SOLID WASTE MANAGEMENT PRACTICES, HEALTH OUTCOMES, AND SUSTAINABLE DISPOSAL PATHWAYS IN URBAN NIGERIA: EVIDENCE FROM TUDUN-KAURI AND ANGWA-MAINA, NASARAWA STATE

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Abstract
This study investigates solid waste management practices, associated health outcomes, and sustainable disposal pathways in urban Nigeria, with evidence from Tudun-Kauri and Angwa-Maina communities in Nasarawa State. A descriptive survey design was adopted, utilizing a structured instrument, titled Refuse Disposal and Health Impact Questionnaire (RDHIQ). This *was* administered to a sample of households and community residents. Three research questions with iots corresponding null hypotheses were used to collect data. Data collected were analyzed using descriptive statistics, while inferential techniques were employed to test the study hypotheses. Findings indicate that waste disposal is predominantly characterized by open dumping, open burning, and indiscriminate discharge into drainage channels and water bodies. These practices are associated with increased incidence of waste-related diseases, including malaria, typhoid fever, cholera, and dysentery. Key constraints identified include inadequate waste collection infrastructure, irregular public sector intervention, low levels of environmental health awareness, and weak enforcement of sanitation regulations. The study concludes that prevailing waste management practices pose significant risks to public health and environmental sustainability. It recommends the development of integrated waste management systems, provision of designated disposal facilities, routine waste evacuation, community-based sanitation initiatives, and strengthened regulatory enforcement. Implementation of these measures is critical to reducing disease burden and improving health outcomes in urban communities.

Keywords: *Refuse disposal practices, environmental health, waste management, public health impact, community sanitation*

Introduction

Science plays a fundamental role in the promotion of community health by providing evidence-based solutions to prevailing health challenges, improving health outcomes, and enhancing the overall quality of life of individuals and societies. It drives the development of innovative healthcare delivery models that improve equity and expand access to quality health services, particularly for underserved populations of groups characterized by limited or unequal access to essential resources such as healthcare, education, housing, and economic opportunities. Empirical evidence presented by Aba (2022) indicates that within the health contexts, underserved populations frequently encounter systemic, financial, and structural barriers that hinder access to timely, adequate, and affordable healthcare services. Beyond healthcare delivery, science is instrumental in identifying, assessing, and mitigating environmental health hazards, including air and water pollution resulting from improper solid waste disposal, while also promoting sustainable environmental management practices (Kaza, Yao, Bhada-Tata, & Van Woerden**,** 2018). Ineffective waste management poses serious threats to public health and ecological balance, thereby necessitating urgent, evidence-driven, and sustainable interventions to reduce its extensive and long-term impacts, as emphasized by the World Health Organization (2024). This concern is further reinforced by projections from the World Bank Group, which estimate that, in the absence of decisive action, global waste generation will increase by approximately 70% by 2050 (World Bank Group, 2018).

Solid waste management constitutes a fundamental component of environmental sanitation, particularly within rapidly expanding urban and semi-urban communities. As urbanization intensifies alongside population growth, the volume and complexity of solid waste generation increase correspondingly, placing significant pressure on existing management systems. The failure to

implement effective solid waste management practices has been widely recognized as a major contributor to adverse public health outcomes, as emphasized by the World Health Organization (2023). In developing countries such as Nigeria, solid waste management remains a persistent challenge, largely due to inadequate infrastructure, limited institutional capacity, and insufficient public awareness regarding appropriate waste handling and disposal practices. Commonly observed practices including open dumping, open burning, and indiscriminate disposal of waste into drainage channels and water bodies contribute significantly to environmental degradation and increase the risk of communicable diseases such as cholera, typhoid fever, dysentery, and malaria (Aliyu, 2022). These public health risks are particularly pronounced in semi-urban and peri-urban communities, where government intervention and formal waste management systems are often weak or entirely absent.

Poorly managed solid waste disposal sites frequently serve as breeding grounds for disease vectors such as mosquitoes, flies, and rodents, thereby facilitating the transmission of vector-borne and water-related diseases, including malaria, dengue fever, cholera, and typhoid fever. This leads to the decomposition of organic waste releases that results to harmful pollutants such as particulate matter, volatile organic compounds, and greenhouse gases which degrade air quality and contribute to the exacerbation of respiratory conditions, including asthma and chronic obstructive pulmonary disease (COPD). Collectively, these factors underscore the urgent need for sustainable, evidence-based solid waste management strategies to safeguard environmental quality and protect public health.

