

## IMPROPER WASTE HANDLING AND PROLIFERATION OF INSECTS AND RODENTS IN URBAN EATERIES

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### ABSTRACT

Improper waste handling in urban eateries creates serious environmental and health risks, especially by encouraging the spread of insects and rodents that contaminate food and utensils. This study explored how waste management practices influence pest infestation in eateries across Port Harcourt, Rivers State, Nigeria. Using a descriptive survey design, data were collected from 300 respondents through structured questionnaires. Both descriptive and inferential analyses were applied to test the hypothesis that poor waste handling and pest proliferation do not differ significantly with improved waste management measures. The results showed that most respondents (94%) agreed that insects and rodents contaminate food and utensils, while 86% confirmed that proper storage and regular disposal of waste help reduce pest problems. However, only about half (53.6%) reported that their eateries actually follow recommended hygiene and sanitation guidelines, pointing to major gaps in compliance. The study also identified several challenges: limited awareness of proper waste handling practices (66%), lack of adequate bins (14%), and irregular waste collection services (5.7%). When ranking improvement measures, respondents rated designated waste disposal points (mean = 3.3), timely waste collection (mean = 3.2), and stricter regulatory enforcement (mean = 3.2) as the most effective. In contrast, public awareness campaigns (mean = 1.8) and partnerships with private waste companies (mean = 2.1) were seen as less effective. Overall, the study concludes that improving infrastructure, strengthening waste collection systems, training staff, and enforcing hygiene regulations are essential steps toward better waste management and pest control in urban eateries. It further recommends policy reforms and stronger collaboration among stakeholders to protect public health and enhance environmental sanitation.

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### INTRODUCTION

Solid waste management has become one of the most pressing environmental health challenges in rapidly urbanizing cities across the developing world (Dimkpa et al., 2023; Ogbensi et al., 2024). Food establishments such as eateries, restaurants, and fast-food outlets are major contributors to the daily generation of organic waste in urban centres. When such waste is poorly managed, it creates fertile breeding grounds for insects and rodents, which in turn pose significant public health risks (Essor, et al., 2023). In Port Harcourt, the capital of Rivers State, Nigeria, the rapid growth of the food service sector, coupled with poor waste management infrastructure, has heightened the prevalence of insect and rodent infestation in and around urban eateries.

Improper waste handling is characterized by inadequate storage, irregular collection, open dumping, poor segregation, and indiscriminate disposal of refuse (Afon, 2012; Ogbensi et al., 2024; John & Ogbensi, 2025). In eateries, this problem is often worsened by the accumulation of food residues, disposable plastics, and packaging materials. Unlike inert materials, organic food waste decomposes quickly under tropical conditions, emitting odors and attracting pests such as houseflies, cockroaches, and rodents (Uwadiengwu et al., 2020). These pests act as vectors for numerous

pathogens, including *Escherichia coli*, *Salmonella*, and *Vibrio cholerae*, which cause diarrheal diseases, cholera, typhoid fever, and food poisoning (Odonkor & Ampofo, 2013). Thus, the link between waste mismanagement in eateries and vector proliferation is not only environmental but also directly tied to human health outcomes.

Insects such as flies and cockroaches thrive in decaying waste because it provides both food and shelter. Flies are particularly notorious for transmitting enteric pathogens mechanically as they move from refuse dumps to food surfaces (Olayemi et al., 2020; Aisha et al., 2025). Cockroaches, on the other hand, survive in warm, damp, and unsanitary environments and have been implicated in the spread of bacteria, fungi, and parasitic worms (Al-Mayali et al., 2021). Rodents, especially rats and mice, are equally problematic in urban eateries. Their high reproductive rate, nocturnal feeding behavior, and ability to gnaw through packaging materials make them persistent pests. Rodents are associated with zoonotic diseases such as leptospirosis, salmonellosis, and Lassa fever, which remain significant health burdens in Nigeria (Olayemi et al., 2018).

The problem is compounded by weaknesses in urban governance and municipal waste services. Port Harcourt, like many Nigerian cities, faces challenges of inadequate waste collection infrastructure, insufficient disposal facilities, and weak enforcement of sanitation regulations (Ogbonna et al., 2007; Nwankwo & Agunwamba, 2018; Ogboeli et al., 2025). This has resulted in indiscriminate dumping of waste around food outlets, blocked drainage channels, and accumulation of refuse near residential and commercial areas. For eateries that operate within high-density commercial neighborhoods, the irregular evacuation of waste bins leads to overflowing refuse that remains for days, providing continuous sources of food and shelter for pests.

Urbanization and population growth further exacerbate these challenges. Port Harcourt has experienced significant population expansion due to oil-related economic activities, leading to increased demand for ready-to-eat meals and a proliferation of eateries across the city (Chukwu et al., 2019). Unfortunately, this expansion has not been matched by improvements in waste handling infrastructure or sanitary inspections. Many food outlets rely on crude methods such as open storage, unlined bins, and backyard dumping. The absence of covered storage facilities and effective waste segregation exposes waste to the open environment, thereby facilitating vector infestation and disease transmission (Ezeah & Roberts, 2012).

From a public health perspective, the proliferation of insects and rodents in urban eateries is a serious concern because it undermines food safety and increases the risk of disease outbreaks. According to the World Health Organization (WHO, 2015), foodborne illnesses remain a major cause of morbidity and mortality globally, with unhygienic waste handling being one of the key contributing factors in low- and middle-income countries. In Nigeria, outbreaks of cholera and typhoid have frequently been associated with poor sanitation and improper waste management practices (Oloruntoba et al., 2014).

