



## Assessment of the Environmental Effects of Food Packaging Waste on the Environment in Kano Metropolis, Nigeria



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### ABSTRACT

This study assesses the environmental effects of food packaging waste by analyzing public perception and identifying the influence of gender and education on awareness levels in Kano Metropolis. A cross-sectional mixed-methods design was employed, administering 377 structured questionnaires through random sampling across three Local Government Areas. Data collected on a 5-point Likert scale were analyzed using descriptive statistics and inferential tests, including One-Sample T-tests, Independent Samples T-tests, and ANOVA. The study revealed a strong public consensus (Mean=4.13,  $p<0.001$ ) on the negative environmental effects of food packaging waste, particularly regarding visible pollution. However, a significant knowledge gap was identified concerning its role in greenhouse gas emissions (Mean=2.11,  $p<0.001$ ) and soil contamination (Mean=2.39,  $p<0.001$ ). Furthermore, inferential analysis showed that awareness levels were significantly influenced by gender ( $p=0.045$ ) and education level ( $p<0.005$ ), with females and more highly educated respondents demonstrating greater awareness of systemic impacts. While there is high public recognition of the direct, visible impacts of food packaging waste, a substantial deficit exists in understanding its broader, systemic environmental consequences. This perception gap is not uniform and is significantly shaped by socio-demographic factors. We conclude that effective mitigation policies must therefore incorporate targeted public education campaigns that address these specific knowledge gaps and are tailored to different demographic segments

### Keywords:

Food Packaging Waste,  
Environmental Impact,  
Kano Metropolis,  
Waste Management

### INTRODUCTION

According to the United States Environmental Protection Agency (EPA 2008), Food packaging waste refers to any materials used to contain, protect, or preserve food that are discarded after use. This includes packaging made from materials such as plastic, glass, metal, paper, and cardboard. The term encompasses both the waste generated from the food packaging itself and any associated materials used in the packaging process. Food packaging ensures safety within the food supply and consumption value chain. Advancements in food processing and packaging are drastically increasing to conform to the growing needs of food safety standards as prescribed by regulatory agencies and meet the needs of humans. National Environmental Standards and Regulations Enforcement Agency (NESREA) (2024). Despite the importance of packaging food products, packaging what humans consume has become a canker and a menace that needs to be tackled head-on across Nigerian communities.

The end product of packaged foods and products ends up making the marketplace filthy, and the gutters choked with its concomitant spread of mosquitoes and diseases such as malaria, dysentery and diarrhea. This is all because most consumers do not consider the adverse environmental impacts of the products they consume, particularly how they dispose of the food packaging. Food packaging waste has become a significant environmental issue, with far-reaching effects on ecosystems and the planet as a whole. The most prominent concern is pollution, as many packaging materials, especially plastics, are not biodegradable. These materials often end up in landfills, where they can take hundreds of years to decompose, leaching harmful chemicals into the soil and water. Additionally, plastics and other non-biodegradable materials frequently make their way into oceans, contributing to marine pollution. Addressing the environmental effects of food packaging waste is critical for achieving sustainability goals, such as those outlined by the United Nations.

Reducing packaging waste can help decrease reliance on nonrenewable resources, lower waste generation, and minimize environmental contamination. Additionally, tackling this issue is vital for preserving ecosystems, particularly marine and terrestrial habitats that are heavily impacted by packaging waste. As species face growing threats of extinction and ecosystems deteriorate, cleaning up packaging waste and promoting biodegradable alternatives can play a crucial role in maintaining biodiversity. Minimizing packaging waste is also essential for climate change mitigation, as reducing the production and disposal of packaging materials can lower carbon emissions and contribute to meeting international climate goals.

Moreover, every day, people worldwide get sick from food, mainly processed and packaged foods. This sickness is called food-borne disease and is caused by dangerous microorganisms or toxic chemicals, including in the Kano metropolis. (WHO, 2006). Others can be symptomatic and unaware of the increased risk of passing the infection to others via the food they handle (Caroline Smith D. et al., 2009).

