



ORIGINAL RESEARCH ARTICLE

Environmental and Health Impacts of Solid Waste Open Disposal in Gonin-Gora and Environs in Chikun Local Government Area, Kaduna State, Nigeria

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ARTICLE INFO

Article History:

Received 17th November 2025

Revised 27th November 2025

Accepted 2nd December 2025

Keywords:

- Health-impact;
- Environment;
- Biodegradable;
- Biomedical;
- Hazard.

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ABSTRACT

For many developing countries, solid waste disposal and management remain a serious, albeit, an under-researched, problem. A case study of environmental and the health impact of open dumps was under-taken in Gonin-Gora, Sabon Tasha and Kakau in Chikun LGA of Kaduna State. Major dump sites were identified, marked and divided into two, based on distance of 0-100metre and 100-200metres, from the dumps. 203 households were administered with a questionnaire. Three soil samples were collected; 1 from each of the study areas. The presence of bacteria, viruses and parasites in the soil samples was analyzed. Health records were obtained from the Comprehensive Health Center at Gonin-Gora, which augmented the data collected from the field. Results from laboratory analysis showed that solid wastes contained disease vectors that are harmful to humans and the environment. Surface is that when the environment is not healthy, the people become vulnerable. Therefore, people living close to waste dumps are more vulnerable to diseases like malaria, typhoid and foul odor, than those living a distance away. It is recommended that to safeguard the environment and community health, the authority saddled with responsibility of waste management should improve on instant of refuse evacuation, while government should provide funds for waste management programs. At the household level, the study recommends the adoption of the 4R; Reduce, Reuse, Recycle, and Recover, as well as to reduce/control the consumption of food items that generate large amounts of waste. Thus, there should be more funding by government and research by scholars to mitigate urban deterioration to create live-able cities.

Introduction

There are many types of solid waste, depending on their sources. Solid waste is commonly categorized in literature into municipal waste, construction waste, biodegradable waste, and biomedical wastes; however, authoritative bodies such as UNEP,

EPA and NESREA typically classify waste under broader categories including municipal, industrial, hazardous, construction and demolition, and healthcare waste which are often considered to be infectious when poorly disposed of. Solid waste disposal connotes the discharge, deposit or dumping of any solid

waste on any land or water body which often induce harmful pathogens into the environment. The Open-dumping approach of solid waste method is a primitive stage of waste disposal management, especially in the developing parts of the world. Waste is a material that is discharged and discarded from each stage of daily human activity which may have adverse effects on human health and the environment. Solid waste disposal sites are found both within and on the outskirts of cities. With increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste generated daily by each household. This waste is ultimately thrown into metropolis disposal sites. Due to poor and ineffective management, the dumpsites turn into sources of environmental and health hazards to people living in the vicinity of such dumps. Living close to a dumpsite is like living close to an enemy.

Open dumpsites in developing countries and urban cities involve indiscriminate disposal of waste which poses a major health and environment problem, especially when they are allowed to pile up and become a melting point for different wastes and bacteria. Since the pronouncement of Kaduna, many people have trooped into the city and a lot of houses have been built. Thus the population in Kaduna is increasing and investment in waste management is still low and has encouraged indiscriminate dumping of waste. The United Nations Environment Program Agency (UNEP, 2000) opined that the waste that is not managed properly, especially solid waste from households and the community, poses serious health challenges and lead to the spread of infectious diseases. There is an increase in population and demand for different food stuffs accompanied by the production of assorted waste base on seasons. For instance, the waste produce during the rainy season is made up of tuber peels, sugar

chaff as well as mango and other fruits waste in the dry season. Omole and Alakinde (2013) observed that Nigeria, among other third world countries, is witnessing an unprecedented growth of cities in recent times, and there is the pressure of urban population that makes existing facilities such as water, electricity, roads, among others to become inadequate. While solid waste generation and disposal have taken unprecedented and precarious dimension, poor waste handling leads to infringements on vital environmental components: including but not limited to soil, water and the air quality. Rapidly industrialization and the population increase in Kaduna has led to migration of people from rural areas to the cities, which results to a lot of metropolis solid waste on daily basis and indeed, the amount of metropolis solid waste which are expected to increase significantly in the near future.

Most of the developing countries practice open dumping of waste products. The menace of solid waste is one of the serious environmental problems in Chikun Local Government Area of Kaduna State. Another main problem of solid waste management is the indiscriminate dumping of waste during the day and night times in locations that are not suitable. Some of these unsuitable locations include drainages, roadsides, open spaces, and commercial areas (markets). Many markets within the vicinity of Gonin-Gora, Sabon Tasha, and Kakau are not properly planned with designated dumpsites. Markets are the largest sites of solid waste that pollutes the environment in the study area, thereby making the environment unattractive and hazardous to human health. In most residential areas, waste is dumped without regard to the environment. One of the reasons responsible for this, is that the environmental management agency has not provided enough refuse disposal containers in many residential areas and where they are available at times,

they are at a far distance to some people or the waste is not being collected promptly.