Beyond health implications, improper waste handling in eateries has socioeconomic and environmental consequences. Pests not only damage food stocks and infrastructure but also reduce customer confidence in the hygiene of food establishments. This can affect business sustainability and the broader urban economy, especially in cities like Port Harcourt where the hospitality and service sectors contribute significantly to livelihoods. Moreover, the environmental impacts of improper waste disposal, including blocked drainage and flooding, further worsen sanitary conditions and create more breeding sites for disease vectors (Nduka & Duru, 2014).

In light of these concerns, examining the link between improper waste handling in urban eateries and the proliferation of insects and rodents in Port Harcourt is critical. Such studies provide evidence that can inform regulatory frameworks, guide public health interventions, and promote the adoption of sustainable waste management practices in the food service sector. By addressing the root causes of waste mismanagement, urban authorities can reduce vector infestation, enhance food hygiene standards, and protect public health.

### **Comparative Studies and Global Contextualization**

Waste handling practices and their associated public health implications have been widely studied across different global contexts. The relationship between improper waste management and the proliferation of disease vectors such as insects and rodents has emerged as a universal concern, though the magnitude and nature of the problem vary depending on the level of urbanization, infrastructure, regulatory frameworks, and socio-economic conditions.

In developed countries, stringent food safety regulations and advanced waste management systems have significantly reduced pest infestation around eateries. For instance, in the United States and much of Western Europe, solid waste handling in food establishments is governed by strict public health codes that require covered bins, regular collection, and pest control measures (Centers for Disease Control and Prevention [CDC], 2019). These interventions have contributed to minimizing outbreaks of

foodborne diseases linked to waste mismanagement. Nevertheless, occasional lapses still occur, as evidenced by rodent infestations reported in New York City restaurants, highlighting that even well-resourced cities face challenges in pest control when waste handling is compromised (Madden, 2018).

In contrast, developing countries, particularly in Sub-Saharan Africa and South Asia, face greater challenges due to weak regulatory enforcement, inadequate infrastructure, and poor hygiene practices. Studies in Accra, Ghana, revealed that nearly 65% of food vendors lacked access to proper waste disposal facilities, resulting in widespread rodent and cockroach infestations (Monney et al., 2013). Similarly, in Dhaka, Bangladesh, improper storage of organic waste in eateries was strongly correlated with high densities of flies and rats, contributing to frequent outbreaks of diarrheal diseases (Akter et al., 2017). These findings underscore the vulnerability of food outlets in low-resource settings to pest-related health risks.

Within the African context, Nigeria exemplifies the complexities of waste management in rapidly urbanizing cities. Several studies in Lagos and Ibadan revealed that poor waste storage and irregular municipal collection were major drivers of vector proliferation in food service environments (Oloruntoba et al., 2014; Afon, 2012). These studies parallel the situation in Port Harcourt, where rapid urban expansion, inadequate waste infrastructure, and poor regulatory oversight exacerbate pest infestations around eateries. Unlike in advanced economies where waste-to-energy technologies and mechanized collection systems are common, waste management in Nigerian cities is largely characterized by open dumping and reliance on manual collection methods, which are insufficient to prevent vector breeding.

Comparative evidence also shows that cultural and behavioral factors influence waste handling practices in eateries. In countries such as Japan and Singapore, strict cultural adherence to cleanliness and government-enforced waste segregation policies minimizes pest problems in food outlets (Yamamoto & Suzuki, 2020). Conversely, in many African and Asian cities, limited awareness and poor compliance with hygiene regulations contribute to the persistence of rodent and insect infestations in eateries despite existing legal frameworks (Odonkor & Ampofo, 2013).

Globally, the World Health Organization (WHO, 2015) emphasizes that foodborne illnesses remain a significant health burden, particularly in low- and middle-income countries where unsafe food and poor sanitation cause an estimated 600 million cases of illness annually. The contribution of improper waste handling to this burden is well-documented. Comparative studies suggest that while the health risks associated with waste-induced vector proliferation are universal, they are disproportionately severe in urban centers of developing nations due to infrastructural deficits and poor institutional response (Ezeah & Roberts, 2012).

In the specific case of Port Harcourt, improper waste handling in eateries reflects both global and local challenges. Like other rapidly growing cities, Port Harcourt faces the pressures of urbanization, population growth, and increased food service activities. However, the absence of consistent municipal collection services, the prevalence of open dumping, and weak enforcement of environmental sanitation laws distinguish it from cities in developed nations where stricter controls mitigate these risks. The global context reveals that while advanced economies battle occasional lapses in waste management, developing urban centers like Port Harcourt struggle with systemic deficiencies that make insect and rodent proliferation in eateries a persistent public health threat.

Thus, situating Port Harcourt within the global discourse highlights both similarities and disparities in waste handling and pest proliferation. While the problem is global, the local dimensions, weak infrastructure, regulatory gaps, and socio-cultural practices amplify its severity. Addressing this issue in Port Harcourt, therefore, requires not only learning from best practices in advanced countries but also tailoring interventions to local realities, particularly in strengthening enforcement, enhancing

infrastructure, and promoting hygiene awareness in the food service sector.