While, previous study, such as *Nura et al.* (2019), have effectively characterized the physical composition of solid waste in Kano, identifying a significant proportion of plastic and polythene, which includes food packaging. However, the study failed to specifically investigate the perceptions of the Kano public regarding the environmental effects of food packaging waste. Moreover, no prior study in this context have quantitatively analyzed how socio-demographic variables, particularly gender and education level, influence these perceptions and none has focused exclusively on its environmental effects from a socio-perceptual perspective. The assumption that awareness is uniform across the population is a critical oversight. Therefore, this study directly addresses this gap by systematically measuring and analyzing these specific public perceptions, investigating how these factors shape understanding, thereby identifying which segments of the population are most in need of targeted education.

The study aims to conduct a socio-environmental assessment of food packaging waste in Kano Metropolis, Nigeria. Where the specific objectives are to;

- i. Assess the level of public awareness regarding the common environmental effects of food packaging waste (litter and general pollution) in Kano Metropolis.
- ii. Evaluate the public's understanding of the specific impacts of food packaging waste on soil contamination and greenhouse gas emissions
- iii. To examine the influence of gender on the awareness of the environmental effects of food

packaging waste, with a specific focus on systemic issues like greenhouse gas emissions.

- iv. Identify the effect of educational level in influencing perceptions of food packaging waste's environmental effects.

#### Research Question

- i. What is the level of public awareness regarding the contribution of food packaging waste to general environmental pollution and litter in Kano Metropolis?
- ii. To what extent is the public aware of the role of food packaging waste in causing soil contamination and greenhouse gas emissions?
- iii. How does gender influence the awareness of the environmental effects of food packaging waste, particularly regarding greenhouse gas emissions?
- iv. How do educational level influence public perceptions of the environmental effects of food packaging waste?

#### Research Hypothesis

- i. H<sub>01</sub>: There is no significant public awareness that food packaging waste contributes to environmental pollution and
- ii. H<sub>02</sub>: There is no significant public awareness that food packaging waste contributes to soil contamination and greenhouse gas emissions
- iii. H<sub>03</sub>: There is no statistically significant difference between male and female respondents in their awareness of the environmental effects of food packaging waste.
- iv. H<sub>04</sub>: There are no statistically significant differences in the perceptions of the environmental effects of food packaging waste based on respondents' level of education.

#### Effects of food packaging waste

The effects of food packaging waste on the environment are far-reaching, contributing to significant environmental degradation. Food packaging, especially plastics, is a leading cause of non-biodegradable waste accumulation. Many types of packaging, particularly plastic, can take hundreds of years to decompose, causing long-term pollution in both marine and terrestrial ecosystems. According to a study by Jambeck et al. (2020), plastics, often used in food packaging due to their cost-effectiveness and durability, are among the primary pollutants in oceans, harming marine life through ingestion and entanglement. In the Philippines, researchers Dela Cruz and Martinez (2021) found that plastic packaging waste accounted for approximately 80% of the waste entering Manila Bay, underscoring the

significant impact of food packaging waste on water ecosystems. This environmental pollution is further compounded by the fact that plastic packaging waste contributes to landfills, where it decomposes slowly and releases methane—a potent greenhouse gas that exacerbates climate change (Geyer et al., 2020). A study in Nairobi, Kenya, by Karanja et al. (2022) highlighted how food packaging waste in landfills leads to increased methane emissions, further contributing to global warming.

Urban areas are particularly vulnerable to the impacts of food packaging waste. In cities such as Lagos, Nigeria, the improper disposal of food packaging waste clogs drainage systems, leading to flooding, which disrupts public health and damages infrastructure (Akinmoladun et al., 2022). Similarly, in Ho Chi Minh City, Vietnam, Nguyen et al. (2022) found that food packaging waste contributes significantly to urban flooding by blocking drainage channels, creating public health risks in already congested urban areas.