Solid waste management involves the systematic processes of waste generation, collection, transportation, treatment, and final disposal arising from households, commercial establishments, and industrial activities. It therefore encompasses the range of methods used to manage, treat, and discard these waste materials, including landfilling, incineration, composting, and, in some cases, open dumping (Bassey, 2017). Solid waste management refers specifically to the safe and efficient handling, treatment, and removal of waste materials generated from human activities, with the primary aim of minimizing health risks and environmental degradation. The methods adopted for managing solid waste vary across regions and are largely influenced by the nature of the waste generated, technological capacity, institutional frameworks, and prevailing environmental considerations (Ibrahim, 2021).

In many Nigerian communities, including Tudun-Kouri and Angwan-Maina,in Nassarawa State, solid waste management practices are often poorly regulated. Due to the absence of organized waste collection systems and limited public awareness of proper waste management practices, residents frequently dispose of waste in nearby bushes, drainage channels, and open spaces (Abubakar & Bala,2023). Such improper solid waste management practices pose substantial challenges to public health, environmental quality, and urban sanitation. In response to these challenges, several solid waste management methods are employed globally and locally, each with distinct advantages and limitations. These includes:

Landfilling, that is one of the most widely adopted methods of solid waste management. This approach involves the burial of waste in designated landfill sites and is considered relatively cost-effective, particularly for the disposal of large volumes of waste (Adebayo, 2020). However, when inadequately designed or poorly managed, landfills can result in groundwater contamination through leachate infiltration and the release of methane gas, a potent greenhouse gas, thereby constituting significant environmental and public health risks. Incineration entails the controlled combustion of solid waste at high temperatures using specialized facilities. This method substantially reduces waste volume and can contribute to energy generation through waste-to-energy technologies. Despite these benefits, incineration may emit toxic gases and particulate matter if emission control systems are insufficient, making strict regulatory oversight and environmental monitoring essential, as emphasized by the

World Health Organization (2023). Composting involves the biological decomposition of biodegradable organic waste, including food remnants, plant residues, and animal droppings, into nutrient-rich compost. This environmentally sustainable method enhances soil fertility and is particularly suitable for agrarian communities. However, its application is limited to organic waste and requires effective waste segregation at the source to ensure optimal outcomes. Recycling, which refers to the systematic collection, processing, and conversion of waste materials such as plastics, paper, glass, and metals into reusable products. Recycling contributes to resource conservation, reduces the burden on landfills, and generates employment opportunities within the waste management sector. Nevertheless, its effectiveness is largely dependent on public participation, adequate infrastructure, and efficient sorting and processing systems (Aba, 2021).

Collectively, these solid waste management methods highlight the importance of integrated, context-specific, and sustainable approaches to addressing the environmental and health challenges associated with improper waste handling. Refuse disposal sites can contaminate surface and groundwater sources, posing a significant risk to human health. The leachate from refuse disposal sites can contain a range of toxic chemicals, including heavy metals, pesticides, and industrial pollutants, which can enter the food chain and cause a range of health problems (NESREA ,2022). Refuse disposal is a critical aspect of environmental health, and its management has severe consequences on human health. Globally, the World Health Organization (WHO) estimate that 24% of all global deaths are linked to environmental factors, including poor waste management (WHO,2018)· The rapid urbanization and population growth in many parts of the world, including Nigeria, have led to an increase in the generation of refuse. Tudun- Kori and Angwa- Maina, a densely populated area in Nasarawa State, Nigeria, is no exception.

Tudun-Kouri and Angwan-Maina, are two growing communities in Lafia Local Government Area of Nasarawa State, have witnessed increased human settlement and urban activities in recent years. However, these developments have not been matched with corresponding improvements in waste management infrastructure. Residents often resort to unsafe refuse disposal methods, resulting in polluted environments and increased incidences of waste-related illnesses. The connection between refuse disposal and human health is well documented in environmental health literature. According to Adewuyi&Olawale (2016), communities with inadequate waste management systems are more prone to disease outbreaks and poor sanitation-related health outcomes. This study, therefore, seeks to examine the solid waste management practices, health outcomes, and sustainable disposal pathways in urban Nigeria: evidence from tudun-kauri and angwa-maina, Nasarawa State.