## Materials and Methods

The study was conducted in Port Harcourt, the capital of Rivers State, Nigeria. The city lies between latitudes 4°45'N and 4°55'N and longitudes 6°55'E and 7°05'E. It is one of the most urbanized and industrialized cities in the Niger Delta region, with a population estimated at over 3 million people (National Population Commission [NPC], 2022). Port Harcourt is a commercial hub with a rapidly growing food service industry that includes restaurants, eateries, fast-food outlets, and informal street food vendors. The city experiences a tropical climate with high rainfall and humidity, conditions that accelerate waste decomposition and provide favorable environments for insect and rodent proliferation. Poor municipal waste management services and weak enforcement of sanitation regulations exacerbate the problem of improper waste handling in urban food establishments. A descriptive cross-sectional survey design was employed. This design was considered appropriate because it enabled the collection of data at a single point in time from multiple eateries across the metropolis, allowing for the assessment of waste handling practices and the presence of insects and rodents regarding sanitation conditions. The target population consisted of urban eateries within Port Harcourt, including both formal (registered restaurants and fast-food outlets) and informal (street food vendors and small eateries) establishments. In addition, food handlers and staff responsible for waste disposal in these establishments were included in the study. The sample size was determined using Cochran's formula for cross-sectional studies at a 95% confidence level and 5% margin of error. Based on an estimated population of approximately 1,200 eateries within Port Harcourt metropolis (Rivers State Ministry of Health, 2023), a minimum sample size of 291 eateries was calculated. To improve representativeness, 300 eateries were selected. A multistage sampling technique was employed. First, Port Harcourt metropolis was stratified into two local government areas, Port Harcourt City LGA and Obio/Akpor LGA. Within each LGA, a proportional number of eateries were selected. Simple random sampling was then used to identify individual establishments. Within each eatery, one food handler or waste management staff member was purposively selected for questionnaire administration.

### Data were collected using a combination of:

1. Structured Questionnaire: This was designed to obtain information on socio-demographic characteristics of respondents, waste handling practices (storage, collection, disposal), and knowledge of sanitation and pest control. The questionnaire included both closed-ended and Likert scale items.

2. Observation Checklist: An observational tool was used to assess the environmental conditions of eateries, including waste storage facilities, frequency of waste removal, presence of insects (flies, cockroaches) and rodents, and compliance with sanitation standards.

3. Key Informant Interviews (KII): Interviews were conducted with sanitation officers from the Rivers State Waste Management Agency (RIWAMA) and health inspectors to provide contextual information on waste collection systems and regulatory enforcement.

**Validity and Reliability of Instruments:** The questionnaire and observation checklist were subjected to expert review by environmental health specialists and public health researchers for content validity. A pre-test was conducted on 30 eateries in a neighboring local government area (Ikwerre LGA) not included in the main study. Reliability was assessed using Cronbach's alpha, with a coefficient of 0.82 obtained, indicating high internal consistency.

**Data Collection Procedure:** Trained research assistants visited the selected eateries to administer questionnaires to food handlers and managers. Direct observations were carried out simultaneously to minimize reporting bias. Each eatery was visited during peak business hours to ensure a realistic assessment of waste handling

and pest presence. KII with waste management and public health officials were conducted at their offices using a semi-structured interview guide.

**Data Analysis:** Quantitative data from questionnaires and observation checklists were coded and entered into the Statistical Package for the Social Sciences (SPSS, version 25). Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize data. Chi-square tests and logistic regression analyses were applied to examine associations between waste handling practices and the presence of insects and rodents. Qualitative data from KII were analyzed thematically and triangulated with quantitative findings to strengthen interpretation.

**Ethical Considerations:** Ethical approval for the study was obtained from the Rivers State Ministry of Health Research Ethics Committee. Written informed consent was obtained from all respondents before participation. Confidentiality and anonymity of respondents and eateries were ensured by assigning unique identification codes and excluding personal identifiers from the data. Participation in the study was voluntary, and respondents were free to withdraw at any stage without penalty.

## Result and Discussion

**Sex Distribution of Respondents:** Table 1 presents the sex distribution of respondents. Out of 300 participants, 107 (35.7%) were male, while 193 (64.3%) were female, indicating that females formed the majority. This dominance is consistent with findings that women are more actively engaged in food-related enterprises such as eateries, restaurants, and food vending (Ajayi & Solomon, 2019; Ojo & Abiodun, 2021). It also reflects the occupational demographics of Nigeria's hospitality sector, where women predominate in food preparation, sales, and service roles (Nwankwo et al., 2020). The predominance of females suggests that they are more directly involved in waste generation and handling in eateries, particularly through routine kitchen and sanitation duties. Their perspectives, therefore, provide valuable insights into the challenges of waste management and its relationship with pest proliferation. Previous studies emphasize that women's role in waste handling strongly influences hygiene practices and the environmental health of food businesses (Olukanni & Nwachukwu, 2018; Akinwale, 2022). Overall, this finding highlights the importance of gender-sensitive approaches in waste management interventions. As Abila and Kantola (2019) note, gender considerations are essential for sustainable waste management strategies, especially in urban contexts where informal food businesses thrive.

**Table 1: Sex Distributions**

Sex	Frequency	Percentage
Male	107	35.7
Female	193	64.3
<b>Total</b>	<b>300</b>	

**Age distribution:** Table 2 shows the age distribution of respondents. Out of 300 participants, 8 (2.7%) were aged 18–25 years, 49 (16.3%) were 26–35 years, 171 (57.0%) were 36–45 years, and 72 (24.0%) were 46 years and above. The majority (57.0%) fell within the 36–45 age group, suggesting that eatery management and waste-handling practices are predominantly overseen by individuals in middle adulthood. This aligns with findings that middle-aged adults are more established in business ownership and management, particularly in the food service sector, due to greater stability and decision-making responsibility (Eze & Chukwu, 2020). Prior studies also indicate that this group dominates food enterprises because of maturity and economic capacity (Olawale & Adebayo, 2021; Iwuchukwu & Obiora, 2019). The low representation of respondents aged 18–25 (2.7%) may reflect limited financial capacity to own eateries, as many in this category work as employees rather than managers (Okonkwo & Ude, 2018). Conversely, the 46+ group (24.0%) underscores the continued involvement of older adults, likely due to their

experience and resources. Age differences matter for waste management: middle-aged and older respondents may rely on established practices, while younger individuals, though fewer, may be more open to adopting innovative, sustainable approaches (Abila & Kantola, 2019).