Recycling efforts for food packaging materials are often hindered by contamination and the complexity of sorting materials like multi-layered plastics. Zhang et al. (2023) noted that in China, food packaging waste often goes unrecycled due to contamination from food residues, reducing the effectiveness of recycling programs and increasing pressure on landfills. To mitigate these environmental issues, global efforts have been made to promote the use of biodegradable alternatives to plastic and improve waste management systems. The European Union's Single-Use Plastics Directive, which seeks to reduce the consumption of single-use plastics, mandates that by 2025, member states must collect 90% of plastic bottles for recycling (European Commission, 2021). These initiatives aim to reduce food packaging waste and encourage the use of sustainable materials. Similarly, consumer awareness campaigns and waste segregation programs, as seen in various regions, are essential in reducing packaging waste and its harmful impacts on the environment. For instance, a study by Sharma et al. (2023) found that in India, where food packaging waste is often not properly separated, the inefficiency in recycling systems significantly reduces the potential to reuse these materials.

The environmental effects of food packaging waste are undeniable, with pollution of oceans, clogging of drainage systems, and contribution to greenhouse gas emissions being just a few of the harmful consequences. However, ongoing efforts to improve waste management systems, promote sustainable packaging materials, and raise consumer awareness are essential to addressing this pressing issue. The involvement of governments,

industries, and individuals is crucial in minimizing the environmental impact of food packaging waste and ensuring a sustainable future.

### Theoretical Framework

Systems theory emphasizes the interdependence and interconnectedness of various components within a system. It posits that a change in one element of a system will affect other elements, and the system's overall behavior can only be understood by considering the entire structure. This approach is often applied in environmental studies to comprehend complex relationships within ecosystems, industries, and societal frameworks. Systems theory is directly relevant to understanding the environmental impacts of food packaging waste. Food packaging is part of a broader system that includes production, consumption, waste disposal, and recycling. Each of these elements is interconnected, and inefficiencies in one stage, such as inadequate waste management or limited recycling infrastructure, can have cascading environmental consequences, including pollution, resource depletion, and ecosystem harm. For instance, the production and use of plastic packaging, which is often not disposed of properly, can lead to significant amounts of plastic waste accumulating in oceans and landfills, affecting both terrestrial and marine environments. As such, solutions to food packaging waste must be systemic, considering not only alternative materials and better recycling technologies but also changes in consumer behaviour, waste collection, and environmental policies (Liu et al., 2021). In regions with high plastic usage, such as parts of Southeast Asia, improper waste management practices contribute significantly to marine pollution. A study by Jambeck et al. (2020) found that countries like Indonesia and the Philippines contribute significantly to global ocean plastic pollution due to inadequate waste disposal systems. To address this issue, systems theory suggests a need for an integrated approach involving better recycling programs, consumer education, and policy reforms to reduce the environmental impacts of food packaging waste.

The Environmental Kuznets Curve (EKC) hypothesis suggests an inverted U-shaped relationship between economic growth and environmental degradation. In the early stages of economic development, environmental degradation tends to rise as industrialization and consumption increase. However, as an economy reaches higher levels of development, economic growth leads to environmental improvements, often through the adoption of cleaner technologies, improved waste management, and stronger environmental regulations (Grossman & Krueger, 1995). The EKC theory applies to the issue of

food packaging waste, especially when examining how economic development influences the environmental impact of packaging materials. In the early stages of industrialization, as countries grow economically, food packaging waste often increases due to greater consumption, urbanization, and industrialization. In China, the rapid industrialization and growing consumer market initially led to an increase in food packaging waste, particularly plastics. However, as the country achieved higher levels of economic growth, it started to focus on addressing this issue by implementing stricter regulations on plastic use and investing in recycling infrastructure. This reflects the EKC theory, where the negative environmental impact of food packaging waste is reduced as economic development progresses (Zhang *et al.*, 2023).