The inappropriate disposal of solid waste can lead to the contamination of surface and ground water through leaching. Soil contamination occurs through direct waste content or air pollution by burning of waste, spreading of diseases by the different vectors like birds, insects and rodents, or the uncontrolled release of methane by anaerobic decomposition of waste. In the case of Chikun Local Government Area of Kaduna State, over the last decades, it has grappled with the challenge of managing its solid waste as a result of phenomenal growth in population and feeding lifestyle that has led to a lot of peels, whereby increasing waste generation in urban centers such as Gonin- Gora and other neighborhoods in Kaduna and environs.

The study seeks to examine the environmental and health impacts of dumpsites on the inhabitants of Gonin-Gora and environs in Chikun Local Government Area, Kaduna State, Nigeria. The following objectives are deemed effective in achieving this aim include the examination of the socio-demographic characteristics of the respondents; To the present solid waste disposal practices in Gonin-Gora, Sabon Tasha and Kakau; Identification of the diseases associated with open dumps; and examination of the ways open dumping of solid waste affects the environment and health of inhabitants in the study area.

The predominance of open dumps in many developing nations has spurred the need to scrutinize the environmental and health implications of dumpsite on the surrounding residents. For instance, Yongsu et al (2008) conducted a cross-sectional epidemiological study to examine the health risk of different waste disposal systems in Cameroon. The study found 14% diarrhea prevalence among

the residents in the study area and a strong statistical, association between household refuse management methods and incidences of diarrhea among the respondents. Similarly, Jung, et al (2005) established that open dumping has potential to reduce environmental quality in neighborhood and can also pose a threat to public health, the environment and even scavengers that depend on scavenging materials for their livelihood. Also, findings from various studies have suggested that children that live around solid waste dumpsites are susceptible to different health risk or complications that can interfere with the development of their vital organs such as their endocrine, nervous, reproductive and even immune systems (Landrigan 2004). In addition, Efe (2013), in his study on waste disposal problems and management in Ughelli, Nigeria, reported that 38% of the respondents in the study area suffered from malaria fever attack as a result of mosquitoes breeding inside gutters that have been taken over by solid waste. 23% suffered from respiratory problems as a result of stench emanating from water, 20% suffered from typhoid fever as a result of the consumption of contaminated water. All of these are closely linked to the scenario of dirty environment. Dung-Gwom and Magaji (2007) researched on the environmental Health problems associated with solid waste management in Gwagwalada-Abuja and discovered that laboratory results from sampled dumps revealed the presence of disease vectors which are harmful to humans and to the environment. The researchers stressed that people living close to dumpsites were more at risk from disease of malaria and foul odor than those living further away. Ahmed (2011) confirm the present of insect vectors of pathogens in dump in Kaduna town. The increasing effort to provide clean urban environment in the face of increasing solid waste menace, makes it imperative to geographers and environmental Health

Scholars to find ways of mitigating the adverse effects of waste on human and the environment. Thus, this study will add to the existing literatures on the subject as a wakeup call to policy makers and government to rise and do the needful to sensitize the global environment quality.

Materials and Methods

Study Area

Gonin-Gora is located on the geographical coordinates of 10° 26' 0" to 7°, 23' 0" North and

between Lat. 10' 16" 0" and 7°, 60 0" East with an area covering 4,645km² with a population of 368,250(NPC 2006). The aborigines are the Gbagyi people who are mostly peasant farmers, cultivating crops such as yam, maize, and cassava, vegetable and so on. There are two major seasons across the state, the Dry windy season and the Rainy (wet) season. The dry season is about five (5) months from early or late April to October.