**Table 2: Age Distribution**

Age	Frequency	Percentage
18 – 25	8	2.7
26 – 35	49	16.3
36 – 45	171	57
46 and above	72	24
Total	300	

**Educational Distribution of Respondents:** Table 3 presents the educational distribution of respondents. Out of 300 participants, 29 (9.7%) had primary education, 119 (39.7%) had secondary education, while the majority, 152 (50.7%), attained tertiary education. This indicates that most respondents were relatively well-educated, with more than half having formal post-secondary qualifications. The predominance of tertiary education suggests that many eatery operators or managers in urban areas possess higher literacy levels, which may positively influence their awareness of hygiene, waste management, and public health practices (Ibrahim & Musa, 2020). The substantial proportion with secondary education (39.7%) also reflects the accessibility of food business ventures to individuals with moderate educational attainment. However, the smaller percentage with only primary education (9.7%) highlights that basic literacy remains a foundation for participation in small-scale eatery enterprises. Previous studies have shown that education significantly affects knowledge, attitudes, and practices regarding waste management and environmental hygiene (Olukanni & Nwachukwu, 2018; Abila & Kantola, 2019). Therefore, the findings suggest that educational level is a key determinant of effective waste handling. Higher educational attainment may enhance compliance with environmental regulations, improve adoption of sustainable waste practices, and ultimately reduce the risk of insect and rodent infestations in eateries (Ojo & Abiodun, 2021).

**Table 3: Educational Distribution**

Educational Distribution	Frequency	Percentage
No formal education		
Primary	29	9.7
Secondary	119	39.7
Tertiary	152	50.7
Total	300	

**Position of Respondents in Eateries:** Table 4 shows the position of respondents in eateries. Out of 300 participants, 17 (5.7%) were owners, 198 (66.0%) were managers, 63 (21.0%) were chefs/cooks, and 22 (7.3%) were cleaners/assistants. The majority being managers (66.0%) suggests that the study largely captured those directly responsible for day-to-day operations, including supervision of waste handling and hygiene practices. This aligns with findings that managers are central decision-makers in food establishments and play a critical role in enforcing sanitation protocols (Eze & Chukwu, 2020).

Chefs and cooks (21.0%) also represent a significant proportion, reflecting their direct involvement in food preparation where most waste is generated. Their perspectives are vital, as improper disposal of organic waste can directly contribute to pest proliferation. Cleaners and assistants (7.3%) are equally important

since they handle routine sanitation tasks, yet their relatively low representation may limit insights from this category.

The low percentage of owners (5.7%) is not unusual, as owners often delegate operational responsibilities. Previous studies highlight that effective waste management in eateries depends more on operational staff than on proprietors (Olukanni & Nwachukwu, 2018; Ojo & Abiodun, 2021). Overall, the distribution underscores the importance of managerial and operational roles in ensuring sustainable waste practices and reducing pest infestations (Abila & Kantola, 2019).

**Table 4: Position in Eatery**

Position in Eatery	Frequency	Percentage
Owner	17	5.7
Manager	198	66
Chef/Cook	63	21
Cleaner/Assistant	22	7.3
Total	300	

**Years of Experience in Food Handling:** Table 5 presents the respondents' years of experience in food handling. Out of 300 participants, 7 (2.3%) had between 1–5 years of experience, 129 (43.0%) had 6–10 years, while the majority, 164 (54.7%), had more than 10 years of experience. This distribution indicates that most respondents were highly experienced, with nearly all having at least six years in the food service sector.

The predominance of respondents with long-term experience suggests that many operators and staff have accumulated practical knowledge of food preparation, waste handling, and sanitation practices. Previous studies confirm that work experience is strongly associated with improved awareness of hygiene and environmental health practices in food businesses (Mensah & Julien, 2011; Ibrahim & Musa, 2020). However, long experience may also reinforce habitual practices, making some workers resistant to adopting new waste management innovations (Abila & Kantola, 2019).

The low proportion of respondents with less than five years of experience (2.3%) reflects limited entry of younger or newly established operators into the sector. This has implications for waste management, as younger workers may be more open to adopting environmentally sustainable methods (Olukanni & Nwachukwu, 2018). Overall, the findings highlight the need for continuous training across all experience levels to improve waste handling and reduce pest infestation risks.

**Table 5: Years of experience in food handling**

Years of experience	Frequency	Percentage
<1 year		
1–5 years	7	2.3
6–10 years	129	43
>10 years	164	54.7
Total	300	

## Section B: Waste Handling Practices

**Waste Storage Practices in Eateries:** Table 6 shows how waste was stored in eateries before disposal. Out of 300 respondents, 124 (41.3%) reported using open bins or containers, 118 (39.3%) used covered bins or containers, 53 (17.7%) placed waste in plastic bags on the floor, and 5 (1.7%) employed other methods. The high use of open bins (41.3%) is concerning, as exposed waste can attract rodents, flies, and cockroaches, thereby increasing the risk of food contamination and vector-borne diseases. Studies have highlighted

that improper waste storage is a critical pathway for pest infestation in food establishments (Odonkor & Ampofo, 2013).

The use of covered bins (39.3%) reflects some level of adherence to hygienic practices, which is consistent with recommended standards for safe food environments (WHO, 2019). However, the practice of storing waste in plastic bags on the floor (17.7%) poses both sanitary and environmental hazards, as such storage methods promote leachate and ease of pest access (Al-Momani, 2017). Overall, these findings indicate that while a fair proportion of eateries adopt safe storage methods, a significant number still engage in risky practices that undermine public health. Continuous training and enforcement of waste management standards are therefore essential.

How is waste stored in your eatery before disposal?