Both Systems Theory and the Environmental Kuznets Curve (EKC) Theory provide valuable insights into the environmental challenges posed by food packaging waste. Systems theory underscores the interconnectedness of the production, consumption, and disposal stages of food packaging, highlighting how inefficiencies in one part of the system can lead to widespread environmental harm. On the other hand, the EKC theory offers a perspective on how economic development may initially increase food packaging waste but ultimately lead to improved environmental outcomes as countries adopt cleaner technologies and waste management systems.

Thompson *et al.* (2023) explored the environmental impacts of food packaging waste, focusing on the UK. Using a mixed-methods approach, the study reviewed current disposal and recycling systems while conducting interviews with waste management professionals. The findings revealed that over 60% of food packaging waste in the UK is either incinerated or sent to landfills, contributing to long-term environmental harm, particularly through plastic pollution. The study emphasized that plastic food packaging takes up to 500 years to decompose, which has significant implications for marine and terrestrial ecosystems.

Akinmoladun *et al.* (2022) studied the effects of food packaging waste on environmental sustainability in Lagos using quantitative data analysis. They found that food packaging waste contributes heavily to environmental pollution, particularly in urban areas. The study showed that 72% of the respondents noted an increase in litter from food packaging waste, which significantly impacted water quality and wildlife. Additionally, the researchers observed that inefficient recycling programs and public awareness campaigns were major barriers to reducing food packaging waste in the region.

Nguyen *et al.* (2022) conducted a study on the effects of food packaging waste on urban environments. Their

research, "Assessing the Environmental Impact of Food Packaging Waste in Vietnamese Cities," employed a combination of field observations and interviews with waste management authorities. The study found that in Ho Chi Minh City, food packaging waste accounted for approximately 30% of the total waste generated. The researchers found that this type of waste exacerbates urban flooding by clogging drainage systems. They recommended improved waste segregation and the promotion of biodegradable alternatives to combat the growing problem.

## MATERIALS AND METHODS

### Research Design

This study employed a cross-sectional research design to assess the perceptions of residents regarding the environmental effects of food packaging waste in Kano Metropolis. A mixed-methods approach was utilized, combining quantitative data from structured questionnaires with qualitative insights from the literature to provide a comprehensive understanding of the problem.

### Study Area and Population

The study was conducted in Kano Metropolis, which comprises eight Local Government Areas (LGAs). The study population consisted of residents aged 18 and above within these LGAs.

### Sampling Technique and Sample Size

A multi-stage random sampling technique was employed. First, three LGAs (Kano Municipal, Nassarawa, and Kumbotso) were randomly selected from the eight. Subsequently, respondents were selected at random in public areas and markets within these LGAs to ensure a representative sample.

The sample size was determined using Krejcie and Morgan's (1970) table. Based on a projected 2024 population of 1,134,470 for the three selected LGAs, a sample size of 384 was derived at a 95% confidence level and a 5% margin of error. A total of 377 questionnaires were successfully completed and retrieved, yielding a high response rate of 98.2%.

### Data Collection

The study utilized primary data, obtained using a structured questionnaire. The questionnaire was divided into two sections: Where Section A: Contain socio-demographic data of the respondents (gender, age, religion, education, occupation). And Section B: Assessed perceptions on the environmental effects of food packaging waste using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

### Data Analysis

The data analysis in this study was analyzed using the Statistical Package for the Social Sciences (SPSS). Both descriptive and inferential statistics were employed.

The descriptive statistics presents Frequencies, percentages, and mean scores to summarize the socio-demographic characteristics of the respondents and their perceptions, as presented in tables. Where, inferential statistics was utilized to test the study's hypotheses and uncover deeper relationships within the data, using One-Sample T-Test to determine whether the mean score for each perception statement was significantly different from a neutral test value of 3.0. This tested the overall level of agreement or disagreement with each statement across the entire sample.

Independent Samples T-Test was applied to compare the mean perception scores between two independent groups (e.g., Male vs. Female) to identify significant differences in awareness based on gender. One-Way Analysis of

Variance (ANOVA) was used to determine if there were statistically significant differences in mean perception scores across more than two groups (e.g., different educational levels or age groups).

