitary water supplies caused by poor sanitation practices combined with inadequate waste management systems. The absence of consistent garbage collection services worsens the situation, leading to soil and water contamination, air pollution, and disease proliferation.

Another pressing health concern is the spread of vector-borne diseases due to poor sanitation practices at solid waste sites. Unsanitary conditions create a conducive breeding ground for disease-spreading organisms such as rodents, insects, and parasites. Consequently, these vectors transmit communicable diseases like cholera, dysentery, and malaria; malaria remains a significant issue for residents in Wadajir and Dharkeynley districts. The high prevalence of such illnesses in Wadajir and Dharkeynley Districts imposes a considerable strain on public health systems while compromising individual well-being.

Besides environmental impacts and public health risks, solid waste dumpsites also impart detrimental social effects on communities within Wadajir and Dharkeynley Districts. Odor problems are a primary concern among community members most affected by improper waste management practices.

Recommendation

I suggest the following recommendations to address the environmental and health impacts of solid waste dumpsites in Wadajir and Dharkeynley districts, Mogadishu, Somalia:

- Develop and implement a comprehensive solid waste management plan for the districts that includes strategies for waste reduction and recycling, proper waste disposal, and effective monitoring and enforcement mechanisms.
- Establish designated landfill sites with appropriate engineering controls such as liners, leachate collection systems, and gas recovery systems to mitigate soil and groundwater contamination.
- Strengthen garbage collection services to ensure regular and efficient waste collection from households and commercial establishments to minimize self-disposal practices.
- Conduct regular monitoring of water quality near dumpsites to detect contamination levels and take appropriate remedial actions as necessary.
- Implement public education campaigns to raise awareness about proper waste disposal practices, the environmental impacts of poor waste management, and the associated health risks.
- Facilitate community involvement in decision-making processes related to solid waste management, promoting a sense of ownership among residents, which can lead to higher compliance with implemented regulations.
- Invest in improving sanitation infrastructure and supporting the expansion of clean water supply systems in affected areas to reduce waterborne diseases.
- Vector control measures: Implement pest control measures to reduce the breeding grounds for disease-spreading organisms at dumpsites. This could include regular cleaning of dumpsites, disposing of waste in enclosed containers, and using insecticides where necessary.
- Address odor problems emanating from dumpsites by implementing practices such as regular compaction or covering them with soil or other odor-neutralizing materials.

Finally, by addressing these recommendations effectively, Wadajir and Dharkeynley districts can minimize the adverse environmental and public health impacts associated with solid waste dumpsites while creating a cleaner, healthier environment for their residents.

Compliance with ethical standards

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Disclosure of Conflict of interest

The authors confirm that there are no conflicts of interest related to the publication of this research paper.

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