Human health, as defined by the World Health Organization (WHO), encompasses not only the absence of disease but also the presence of complete physical, mental, and social well-being. This broad definition highlights the importance of multiple factors in ensuring overall health, among which environmental sanitation stands out as a critical determinant. Environmental sanitation refers to the management of environmental conditions that affect human health, including waste disposal, water supply, and hygiene practices. Inadequate sanitation, particularly the improper disposal of refuse, has far-reaching implications for human health. When waste is disposed of indiscriminately, in open dumps, waterways, or poorly managed landfills it becomes a breeding ground for disease-carrying organisms. Mosquitoes, for example, breed in stagnant water found in discarded containers, leading to increased incidence of malaria and dengue fever. Rats, which thrive in refuse dumps, are known carriers of diseases such as leptospirosis and Lassa fever. Flies, which are attracted to decaying organic waste, often act as mechanical vectors for pathogens that cause cholera, typhoid fever, and other gastrointestinal illnesses. Communities with poor waste management systems and high levels of environmental pollution tend to experience frequent outbreaks of communicable diseases. The health burden in such areas is compounded by the lack of access to clean water, inadequate drainage, and limited health education. As noted by Adebayo, (2019), uncollected refuse not only promotes the spread of diseases but also diminishes the overall quality of life, contributing to psychological stress,

physical discomfort, and social disintegration. Sustainable strategies are needed to safeguard and protect human health in those communities.

In some part of Nigeria, solid waste management continues to be a persistent environmental and public health concern. Urban centers frequently experience improper waste segregation, irregular waste collection, and the absence of sustainable disposal mechanisms. Such conditions facilitate the proliferation of disease vectors, contaminate water sources, degrade air quality through open burning, and increase the incidence of communicable and non-communicable diseases. Tudun-Kouri and Angwa-Maina communities in Nasarawa State exemplify these challenges. Observations and local reports indicate prevalent open dumping of waste, poor drainage systems clogged with refuse, and limited access to organized waste collection services. Residents are consequently exposed to health risks such as malaria, typhoid fever, cholera, respiratory infections, and dermatological conditions.

Statement of the Problem

Despite sustained environmental sanitation campaigns, unsafe refuse disposal practices persist in many communities in Nasarawa State. In Tudun-Kauri and Angwa-Maina, uncollected waste is widespread, resulting in offensive odors, blocked drainage systems, and proliferation of disease vectors. These conditions pose significant health risks, yet there is limited empirical evidence assessing the scale and health implications of the problem within these communities. In addition, weak awareness and enforcement of environmental health regulations further exacerbate the situation, constraining effective policy response.

Solid waste is frequently discarded in open spaces, roadside drains, and water channels, reflecting inadequate regulation and absence of sustainable management strategies such as segregation, recycling, and composting. Consequently, residents are exposed to unsanitary conditions associated with recurrent health challenges. However, the relationship between specific disposal practices and health outcomes remains insufficiently documented.

The lack of data-driven insights limits the capacity of policymakers and environmental health authorities to design targeted and sustainable interventions. This study therefore seeks to evaluate prevailing waste disposal practices, examine their public health implications, and provide evidence-based recommendations for improving waste management in Tudun-Kauri and Angwa-Maina communities of Nasarawa State.

Research Questions

The following research questions guided the study:

i. What are the predominant solid waste management disposal methods used in Tundu-Kouri and Angwa-Maina communities?
ii. What are the health challenges associated with the current refuse disposal practices in Tundu-Kouri and Angwa-Maina communities?
iii. What sustainable strategies can be recommended to improve refuse disposal practices and enhance public health in Tundu-Kouri and Angwa-Maina communities?

1.5 Research Hypotheses

To guide this study, the following research hypotheses are formulated and tested at 0.05 level of significance.

Ho_1: There is no significant difference in the refuse disposal methods used in Tundu-Kouri and Angwa-Maina communities.

Ho_2: There is no significant association between current refuse disposal practices and health challenges in the communities.

Ho$_3$: There are no sustainable strategies that can significantly improve refuse disposalpractices and mitigate health risks in Tudun- Kouri and Angwa- Maina communities.

Methodology

This study adopted a descriptive survey research design, which is appropriate for the systematic collection, description, and analysis of data concerning the effects of refuse disposal on human health. The choice of this design is predicated on its suitability for obtaining detailed information from a defined population, thereby enabling the identification of patterns, relationships, and prevailing conditions within the study area.

The research was conducted in Tudun-Kauri and Angwa-Maina, two prominent communities located within Lafia Local Government Area of Nasarawa State, Nigeria. These communities were purposively selected due to their observable environmental sanitation challenges, particularly those associated with improper refuse disposal practices. Characterized as semi-urban settlements with rapidly increasing populations, both areas exhibit inadequate waste management infrastructure and limited access to organized sanitation services.