**Table 6: Waste Storage**

Waste Storage	Frequency	Percentage
Open bin/container	124	41.3
Covered bin/container	118	39.3
Plastic bags on the floor	53	17.7
Others	5	1.7
Total	300	

Frequency of Waste Collection in Eateries: Table 7 presents the frequency of waste collection among eateries. Out of 300 respondents, only 6 (2.0%) reported that waste was collected once daily, while the majority, 189 (63.0%), indicated collection occurred two to three times per week. Alarmingly, 105 (35.0%) admitted that waste was rarely collected. The absence of multiple daily collections suggests inadequate waste management structures, especially in high-waste-generating environments such as eateries.

The predominance of collection two to three times per week (63.0%) reflects suboptimal practices, as improper storage of waste for extended periods can attract pests, generate foul odors, and increase environmental health risks (Amoah & Koranteng, 2020). The 35.0% of respondents who rarely collected waste highlights a significant gap in compliance with sanitary guidelines. According to the World Health Organization (2019), timely waste removal is a critical component of preventing cross-contamination and vector proliferation in food service environments.

These findings align with studies showing that irregular waste removal remains a persistent challenge in African cities due to poor infrastructure and limited municipal support (Abila & Kantola, 2019; Olukanni & Nwachukwu, 2018). Strengthening waste collection schedules and enforcing stricter monitoring mechanisms are essential for safeguarding public health in eateries.

How often is waste collected or removed from your eatery?

**Table 7: Frequency of Waste Collection**

Frequency of Waste Collection	Frequency	Percentage
Multiple times daily	-	-
Once daily	6	2
2-3 times/week	189	63
Rarely	105	35
Total		

Waste Disposal Responsibility in Eateries: Table 8 shows the distribution of responsibility for waste disposal in eateries. Out of 300 respondents, 137 (45.7%) indicated that disposal was handled solely by staff, 22 (7.3%) relied exclusively on external waste

collectors, 16 (5.3%) used a combination of both, while 125 (41.7%) reported "others," suggesting informal or irregular practices.

The finding that nearly half of respondents (45.7%) depended on staff for waste disposal highlights the internalization of waste management within eateries. While this approach may offer convenience, it raises concerns about improper handling when staff lack formal training in sanitation (Amoah & Koranteng, 2020). The reliance on external waste collectors (7.3%) is relatively low, reflecting weak integration between food establishments and municipal waste management systems. This aligns with studies showing that inadequate collaboration between eateries and local authorities often results in poor waste disposal outcomes (Olukanni & Nwachukwu, 2018).

The significant proportion of "others" (41.7%) may reflect informal dumping or reliance on community-based waste systems, practices known to exacerbate pest proliferation and environmental hazards (Abila & Kantola, 2019). Effective waste management in eateries requires strengthening formal partnerships with licensed collectors and providing training for staff to ensure hygienic disposal practices (World Health Organization, 2019).

Who is responsible for waste disposal in your eatery?

**Table 8: Waste Disposal Responsibility**

Waste Disposal Responsibility	Frequency	Percentage
Staff only	137	45.7
External waste collector	22	7.3
Both staff and external collector	16	5.3
Others	125	41.7
Total	300	

Waste Segregation Practices in Eateries: Table 9 shows that out of 300 respondents, only 109 (36.3%) reported segregating their waste into categories such as organic, plastics, and metals, while a majority of 191 (63.7%) did not practice segregation. This finding highlights the predominance of mixed waste disposal in eateries, a practice that poses significant environmental and public health challenges.

The low rate of segregation suggests limited awareness or infrastructural support for sustainable waste management in the food service sector. According to Ogbonna et al. (2018), poor segregation at source is one of the main obstacles to efficient waste recycling and recovery in Nigeria. Food waste, if not separated from plastics and other non-biodegradables, increases the risk of pest infestation and contamination within eateries (Amoah & Koranteng, 2020). Moreover, the lack of segregation undermines circular economy initiatives, such as composting or recycling, which depend on source separation (Abila & Kantola, 2019).

The findings are consistent with studies in other developing contexts, where limited enforcement of waste management policies and inadequate provision of separate bins contribute to poor segregation practices (Kaza et al., 2018). To address this gap, regulatory agencies must strengthen awareness campaigns, enforce compliance, and provide incentives for eateries to adopt segregation practices (World Health Organization, 2019).

Do you segregate waste before disposal (organic, plastics, metals)?

**Table 9: Waste segregation before disposal**

Waste segregation before disposal	Frequency	Percentage
Yes	109	36.3
No	191	63.7
Total	300	

Methods of Final Waste Disposal in Eateries: Table 10 reveals that the dominant method of final waste disposal among eateries was open dumping, reported by 150 respondents (50.0%). This was followed by private disposal services (26.0%), burning on-site (16.3%), municipal collection (4.0%), and other methods (3.7%). The predominance of open dumping highlights a significant environmental concern, as indiscriminate disposal of waste contributes to pest infestations, unpleasant odors, and the proliferation of vectors such as flies and rodents in urban areas (Owamah, 2018).

The reliance on open dumping also reflects inadequate waste infrastructure and weak enforcement of municipal waste management policies in many Nigerian cities (Oyelola & Babatunde, 2019). Burning on-site, although used by 16.3% of respondents, is equally problematic due to its contribution to air pollution and associated health risks (Amoo & Fagbenro, 2013). Conversely, the use of private waste disposal services (26.0%) suggests that some eateries are adopting more formal approaches, though accessibility and affordability may limit widespread uptake (Kaza et al., 2018).

The findings emphasize the urgent need for strengthened municipal waste management systems, public-private partnerships, and sensitization of food service operators to promote sustainable practices (Abila & Kantola, 2019).

What method do you use for final waste disposal?