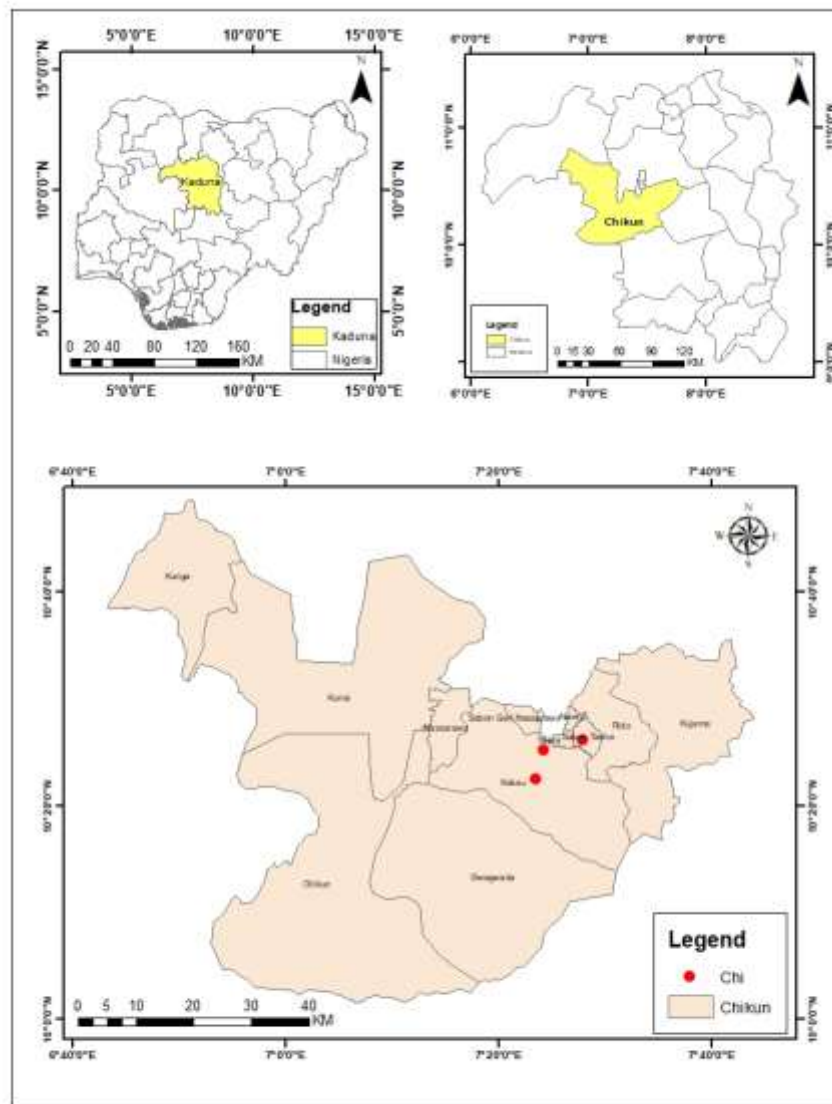


Figure 1: The study area

Survey

A reconnaissance survey was conducted round the Gonin-Gora and environs in the month of February 2025 during which the neighborhood dumpsites within the study area were identified.

Data Collection and Sources

Primary data was collected in Gonin-Gora, Sabon Tasha and Kakau because these areas have conspicuous dumpsites spread within the neighborhoods. Data were obtained from respondents in the area through questionnaire survey. Laboratory analysis was also used to identify the vectors in the dumpsites and

associated diseases. Secondary data were gathered from the registry of the Primary Health Centers (PHC) in the study areas, journals publications and other relevant internet sources.

Sampling Method

The study areas consisted of a total 31,679 housing units of which a sample of 203 units were selected for the survey. The population figures of residents in the study areas were obtained from the office of the National Population Commission (NPC 2006) in Kaduna. The Yamane (1967) formula was used to establish the respondents' sample size.

Table 1: Sample Size

Study Area	Housing Unit	Sample Size
Gonin-Gora	3,806	24
Sabon Tasha	27,251	175
Kakau	622	4
Total	31,679	203

Source: Field Work 2024

$$Yamane = \frac{P}{1+p(\epsilon)^2} \quad (1)$$

Where P = 31,679

ε = 0.07 since ε population is less than 100,000

S 202.5 ~ 203

The systematic sampling of households was considered appropriate in this study which ensure equal opportunity in the selection of the respondents. To determine the effect of dumpsite on respondents, it was pertinent to divide the respondent into those living close to dumpsites (about 100 meters) and those living far from the dumpsites about (200 meters away). The data were collected and presented in tabular form and analyzed using SPSS data analysis of descriptive statistic method with results presented in tables, chart, pie.

Laboratory Procedure

To find out the bacteria present in dumpsites, all the samples taken from dumpsites were tested with the convention pour-plate on plate

counting agar. 1 ml of homogenate sample was used with 20 ml melted and cooled culture medium incubation temperatures were at 22°C and 30°C for 72hrs in aerobic condition. The total viable count was also estimated by filtering 0.1, 10 and 100ml sample through a sterile 0.2µm cellulose membrane filter (Millipore corporation) to capture microbial cells and placed onto reasoned 2A (R2A) agar (difio, Kansas) and incubated at 22c for 4-4 days for evaluation of the viable count. 20 ml of sterile phosphate buttered was used with the 0.1 and 1 ml samples to increase the volume filtered, allowing better dispersion of cells to be grown on the filter paper. All the samples were tested

with this method and the result expressed (cfu g-i).

Results and Discussion

Socio-Demographic Characteristics of Respondent

The socio-demographic characteristics of the respondents are in table 2.

Analysis of the questionnaire resulted to the following findings. About 69% of the respondents were identified as male against 31% females. The dominance of male respondents could be linked to cultural practice where the male folks are ideally supposed to welcome visitors to their homes.