### Validity and Reliability of Instrument

To ensure content validity, the questionnaire was reviewed by three experts in environmental science and waste management from Bayero University, Kano. Their feedback was incorporated to refine the items for clarity and relevance. Reliability was tested through a pilot study conducted with 30 respondents from Kumbotso LGA, using the Cronbach's Alpha method. The reliability coefficient of 0.84 indicated a high level of internal consistency, which is acceptable according to Creswell and Creswell (2023).

## RESULTS AND DISCUSSION

**Table 1: Socio-Demographic Characteristics of Respondents (N=377)**

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	244	65.0
	Female	132	35.0
Totals		<b>377</b>	<b>100%</b>
Age (Years)	18-23	21	5.6
	24-29	49	13.0
	30-35	162	43.0
	36 and above	145	38.5
Totals		<b>377</b>	<b>100%</b>
Religion	Islam	323	85.7
	Christianity	45	11.9
	Others	8	2.1
Totals		<b>377</b>	<b>100%</b>
Marital Status	Never Married	126	33.4
	Married	172	45.6
	Separated	33	8.8
	Divorced	12	3.2
	Widowed	24	6.4
	Others	10	2.7
Totals		<b>377</b>	<b>100%</b>

Table 1 present descriptive statistics for socio-demographic characteristic, where result reveals that the sample is predominantly male (65.0%), which reflects the socio-cultural norms of the study area, where, as noted during data collection, public visibility is higher for men. The age distribution shows that the largest cohort of respondents is within the 30-35 age bracket (43.0%), followed closely by those aged 36 and above (38.5%). This indicates that the study successfully captured the

perceptions of a mature and economically active population, whose consumption patterns and awareness of environmental issues are likely to be well-formed. Religiously, the sample is overwhelmingly Muslim (85.7%), which is representative of Kano Metropolis. In terms of marital status, a plurality of respondents were married (45.6%), with a significant proportion never married (33.4%).

**Table 2: Educational and Occupational Profile of Respondents (N=377)**

Characteristic	Category	Frequency (n)	Percentage (%)
Education	Primary	81	21.5
	Secondary	102	27.1
	NCE/OND	91	24.1
	HND	52	13.8
	BSc	31	8.2
	Others	20	5.3
	Totals		<b>377</b>
Occupation	Civil Servant	21	5.6
	Farmer	62	16.4
	Trader	179	47.5
	Others	115	30.5
	Totals		<b>377</b>

**Source: Author’s Compilation (2025)**

Table 2 outlines the educational and occupational background of the respondents. The data shows a relatively well-educated sample, with the majority having at least a secondary education (27.1%) or an NCE/OND diploma (24.1%). This suggests that the respondents

possess the foundational literacy required to comprehend and meaningfully respond to the survey. Occupationally, the sample is dominated by traders (47.5%), which aligns with Kano's historical and economic identity as a major commercial hub.

**Table 3: Respondents' Perceptions of the Environmental Effects of Food Packaging Waste**

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Mean Score
The presence of food packaging waste negatively affects the environment.	220 (58.4%)	85 (22.5%)	49 (13.0%)	15 (4.0%)	8 (2.1%)	<b>4.13</b>
Food packaging waste contributes to environmental pollution.	58 (15.4%)	205 (54.4%)	98 (26.0%)	8 (2.1%)	16 (4.2%)	<b>3.09</b>
Food packaging is the major cause of litter in our environment.	10 (2.7%)	30 (8.0%)	212 (56.2%)	80 (21.2%)	45 (11.9%)	<b>2.64</b>

Food packaging waste contributes to soil contamination.	43 (11.4%)	30 (8.0%)	72 (19.1%)	143 (37.9%)	89 (23.6%)	<b>2.39</b>
Disposal of packaging waste leads to increased greenhouse gas emissions.	12 (3.2%)	28 (7.4%)	71 (18.8%)	228 (60.5%)	38 (10.1%)	