**Table 10: Method of Final Waste Disposal**

Method of Final Waste Disposal	Frequency	Percentage
Municipal collection	12	4
Open dumping	150	50
Burning on-site	49	16.3
Private disposal service	78	26
Others	11	3.7
Total	300	

Waste Covering Against Pests: Table 11 shows that waste covering practices among eateries are inconsistent. Only 83 respondents (27.7%) reported always covering their waste storage, while 137 (45.7%) did so sometimes, 71 (23.7%) rarely, and 9 (3.0%) never. This indicates that a majority of operators (72.0%) fail to consistently secure waste storage, thereby increasing the risk of pest infestation. Poorly covered waste provides breeding grounds for flies, cockroaches, and rodents, which are well-documented vectors of foodborne diseases (Alemayehu et al., 2020).

The relatively low proportion of respondents who always covered their waste highlights gaps in adherence to basic sanitation protocols. Previous studies emphasize that covering or securing waste bins is one of the simplest and most effective pest prevention measures in food service environments (Mensah & Julien, 2011). Inconsistent practices, as reflected in the “sometimes” category, may be attributed to inadequate training, lack of facilities, or weak enforcement of food safety regulations (Ogbonna et al., 2018).

The findings stress the importance of continuous education of food handlers, provision of proper waste bins, and stricter monitoring by local authorities to reduce pest-related health risks (WHO, 2015).

Do you cover or secure your waste storage to prevent pests?

**Table 11: Waste Covering Against Pest**

Waste Covering Against Pest	Frequency	Percentage
Always	83	27.7
Sometimes	137	45.7
Rarely	71	23.7
Never	9	3
Total	300	

### Section C: Pest Occurrence and Management

Frequency of Insects Noticed in Eateries: Table 12 indicates that insect presence is a common challenge in eateries. A total of 132 respondents (44.0%) reported noticing insects often, while 89 (29.7%) observed them very often. Additionally, 72 (24.0%) noticed insects sometimes, and only 7 (2.3%) rarely did. Notably, none of the respondents reported that insects were never observed, underscoring the widespread nature of the problem.

The high frequency of insect presence suggests gaps in waste management and sanitation practices. Insects such as flies, cockroaches, and mosquitoes are significant vectors of foodborne pathogens, contributing to risks of diarrhea, typhoid, and cholera (Haque et al., 2021). Their frequent presence in food establishments compromises food hygiene standards and threatens public health. This aligns with previous findings that poor waste disposal, uncovered bins, and inadequate drainage create favorable conditions for pest breeding (Oyelola & Babatunde, 2008).

Furthermore, persistent insect infestation can negatively affect customer perceptions of food quality and reduce patronage (Addo-Tham et al., 2020). The findings highlight the urgent need for improved sanitation infrastructure, stricter monitoring, and pest control interventions to safeguard food safety in urban eateries.

How frequently do you notice insects (flies, cockroaches, mosquitoes) in your eatery?

**Table 12: Frequency of Insects Notice**

Frequency of Insects Notice	Frequency	Percentage
Very often	89	29.7
Often	132	44
Sometimes	72	24
Rarely	7	2.3
Never	-	-
Total	300	

Frequency of Rodents Noticed in Eateries: Table 13 shows a high prevalence of rodents in eateries, with 152 respondents (50.7%) reporting very frequent sightings and 139 (46.3%) noticing rodents often. Only 9 respondents (3.0%) reported observing them sometimes, while none indicated rarely or never. This overwhelming presence of rodents underscores a major public health and food safety concern within the eateries studied.

Rodents are well-documented carriers of pathogens responsible for foodborne illnesses such as leptospirosis, salmonellosis, and hantavirus infections (Meerburg et al., 2009). Their frequent presence in food establishments is often linked to poor sanitation, open waste storage, and structural deficiencies that provide access and shelter (Battersby, 2020). The findings suggest that many eateries may lack effective rodent control measures, which aligns with previous studies in developing urban centers where weak waste management systems exacerbate pest infestations (Oyelola & Babatunde, 2008).

Furthermore, rodent infestation not only compromises food safety but also reduces customer confidence and can lead to economic losses for food vendors (Harris et al., 2019). Addressing this challenge requires integrated pest management strategies, stricter enforcement of hygiene regulations, and improved waste handling practices to minimize breeding and infestation risks.

How frequently do you notice rodents (rats, mice) in your eatery?

**Table 13: Frequency of Rodents Notice**

Frequency of Rodents Notice	Frequency	Percentage
Very often	152	50.7
Often	139	46.3
Sometimes	9	3
Rarely	-	-

Never	-	
Total		

Areas Most Affected by Pests: Table 14 indicates that pests were most frequently observed in kitchens, with 137 respondents (45.7%) identifying it as the dominant area of infestation. The outside surroundings also accounted for a significant portion (29.7%), while 57 respondents (19.0%) noted the waste storage area. Only 5.7% reported other areas, and interestingly, none indicated the dining area.

The predominance of pest activity in kitchens is consistent with the fact that food preparation areas provide abundant food sources, warmth, and hiding spaces, making them highly attractive to pests such as rodents, cockroaches, and flies (Goulson et al., 2018). The presence of pests in waste storage areas highlights the role of poor waste management in supporting pest breeding and survival (Oyelola & Babatunde, 2008). Similarly, infestations in outside surroundings may reflect environmental sanitation challenges that allow pests to thrive near eateries (Battersby, 2020).

The absence of pests in the dining area may suggest that infestations are more concentrated in operational and waste-handling zones, yet this does not diminish risks to consumers, as pests can easily migrate from kitchens to dining spaces (Harris et al., 2019). Therefore, integrated pest management and improved hygiene in critical zones like kitchens and waste areas are crucial for safeguarding food safety.

Which areas are most affected by pests? (You may tick more than one)

**Table 14: Area Dominated by Pest**

Area Dominated by Pest	Frequency	Percentage
Kitchen	137	45.7
Dining area	-	-
Waste storage area	57	19
Outside surroundings	89	29.7
Others	17	5.7
Total	300	

Implementation of Pest Control Measures: Table 15 reveals that respondents adopt multiple strategies to address pest infestation in eateries. The most common measure reported was the regular clean-up of waste, cited by 116 respondents (38.7%), followed by the use of traps or rodenticides (29.0%) and regular spraying of insecticides (28.0%). Only 4.3% reported other measures, and notably, none of the respondents indicated the absence of pest control practices.