Table 2: Distribution of respondents based on their socio-demographic characteristics

Respondents	Frequency	Percent
Male	140	69%
Female	63	31%
Total	203	100%
Age Class (years)		
20 – 30	77	38%
31 – 40	57	28%
41 – 50	46	23%
51 >	23	11%
Total	203	100%
Level of Education		
Primary	49	24.2%
Secondary	30	14.8%
Tertiary	40	20%
Vocational	24	12.3%
Others	60	30%
Total	203	100%
Occupation		
Traders	33	16%
Civil Servants	91	45%
Artisan	62	31%
Retired	17	8%
Total	203	100%

Source: Authors Fieldwork 2025

The result of the study with respect to respondent ages in table 2 revealed that about 38% of the respondents were at least 30 years old, while 28% of them were between the ages of 31-40 years. 23% were between 41-50 years and 11% represented those of 51 years and above. The mean age of the respondents was approximately 52% indicating that the respondents are generally matured in age.

The educational background of the respondents revealed that 24.2% of the respondents attended Primary School, 14.8% had Secondary School education and 20% had

high level education. Respondents with vocational skill acquisition were represented by 12.3% while others, meaning those without formal education or attended workshop were represented by 30%. The main occupational engagement as revealed in table 2 shows that 45% of respondents were Civil Servants while 31% and 16% were artisans and traders respectively. The retirees among the respondents stood at 8%.

Duration of stay near dumpsites

The chart in figure 1 reveals insight into the respondents' duration of residency in Gonin-

Gora and surrounding areas. Majority of respondents (61%) have lived in the community for duration of between 11-20 years, indicating a significant long-term residency in the area. A smaller group, 30%, has lived there for 6-10 years, while only 9% have stayed for less than 5 years. The high percentage of long-term residents (11-20 years) suggests community stability, which can have complications for environmental and health challenges. Residents with long tenures are more likely to be aware of the local issues, such as solid waste disposal practices and their effects on health and the environment.

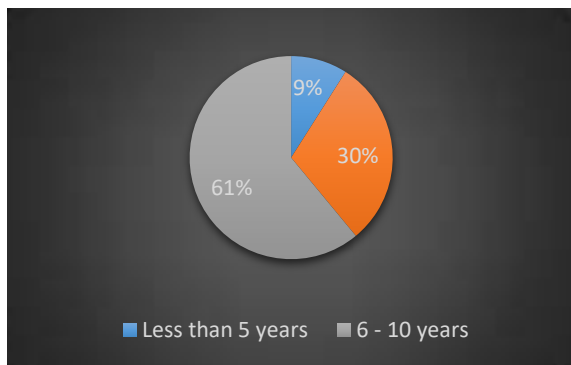


Figure 1: Duration of Stay Near Dumpsite Method

Waste Management Method

The waste management data in figure two (2) from Gonin-Gora and its environs in Chikun Local Government Area reflect a concerned trend in household waste disposal practices, with a significant proportion of the population relying on unsustainable methods. Here’s a breakdown of the analysis:

Over half of the households (53%) resort to open dumping, which is the most common method of waste disposal. This indicates a lack of structured waste management system or proper facilities. Open dumping can contribute significantly to environmental degradation, such as soil contamination, water pollution, and air quality issues, alongside health risk like the spread of disease due to vectors like insects and rodents. A quarter of the respondents (25%) dispose of their waste

Long-term residents are likely to have witnessed the evolution of waste disposal practices and might better understand the historical context of the solid waste issues. Their longer exposure also means they have experienced prolonged health risk due to open dumping practices. With more than 90% of respondents having lived in the community for over 5 years, there is a potential for collective or community-based interventions. The residents’ deep ties to the area can foster stronger engagement in improving waste management practice.

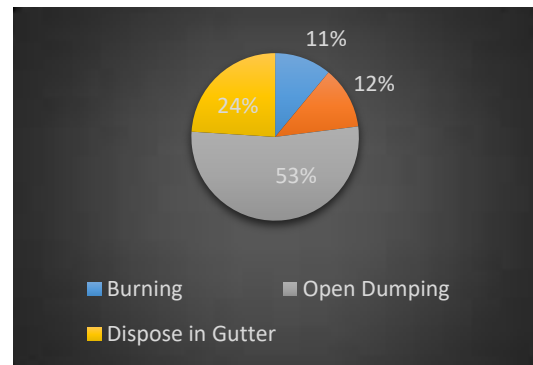


Figure 2: Waste Management Method

in gutters, which poses severe risk to public health and infrastructure. Waste in gutters lead to blockages, increasing the likelihood of flooding during raining seasons. Furthermore, stagnant waters in blocked gutters become breeding grounds for disease-carrying mosquitoes, contributing to malaria outbreaks and other water-borne diseases. Though burning is less prevalent, it still constitutes 12% of the waste management methods. While this may reduce this visible waste, it introduces harmful pollutants into the air, leading to respiratory issues for those living nearby and contributing to the overall poor air quality in the region. Only a small percentage (10%) of respondents uses proper waste disposal methods, like dropping waste in designated containers. This indicates a scarcity

of waste management infrastructure or inadequate awareness of its use. These containers, if placed more strategically and collected regularly, could provide a more sustainable solution to waste disposal challenges in the area.