Furthermore, the prevalence of indiscriminate dumping sites, coupled with reported public health concerns including malaria, cholera, typhoid fever, and other sanitation-related diseases renders these communities particularly suitable for investigating the nexus between refuse disposal practices and human health outcomes.A sample of 100 respondents was selected using a stratified random sampling technique, with equal representation from Tudun-Kauri (50) and Angwa-Maina (50). Stratification by community ensured balanced representation, while random selection of households and one adult per household enhanced diversity across age, gender, and occupation. Additionally, health facility staff and community leaders were purposively included due to their relevance to waste management and public health. Data were collected using a structured questionnaire titled *Refuse Disposal and Health Impact Questionnaire (RDHIQ)*, comprising close-ended items (multiple-choice and yes/no) to facilitate clarity and ease of analysis. The instrument was designed to obtain relevant information from residents of both communities. The data collected were coded and analyzed using descriptive statistics such as frequency counts, percentages, and mean scores to summarize responses. Inferential statistics such as Chi-square (χ^2) test was used to test the hypotheses at 0.05 level of significance to determine the relationship between refuse disposal methods and human health outcomes. This is to examine the relationships between categorical variables such as the relationship between refuse disposal methods and reported health issues. This test was appropriate because it helps determine whether observed differences between groups are statistically significant.

Results

The results of the study are presented in accordance with the research questions and hypotheses. Descriptive statistics such as frequency counts, percentages, and mean scores were used to summarize the responses, while the Chi-square (χ^2) test was used to test the hypotheses at 0.05 level of significance.

Research Question 1

What are the predominant refuse disposal methods used in Tundu-Kouri and Angwa-Maina communities?

Table 1: *Predominant refuse disposal methods used among the communities.*

Refuse Disposal Method	Frequency (F)	Percentage (%)
Open Dumping	40	42.11
Burning	21	22.11
Burying	0	0.00
Waste bin / Collected	26	27.37
Others	8	8.42
Total	95	100.00

Table 1 reveals that open dumping was the most common method (42.11%), followed by waste bins/collected (27.37%) and burning (22.11%). Other methods accounted for 8.42%, while burying was not practiced at all.

Research Question 2

What are the health challenges associated with the current refuse disposal practices in Tundu-Kouri and Angwa-Maina communities?

Table 2: *Reported health problems among residents*

Health Problems	Frequency (F)	Percentage (%)
Malaria	25	26.32
Diarrhoea	15	15.79
Typhoid	19	20.00
Skin infections	12	12.63
Respiratory problems	11	11.58
Cholera	13	13.68
Total	95	100.00

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Table 2 indicates that malaria (26.32%) and typhoid (20.00%) were the most reported health problems, followed by cholera (13.68%) and diarrhea (15.79%). Skin infections (12.63%) and respiratory problems (11.58%) were reported less frequently.

Research Question 3

What sustainable strategies can be recommended to improve refuse disposal practices and enhance public health in Tundu-Kouri and Angwa-Maina communities?

Table 4: *Sustainable Strategies for Improved Refuse Disposal and Public Health*

Sustainable strategies	Frequency (F)	Percentage (%)
Provision of more waste bin/ collection points	30	31.58
Community sensitization& awareness campaigns	25	26.32
Enforcement of sanitation law / Penalties	15	15.79
Regular evacuation of Refuse by authorities	18	18.95
Partnership with NGOs / private sector on waste management	7	7.35
Total	95	100.00

Table 4 reveals that the majority of respondents suggested the provision of more waste bins/collection points (31.58%) and community sensitization/awareness campaigns (26.32%) as the most sustainable strategies to improve refuse disposal and promote public health. Regular evacuation of refuse (18.95%) and enforcement of sanitation laws (15.79%) were also highlighted. A smaller proportion (7.37%) recommended partnerships with NGOs or private waste management organizations.

Hypothesis I

There is no significant difference in the refuse disposal methods used in Tundu-Kouri and Angwa-Maina communities.

Table 5: Chi-square Test of Difference in Refuse Disposal Methods between Communities

Variable	X^2 - Value	Df	P-Value	Decision
Disposal method vs. Community	10.82	3	0.013	Reject Ho1

Table 5 shows Chi-square result ($\chi^2 = 10.82$, $p = 0.013 < 0.05$) that reveals a significant difference in the refuse disposal methods between Tundu-Kouri and Angwa-Maina. Therefore, the null hypothesis is rejected. This implies that disposal practices varied significantly across the two communities.

Hypothesis 2:
There is no significant association between current refuse disposal practices and health challenges in the communities.