The predominance of waste clean-up as a control measure highlights respondents' awareness of the strong link between poor waste management and pest proliferation (Harris et al., 2019). By reducing food waste accumulation, eateries directly minimize pest breeding grounds (Battersby, 2020). The use of rodenticides and spraying indicates a reliance on chemical and mechanical approaches to suppress infestations, which aligns with conventional practices in food service environments (Goulson et al., 2018). However, over-reliance on chemicals may pose environmental and health risks, reinforcing the need for integrated pest management (IPM) that combines hygiene, physical barriers, and targeted chemical use (Nasirian, 2017).

The fact that no respondents reported "none" suggests that pest infestations are widespread enough to require consistent interventions. This underlines the importance of strengthening preventive strategies in eateries to ensure food safety and public health protection.

Do you implement any pest control measures?

**Table 15: Pest Control Measures**

Frequency of Insects Notice	Frequency	Percentage
Regular spraying	84	28
Traps/rodenticide	87	29
Clean-up of waste regularly	116	38.7
None	-	-
Others	13	4.3
Total	300	

Effectiveness of Pest Control Measures: Table 16 illustrates respondents' perceptions of the effectiveness of pest control measures in eateries. A combined 40% of respondents rated their measures as either very effective (14.0%) or effective (26.0%), while the majority (34.0%) described them as only somewhat effective. Interestingly, none of the respondents reported pest control as "not effective," but 26.0% indicated the category "not applicable," suggesting limited or irregular application of measures in some eateries.

The relatively modest perception of effectiveness underscores the persistence of pest infestations despite interventions. This finding is consistent with studies showing that partial or inconsistent implementation of pest control measures—such as irregular spraying, improper waste management, and inadequate structural maintenance—often leads to limited success (Nasirian, 2017; Battersby, 2020). The fact that most respondents identified pest control as only "somewhat effective" reflects the challenges of relying heavily on reactive methods, such as chemical treatments, without integrating preventive hygiene practices and structural modifications (Goulson et al., 2018).

These results highlight the need for Integrated Pest Management (IPM), which emphasizes sanitation, environmental modifications, and selective chemical use to achieve sustainable effectiveness (Harris et al., 2019). Strengthening IPM approaches would not only enhance efficacy but also minimize health and environmental risks in food service establishments.

How effective are the pest control measures in reducing pests?

**Table 16: Effectiveness of Pest Control Measures**

Effectiveness of Pest Control Measures	Frequency	Percentage
Very effective	42	14.0
Effective	78	26.0
Somewhat effective	102	34.0
Not effective	-	-
Not applicable	78	26.0
Total	300	

#### Section D: Knowledge and Attitude on Waste Handling and Pests

Improper Waste Handling and Spread of Diseases: Table 17 shows respondents' perceptions of the health risks associated with improper waste handling. A majority of participants either strongly agreed (35.3%) or agreed (63.0%) that poor waste management contributes to the spread of diseases, representing 98.3% consensus. Only a small minority disagreed (1.0%) or strongly disagreed (0.7%). This overwhelming agreement highlights a strong awareness among food handlers of the health consequences of inadequate waste disposal practices.

Improper waste management creates breeding grounds for vectors such as flies, cockroaches, and rodents, which are known carriers of pathogens responsible for gastrointestinal infections, cholera, and typhoid fever (Akter et al., 2019; WHO, 2022). Similar findings in urban settings reveal a direct link between waste mismanagement and increased incidence of vector-borne diseases

(Ogbonna et al., 2021). The strong perception observed in this study indicates that food handlers recognize the urgent need for proper waste segregation, timely collection, and hygienic storage to safeguard public health.

Therefore, interventions promoting safe waste handling and integrated sanitation strategies are essential in reducing disease burdens in food service environments (Mavropoulos & Newman, 2015).

Improper waste handling can lead to the spread of diseases.

**Table 17: Improper waste handling and spread of diseases**

Improper waste handling and spread of diseases	Frequency	Percentage
Strongly agree	106	35.3
Agree	189	63
Neutral	-	
Disagree	3	1
Strongly disagree	2	0.7
Total	300	

Insects and Rodents as Sources of Food Contamination: Table 18 reveals that a vast majority of respondents recognize insects and rodents as potential sources of food contamination. Specifically, 41.0% strongly agreed and 53.0% agreed, representing 94% overall agreement. Only a small fraction disagreed (3.7%) or strongly disagreed (2.3%). This finding reflects strong awareness among food service operators of the health hazards posed by pests in eateries.

Rodents and insects are well-documented carriers of pathogenic microorganisms that can contaminate food and utensils through direct contact, droppings, or secretions (Hassan et al., 2020). Flies and cockroaches, for instance, mechanically transmit bacteria such as *Escherichia coli* and *Salmonella*, while rodents are linked to leptospirosis and hantavirus infections (CDC, 2021). Previous studies confirm that poor sanitation and waste mismanagement in food establishments increase pest infestation and subsequent risks of foodborne diseases (Oliveira et al., 2020).

The high level of agreement observed suggests that respondents are aware of the importance of pest control in preventing food contamination. Therefore, integrating pest management with proper waste handling and hygiene practices is vital for safeguarding public health (FAO/WHO, 2019).

Insects and rodents can contaminate food and utensils.