Effect of open dumping on the environment

The chart in Figure three (3) presents the effects of open dumping on the environment, as part of the study on “Environmental and Health Impact of Solid Waste Open Disposal in Gonin-Gora and environs”, reveals several key findings about the negative consequences of open dumping practices. The second most prominent issue reported by the respondents is the strong offensive odor put at 23%, emanating from the dumpsites. This odor can reduce the quality of life for those living nearby and is particularly problematic in residential areas. It can also have secondary effects, such as headaches, nausea, or respiratory problems due to exposure to harmful gases. Eye sore (7%) represents a smaller portion of the responses but still indicates a significant aesthetic issue. Open dumps are displeasing the eye and can lead to a loss of environmental beauty, which might deter investments, tourism, or community pride. Over 37% of the respondents

acknowledged that open dumps attract disease vectors like flies, rats, and other pests that carry disease. These vectors can increase the incidence of diseases such as malaria, typhoid, cholera, and others in nearby communities. The high frequency of this response reflects the immediate health risk posed by poorly managed waste. This agrees with the medical record from the PHC 2025 in Gonin-Gora that 114 and 1,399 residents have suffered from diarrhea and malaria respectively. About 17% of the respondents confirmed that open dumps often lead to the contamination of nearby water sources, either through surface runoff during rains or leaching into the groundwater. Polluted water can carry hazardous substances, leading to health issues such as waterborne disease. In areas where ground water is a key water source, this contamination poses a serious risk to the local population. Similar to the “eye sore”, 15% respondents felt the loss of aesthetics relates to the degradation of the environment’s visual appeal. The loss of aesthetics can impact the community’s well-being and sense of pride in their surroundings. It can also have broader economic effects, especially if the area is reliant on land value or tourism.

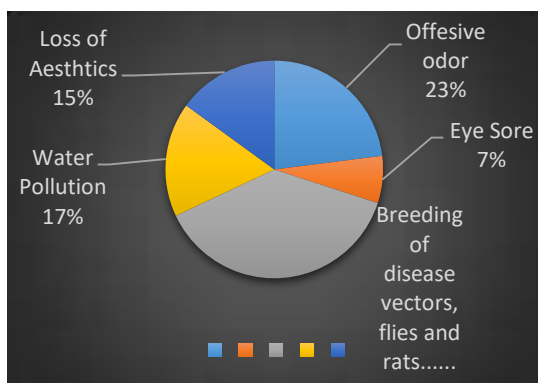


Figure 3: Effect of Open Dumpsite on the Environment

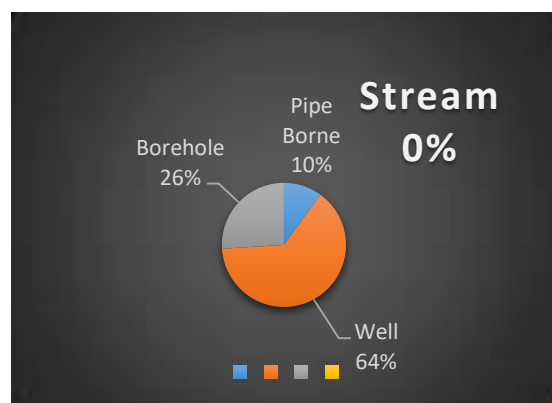


Figure 4: Source of Water Supply

Source of water supply

Figure 4 provides insights on the distribution of water access and its implications for health and environmental risk associated with solid waste disposal in Goni-Gora and environs. The majority of respondents put at 64%, rely on wells as their primary source of water. This suggests that many people in the area are dependent on groundwater. Since open dumpsites are prevalent and poorly managed, there is a significant risk of groundwater contamination due to leaching of harmful substances from these dumpsites. This contamination can lead to waterborne diseases such as diarrhea and typhoid, which are commonly associated with polluted water sources. 26% respondent affirmed that Boreholes was their source of water, but this group is smaller than those using wells, while boreholes are generally considered safer than wells due to their deeper extraction point, they are not immune to contamination, especially in areas with poor waste management. If the dumpsites leach harmful pathogens or chemicals into the ground water, it could still affect boreholes, posing health risk to this group as well. Only a small percentage of the population represented by 10% has access to pipe-borne water. This is usually a more reliable and safer source of water, but the low percentage suggests that infrastructural development in the area is insufficient to provide widespread clean water. The limited access to pipe-borne water puts greater pressure on groundwater sources, which are vulnerable to contamination.