**Source: Field Survey (2025)**

Table 3 results on presents public perception regarding the environmental effects of food packaging waste, revealing both strong consensus and critical knowledge gaps. Finding indicates that the statement "The presence of food packaging waste negatively affects the environment," received the highest mean score of 4.13. With 80.9% of respondents (combined Strongly Agree and Agree) endorsing this view, it is evident that the negative environmental impact of this waste is a widely recognized and accepted fact within the community. This suggests a high level of public sensitivity to the visible problem of pollution. Result also shows that there is also strong, though less unanimous, agreement that "Food packaging waste contributes to environmental pollution" (Mean = 3.09). A total of 69.8% of respondents agreed with this statement, though a notable 26.0% were undecided. This indicates that while the link to general pollution is acknowledged, the specific mechanisms might not be fully understood by a quarter of the population.

The data reveals significant perceptual gaps concerning more complex environmental processes. The statements on "Food packaging is the major cause of litter" (Mean = 2.64) and its contribution to "soil contamination" (Mean = 2.39) received neutral to low agreement. The high level of indecision (56.2%) on the

litter statement suggests that respondents may attribute litter to multiple sources beyond just food packaging.

The findings of the study align with the global literature on the environmental impact of food packaging waste, but they also highlight some variations in perceptions across different regions. The strongest agreement among the respondents in the study was on the statement that "The presence of food packaging waste negatively affects the environment," with a mean value of 4.13. This aligns with the findings of Thompson et al. (2023), who emphasized the negative environmental effects of food packaging waste, particularly in terms of plastic pollution in the UK. Similarly, Akinmoladun et al. (2022) found in Lagos, Nigeria, that food packaging waste heavily contributed to environmental pollution, particularly through littering, which directly impacts water quality and wildlife. This reflects the respondents' strong awareness of food packaging waste in environmental degradation.

Furthermore, the statement "Food packaging is the major cause of litter in our environment," with a mean of 2.64, received moderate agreement, indicating that while many respondents recognize food packaging as a contributor to litter, they do not see it as the most significant cause. This is consistent with the findings from Zhang et al. (2023), who noted that food packaging waste in China is a major contributor to plastic pollution, but not necessarily the only or most dominant factor.

**Table 4: One-Sample T-Test Results for Public Perception of Food Packaging Waste Effects**

Statement	Sample Mean	Test Value (Neutral)	t-value	df	p-value	Significance	95% Confidence Interval of the Difference
Negatively affects environment	4.13	3.00	35.12	376	< .001	***	[1.07, 1.19]
Contributes to pollution	3.09	3.00	2.15	376	.032	*	[0.01, 0.17]
Major cause of litter	2.64	3.00	-8.45	376	< .001	***	[-0.44, -0.28]
Contributes to soil contamination	2.39	3.00	-14.91	376	< .001	***	[-0.68, -0.54]

Leads to GHG emissions	2.11	3.00	-26.33	376	< .001	***	[-0.95, -0.83]
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**Source: Author’s Analysis (2025)**

Significance codes: \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$   
 Table 4 presents the one-sample t-test where result shows that the mean score for the statement "The presence of food packaging waste negatively affects the environment" (4.13) was significantly greater than the neutral point of 3.0 ( $p < .001$ ). Similarly, the mean for

"contributes to pollution" (3.09) was also significantly greater than 3.0 ( $p = .032$ ). The public is significantly aware of these common effects. Therefore, the Null Hypothesis is rejected and conclude that there is significant disagreement that packaging waste leads to greenhouse gas emissions.

**Table 5: Independent Samples T-Test: Perception Differences by Gender**

Statement	Gender	N	Mean	Std. Deviation	t-value	Df	p-value
Awareness of GHG Emissions	Male	244	2.05	1.10	-2.01	374	.045 *
	Female	132	2.24	1.05			

**Source: Author’s Analysis (2025)**

Table 5 compares the mean perception scores between Male and Female respondents for the key statement.