Table 6: Chi-square Test of Association between Disposal Practices and Health Problems

Variable	X^2 - Value	Df	P –Value	Decision
Disposal vs. Health Issues	12.45	4	0.014	Reject Ho_2

Table 6 reveals that Chi-square result ($\chi^2 = 12.45$, $p = 0.014 < 0.05$) indicates a statistically significant association between refuse disposal methods and health challenges. Thus, the null hypothesis is rejected. This suggests that poor disposal practices contributed to reported health problems such as malaria, diarrhea, typhoid, and cholera.

Hypothesis 3
There are no sustainable strategies that can significantly improve refuse disposal practices and mitigate health risks in Tundu-Kouri and Angwa-Maina communities.

Table 8: Chi-square Test of Sustainable Strategies for Waste Management

Variable	**X^2 - Value**	**Df**	**P - Value**	**Decision**
Strategies vs. Effectiveness	**15.29**	**3**	**0.04**	**Reject Ho4**

Table 8 reveals Chi-square result ($\chi^2 = 15.29$, $p = 0.004 < 0.05$) that indicates that sustainable strategies such as community clean-up, provision of waste bins, enforcement of policies, and awareness campaigns can significantly improve refuse disposal and reduce health risks. Hence, the null hypothesis is rejected.

Discussion

The study revealed that open dumping (42.11%) and burning (22.11%) were the predominant methods of refuse disposal, while proper waste bin collection (27.37%) and other methods were less practiced. This finding aligns with Aliyu (2022) and Oluwole (2023), who also reported that open dumping and burning were common in Kaduna and Lagos due to limited waste management infrastructure. The rural/semi-urban context of Tudun-Kauri and Angwa-Maina, where recycling awareness and facilities are minimal, Malaria (26.32%) and diarrhea (15.79%) were the most common health issues reported by residents. This is consistent with Abubakar (2023) in Nasarawa State and Abah (2024) in Imo State, who also highlighted malaria and diarrhea as major health risks linked to poor waste disposal. It also supports NESREA (2022), who noted a significant link between dumpsite proximity and malaria prevalence. The persistence of these diseases indicates that environmental sanitation remains a public health challenge in semi-urban communities.

The study revealed that more than half of the respondents (56.84%) were unaware of any government policies on refuse disposal. This finding aligns with Abubakar and Bala (2024), who reported poor awareness of sanitation regulations in Makurdi. The low level of awareness suggests weak policy implementation and limited community sensitization in Tudun-Kauri and Angwa-Maina. Unlike urban areas where residents are often exposed to frequent health campaigns and media outreach, rural communities may not receive such regular interventions, thereby widening the knowledge gap (Aba , 2022).

The Chi-square analysis confirmed a statistically significant relationship ($\chi^2 = 12.45$, $p = 0.014$) between refuse disposal methods and reported health problems among residents. This supports the findings of Adewuyi & Olawale (2016) as well as Ibrahim (2024), who also established that poor disposal methods such as open dumping and burning increase the risk of vector-borne and waterborne diseases. The implication is that improper waste disposal practices directly influence the disease burden within the communities, particularly malaria, typhoid, and diarrhea.

The study further revealed that residents identified several sustainable strategies for improving waste disposal practices and enhancing public health. These include the provision of adequate waste bins and refuse collection points, regular evacuation of refuse by waste management authorities, community sensitization and awareness campaigns, stricter enforcement of sanitation and environmental laws, and the improvement of waste management infrastructure. These findings are consistent with the work of Bassey (2024), who emphasized the role of structured waste management systems and policy enforcement in reducing health risks associated with poor disposal practices. By adopting these strategies, Tudun-Kauri and Angwa-Maina communities can mitigate the health hazards linked to improper waste management and promote a cleaner, healthier environment

Open dumping and burning were the most common disposal practices, while awareness of government policies was low. Malaria and diarrhea emerged as the leading health problems associated with poor waste management. Statistical analysis confirmed a significant relationship between disposal methods and health outcomes. The findings underscore the urgent need for improved sanitation infrastructure, stricter enforcement of waste management policies, and greater community sensitization to mitigate health risks.

Recommendations

Based on the findings, the following recommendations are made:

i. Provision of Sanitation Infrastructure: The Nasarawa State Government, in collaboration with relevant local authorities, should prioritize the provision of adequate waste management infrastructure, including strategically located refuse bins and the institution of efficient, routine waste collection systems in Tudun-Kauri and Angwa-Maina.
ii. Public Sensitization and Environmental Education: There is a need for the design and implementation of sustained, community-based sensitization programmes aimed at enhancing public awareness of proper waste disposal practices and their associated public health implications, particularly in relation to preventable diseases.

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