Dumpsite proximity

The chart in figure five (5) regarding the distance from respondents' house to the nearest dumpsite provides valuable insight into the environmental and health dynamics in Gonin-Gora and its environs. With respect to closeness to dumpsites, 23% of respondents live within 100 meters of a dumpsites, indicating that almost a quarter of the population is exposed to potentially higher environment and health risks due to proximity to solid waste. Living this close to open dumpsites can lead to increased exposure to air pollution, disease vectors (like flies, mosquitoes), and water contamination. The mosquito is a small insect that has killed many people due to its bite and separate of Malaria. Dabur (2011) confirm that 97% of Nigerian Households have likelihood of catching Malaria due to mosquito bite, while 77% of respondents live over 200 meters away from the nearest dumpsites. Although these individuals are at lower immediate risk, the health and environmental risks posed by poor waste management can still affect them indirectly, especially through contamination of groundwater or air pollution from burning waste.

Open dumps pose serious environmental risks, such as contamination of nearby water sources through leaching, soil degradation, and air pollution from burning waste. These effects are compounded by poor infrastructure, as noted in the study, and pose health risks, including respiratory illnesses, waterborne diseases like diarrhea, and malaria due to mosquito breeding.

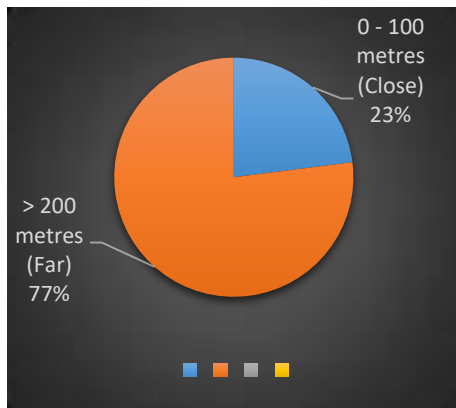


Figure 5: Dumpsite Proximity

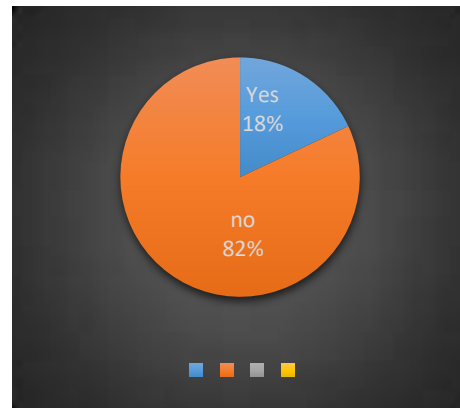


Figure 6: Availability of Dumpsite in Neighborhood

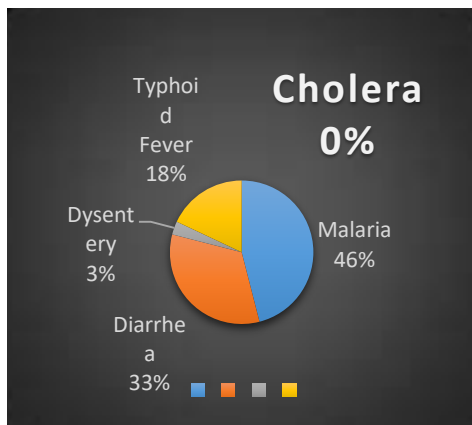


Figure 7: Experiencing of Diseases in Recent Time

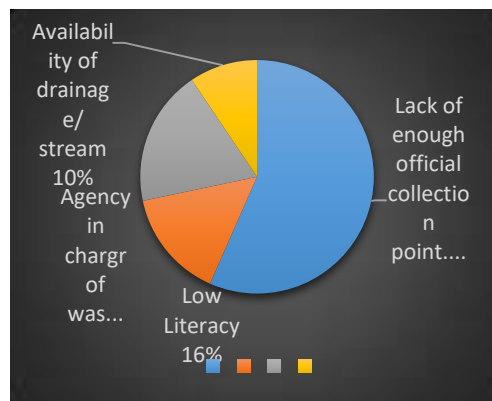


Figure 8: Reasons for Waste Disposal

The chart in figure nine (9) offers key insights into the primary causes of waste management issues in Gonin-Gora and surrounding areas. Based on the frequency and percentage breakdown, here's an analysis of the reasons provided:

The overwhelming majority of respondents (55%) attribute the problem to the lack of adequate waste collection points. This indicates that the infrastructure for waste management in the area is insufficient, leading residents to resorts to indiscriminate disposal. The absence of accessible and well-distributed collection points forces people to dump waste wherever they find convenient.