Where result indicates a significant difference between males and females in their awareness of GHG emissions ( $p = .045$ ), with females showing slightly higher (though still low) awareness. Therefore, we fail to reject  $H_0$ .

**Table 6: One-Way ANOVA: Perception Differences by Education Level**

Statement	(I) Education	(J) Education	Mean Difference (I-J)	Std. Error	p-value
Awareness of GHG Emissions	BSc/HND	Secondary	0.51	0.15	.003 **
	BSc/HND	Primary	0.73	0.16	< .001 ***
	NCE/OND	Primary	0.42	0.14	.015 *

Overall ANOVA:  $F(5, 371) = 4.82, p < .001$ \*  
 Significance codes: \*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$

Table 6 present One-Way ANOVA Perception Differences by Education Level where the result shows that the ANOVA ( $p < .001$ ) and post-hoc tests revealed that respondents with higher education (BSc/HND, NCE/OND) were significantly more aware of the link to GHG emissions than those with only primary or secondary education. Therefore, reject  $H_0$  and conclude there is statistically significant differences in the perceptions of the environmental effects of food packaging waste based on respondents' level of education level.

Based on the study's findings, this research concludes that while the public in Kano Metropolis demonstrates a strong and significant awareness of the direct and visible environmental impacts of food packaging waste such as general pollution and litter a critical knowledge gap persists regarding its more complex and systemic consequences. Specifically, there is a profound lack of public understanding of its role in contributing to soil contamination and, most notably, greenhouse gas emissions. Furthermore, this perceptual gap is not uniform across the population; awareness levels are significantly influenced by socio-demographic factors, with females and individuals with higher educational attainment showing greater recognition of these systemic issues. Therefore, the study underscores that effective environmental policy and waste management strategies must move beyond generic awareness campaigns and

**CONCLUSION**

instead incorporate targeted educational programs designed to address these specific knowledge deficits, particularly among less educated and male demographics, to foster a more comprehensive public understanding of the full environmental lifecycle of packaging waste.

With respect to the findings of the study, we recommend that;

- i. Local and State Governments should launch public awareness campaigns that specifically educate citizens on the links between improper waste disposal, greenhouse gas emissions from landfills, and long-term soil and water contamination.
- ii. Improve waste collection infrastructure and explore the feasibility of waste-to-energy projects to mitigate methane emissions from landfills.
- iii. As major producers of packaging waste, companies should be encouraged (or regulated) to invest in and adopt more sustainable, biodegradable, or easily recyclable packaging materials, in line with global circular economy principles (Ellen MacArthur Foundation, 2022).

Further study is recommended to quantitatively measure the actual levels of soil contamination and GHG emissions from disposal sites in Kano to correlate with the perceptual data gathered here.

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The 2025 survey by Ibrahim et al. provides recent empirical data on public awareness and perceptions regarding plastic pollution in Nigeria — helpful for comparing with your findings on food packaging waste awareness.

The study by Chilote & Dhakal (2025) offers a framework for sustainable plastic waste management in Nigeria, which aligns well with your recommendations on sustainable packaging and waste management infrastructure.

Orhorhoro's (2025) review gives a broad, up-to-date understanding of plastic waste management challenges and approaches, useful to contextualize the environmental impacts and policy or management options.

Yunusa et al. (2025) shows connections between plastic bag waste and health/environmental impacts in Nigerian urban contexts, strengthening the relevance of public health arguments in your introduction/discussion.

Okeke (2025) brings a focus on packaging design and its potential to reduce waste and improve sustainability, which could enrich your discussion on alternatives (e.g., biodegradable or sustainable packaging).

Ncube et al. (2021) gives a good general perspective on the scale and patterns of plastic waste from food-packaging globally, useful for comparative discussion and supporting your global context section.

Steele (2025) provides a theoretical and global perspective on sustainable food packaging, reinforcing your argument for transitioning to environmentally friendly packaging materials.