A smaller, but still significant, portion of respondents (16%) believe that low literacy contributes to the problem. This suggests that

a lack of education and awareness regarding proper waste disposal methods and environmental health could be leading to poor waste management practices. Education programs might be necessary to inform the community about the dangers of indiscriminate disposal and how to manage waste more responsibly. Nearly one-fifth of respondents (19%) feel that the local waste collection agency is not fulfilling its duties effectively. This could point to inefficiencies, such as irregular waste pickups, inadequate coverage, or poorly managed waste facilities. Improving the operational effectiveness of waste collection services would likely reduce indiscriminate disposal practices. A smaller group (10%) blames the proximity to drainage systems and streams as a factor. This suggests that residents might be using these natural or built features as informal dumping sites,

perhaps due to convenience or a lack of alternatives. This highlights a need for proper

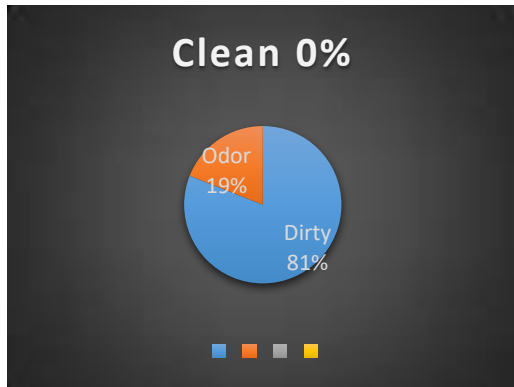


Figure 7: Perception on Surrounding Environment

The analysis of the perception regarding the surrounding environment based on the provided chart in figure ten (10) yields significant insights into the attitude and the experiences of residents living in Gonin-Gora and its environs in Chikun Local Government Area, Kaduna State, Nigeria.

A striking 81% of respondents perceive their environment as dirty. This dominant viewpoint suggests a significant concern about the taste of waste management in the area and highlights the residents' awareness of the health and environmental risk associated with poor solid waste disposal practices. The 19% of respondents who noted an odor indicates that even those who may not directly label their surroundings as dirty are still affected by the unpleasant smells emanating from the waste sites. This aspect may contribute to health issues and further deteriorate the quality of life in the community. The fact that no respondents reported their environment as clean is particularly alarming. It signifies a lack of effective waste management practices, inadequate infrastructure for waste disposal, and possibly an absence of community engagement in maintaining cleanliness.

The most preferred method for waste management among respondents is frequent

environmental monitoring and management of natural resources to prevent misuse.

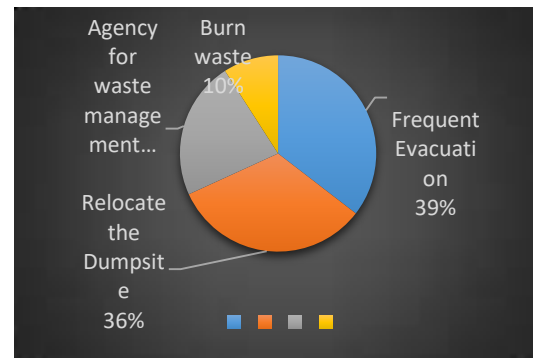


Figure 8: Proper Mode of Waste Management

evacuation put at 39% respondents. This indicates a strong community desire for regular and efficient waste collection services. It suggests that residents feel overwhelmed by waste accumulation and are looking for solutions that minimize the visibility and health risks associated with stagnant waste. This preference also highlights the inadequacy of current waste management systems and the need for improved municipal services. A close second preference represented by 36% respondents is relocating the dumpsite. This response reflects concerns about the negative environmental and health impacts of existing dumpsites, particularly in residential areas. The proximity of waste disposal sites to communities maybe perceived as a health hazard, indicating a need for strategic planning in waste management that that considers public health and safety. A smaller percentage of respondents (15%) believe that the waste management agency should take more proactive measures. This response highlights a lack of trust or satisfaction with the current waste management authority's effectiveness. It may also indicate a desire for more community engagement and responsibility from local agencies to educate residents about proper waste disposal and management practice. Only 10% of respondents support the practice of burning

waste. This relatively low figure suggests an awareness of the environmental health risks associated with burning waste, such as air pollution and the release of toxic substances. It may also reflect cultural shifts toward more sustainable waste management practices.

Microbial contamination and health risks in dumpsite soil: a comparative study of Gonin-Gora, Sabon Tasha, and Kakau

Findings for testing microbial bacteria and fungi in dumpsite soil, specifically focusing on three locations: Gonin-Gora, Sabon Tasha, and Kakau is given as follows. The results from the three dumpsites locations (A, B, and C) were quantified and expressed as Colony Forming Units per gram (CFU g⁻¹) in comparison to control samples.

Table: Laboratory Results

Parameters	Unit	Sample A (Gonin-Gora)	Sample B (Sabon Tasha)	Sample C (Kakau)	Control	FMC Unit Limit
Total Coliform	CFU g ⁻¹	680	520	TNC	240	400
Total HB	CFU g ⁻¹	277	243	380	7	NS
Total HF	CFU g ⁻¹	165	214	246	12	NS
F. Coliform	CFU g ⁻¹	297	220	417	0	200
F. Streptoloci	CFU g ⁻¹	217	234	410	13	0.0
HUB	CFU g ⁻¹	361	288	581	23	NS
Asperillus	CFU g ⁻¹	273	286	561	0	NS
Rhizopus	CFU g ⁻¹	167	223	410	0	NS

Abbreviation: TNC - Too Numerous to Count; HUB - Hydrocarbon Utilizing Bacteria; HUF - Hydrocarbon Utilizing Fungi; THB - Total Heterotrophic Bacteria; THF - Total Heterotrophic Fungi; CFU - Colony Form Unit; NS - Not Stated; Fm ENV - Federal Ministry of Environment

Notes: TNC indicates "Too Numerous to Count", suggesting a high microbial load in that sample. The control values show significantly lower counts, highlighting the pollution levels in the dumpsite samples compared to uncontaminated soil. Both Goni-Gora (680 CFU/g) exceed the control (240 CFU/g) and the Federal Ministry of Environment limit (400 CFU/g), indicating a severe contamination issue. Total Coliforms are indicative of fecal contamination, raising health concerns as they can indicate the presence of pathogenic organisms. Fecal coliforms and Streptococci were found in significant numbers, indicating potential health risks, as these organisms can cause gastrointestinal diseases. The presence of HUB and HUF suggests that these sites might have been exposed to hydrocarbon pollutants, possibly from waste disposal practices.

The present of Coliform such as *Escherichia* shows that wastes are contaminated with Faecal impurities. The results align with findings by Oyekan and Salyrran (2015), which linked dumpsites to the breeding grounds for disease vectors like flies and rats. This is critical in understanding the public health risk associated with open dumping. The mention of Lassa fever and malaria highlights the direct link between dumpsite conditions and disease transmission, particularly in vulnerable populations, such as children.

Conclusion

The study has established that solid waste management in Gonin-Gora and its environs poses significant challenges to both public health and the environment. The issues surrounding waste collection, storage, and disposal remain largely intractable, exacerbated by rapid population growth, urbanization, and inadequate infrastructural support. The presence of high levels of total coliforms, fecal coliforms, and other pathogenic microorganisms underscores the urgent need for immediate intervention to mitigate the associated health risks and to restore environmental quality.

It is evident that the current approach to waste management is insufficient, and both governmental agencies and residents must take proactive roles in addressing this pressing concern. Sustainable waste management requires coordinated efforts, policy enforcement, and active public participation. To improve the open disposal of solid waste in Gonin-Gora and surrounding neighborhoods, several strategic recommendations are proposed.

First, there must be a deliberate and organized effort to enhance waste management practices through public awareness and education campaigns. Government and civil society organizations should initiate programs aimed at shaping community attitudes toward proper sanitation and responsible refuse management. Sensitizing residents on the environmental and health consequences of indiscriminate dumping can foster behavioral changes that support cleaner neighborhoods and reduce environmental degradation.

Second, government intervention must be robust and proactive. Policies such as the “polluter-pay” principle should be strictly enforced to hold individuals and businesses accountable for improper disposal of waste. In addition, stringent monitoring and regulation of streets, public spaces, and marketplaces are essential. Adequate funding should be allocated to the relevant environmental management agencies, ensuring they have access to the necessary machinery, equipment, and staff welfare to execute their responsibilities effectively. This approach will strengthen institutional capacity and enhance the efficiency of waste management operations.

Third, a culture of sustainable waste practices should be promoted through the adoption of the 4Rs: Reduce, Reuse, Recycle, and Recover.

- **Reduce:** Efforts should focus on minimizing the generation of waste. Residents should be encouraged to consume responsibly and avoid products that create excessive or non-biodegradable waste. The use of biodegradable packaging should be prioritized to decrease environmental pollution.
- **Reuse:** The principle of converting waste into wealth should be embraced. Items such as plastic containers, glass bottles, and other reusable materials should be retained for secondary use rather than discarded. This reduces the volume of waste and fosters an environmentally conscious mindset among the populace.
- **Recycle:** Materials that would otherwise contribute to landfill accumulation, such as plastics, glass, metals, and paper, should be processed and repurposed into new products. Municipal waste contains significant quantities of recyclable materials, and systematic recycling programs can transform waste into economic opportunities while reducing environmental harm.
- **Recover:** Efforts should also focus on refurbishing or upgrading used items to extend their lifespan. Recovery of functional materials minimizes the need for new purchases, reduces waste production, and conserves natural resources.

Finally, further research should be encouraged to identify and characterize the specific pathogens present in the environment. Detailed studies on microbial contamination, vectors, and other health hazards associated with open dumpsites will provide valuable data for designing targeted interventions. This knowledge will enable public health agencies,

policy-makers, and environmental managers to implement evidence-based strategies that protect residents and improve environmental outcomes.

In conclusion, sustainable waste management in Gonin-Gora and environs requires a multi-pronged approach that combines policy enforcement, community education, institutional strengthening, and sustainable practices guided by the 4Rs framework. By fostering collaboration between government, residents, and environmental agencies, the adverse impacts of solid waste on human health and the environment can be significantly reduced. These measures, if implemented consistently and monitored effectively, will contribute to cleaner, safer, and healthier communities while promoting environmental stewardship and sustainable urban development.

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