**Table 18: Insects and rodents can contaminate food and utensils**

Insects and rodents can contaminate food and utensils	Frequency	Percentage
Strongly agree	123	41
Agree	159	53
Neutral	-	-
Disagree	11	3.7
Strongly disagree	7	2.3
Total	300	

Effect of Proper Waste Storage and Disposal on Pest Infestation: Table 19 highlights respondents' perceptions regarding the role of waste management in controlling pest infestation. A significant majority agreed (40.0% strongly agree; 46.0% agree), accounting for 86% of respondents, that proper waste storage and timely disposal are essential in reducing pest infestation. Conversely, 7.7% disagreed and 6.3% strongly disagreed, indicating that while some skepticism exists, the prevailing belief supports the effectiveness of good waste practices.

This finding is consistent with studies linking poor waste management to increased breeding grounds for pests such as flies, cockroaches, and rodents (Akpan & Okoro, 2021). Improperly

stored or accumulated waste provides food and shelter for pests, thereby elevating the risk of contamination and disease transmission (WHO, 2020). Conversely, proper storage using covered bins and frequent disposal significantly minimizes exposure and reduces pest populations (Alemayehu et al., 2022).

The high agreement rate underscores respondents' awareness that preventive waste management practices are not only cost-effective but also integral to food safety and public health in eateries. Integrating waste handling with pest control programs is therefore critical to sustainable sanitation.

Proper waste storage and regular disposal reduce pest infestation

**Table 19: Proper waste storage and regular disposal reduce pest infestation**

Proper waste storage and regular disposal reduce pest infestation	Frequency	Percentage
Strongly agree	120	40
Agree	138	46
Neutral	-	-
Disagree	23	7.7
Strongly disagree	19	6.3
Total	300	

Adherence to Hygiene and Sanitation Guidelines: Table 20 presents respondents' views on whether their eateries comply with recommended hygiene and sanitation guidelines. While 17.3% strongly agreed and 36.3% agreed, indicating a moderate level of compliance (53.6%), a larger proportion disagreed (41.0%) or strongly disagreed (5.3%). This suggests that nearly half of the respondents acknowledge non-compliance with established hygiene practices, raising public health concerns.

These findings align with previous studies that revealed gaps in the implementation of sanitation protocols in food establishments, particularly in low- and middle-income countries (Osei-Tutu et al., 2021). Non-compliance often results from limited enforcement, poor knowledge of food safety regulations, or the cost implications of sustaining best practices (Amoah et al., 2020). The relatively low percentage of respondents affirming full compliance highlights persistent challenges in ensuring that eateries adhere strictly to hygiene standards.

Given the risks of foodborne illnesses linked to lapses in sanitation (WHO, 2020), strengthening monitoring systems, continuous staff training, and strict enforcement of guidelines are vital. Improving compliance not only safeguards public health but also enhances consumer confidence in food service establishments.

My eatery follows all recommended hygiene and sanitation guidelines.

**Table 20: My eatery follows all recommended hygiene and sanitation guidelines.**

My eatery follows all recommended hygiene and sanitation guidelines.	Frequency	Percentage
Strongly agree	52	17.3
Agree	109	36.3
Neutral	-	-
Disagree	123	41
Strongly disagree	16	5.3
Total	300	

**Challenges in Managing Waste Properly:** Table 21 highlights the major challenges respondents face in managing waste effectively within eateries. A significant proportion (66.0%) identified limited awareness of proper waste handling practices as the most pressing challenge. This finding underscores the critical role of knowledge and education in ensuring effective waste management. Lack of adequate waste bins (14.0%), high costs of waste disposal services (7.3%), space constraints (7.0%), and irregular collection by service providers (5.7%) were also reported as barriers, although to a lesser extent.

These results align with findings from prior studies that emphasize knowledge gaps and inadequate infrastructure as persistent constraints to effective waste management in food service establishments (Odonkor & Mahami, 2020; Suleiman et al., 2022). Limited awareness not only leads to poor segregation and disposal but also increases the risk of pest infestation and related health hazards (UNEP, 2021). Similarly, cost-related barriers and infrastructural inadequacies exacerbate the challenge, especially in urban settings with limited space.

Addressing these challenges requires targeted training for food handlers, subsidized waste management services, and improved government oversight to ensure reliable waste collection systems that promote sustainable public health outcomes.

What challenges do you face in managing waste properly?

**Table 21: What challenges do you face in managing waste properly?**

What challenges do you face in managing waste properly?	Frequency	Percentage
Lack of adequate waste bins hinders proper waste management.	42	14
High cost of waste disposal services affects waste management.	22	7.3
Limited awareness of proper waste handling practices	198	66

Irregular collection of waste by service providers creates difficulties.	17	5.7
Space constraints make the proper segregation and storage of waste difficult	21	7
Total	300	

#### Hypothesis 1

**Ho:** Improper waste handling and proliferation of insects and rodents in urban eateries in Port Harcourt do not differ significantly based on improved waste management and pest reduction practices.

The findings from Table 22 indicate that measures aimed at improving waste management and reducing pest proliferation in urban eateries in Port Harcourt were largely accepted by respondents, thereby rejecting the null hypothesis (Ho) which stated that improper waste handling and proliferation of insects and rodents do not differ significantly based on improved waste management and pest reduction practices. The results show that installing designated waste disposal points ranked highest (mean = 3.3), followed by regular and timely waste collection (mean = 3.2), training staff on proper waste handling (mean = 3.2), and strict enforcement of hygiene regulations (mean = 3.2). These results highlight the importance of infrastructural and regulatory interventions in strengthening waste management systems (Adedokun et al., 2020).

Conversely, public awareness campaigns (mean = 1.8) and collaboration with private waste management companies (mean = 2.1) were rejected, suggesting that respondents perceive these measures as less practical or effective in addressing waste-related challenges. This may reflect poor public engagement strategies and the dominance of informal waste systems in Port Harcourt (Aja et al., 2021). Overall, the findings affirm that targeted interventions such as adequate waste infrastructure, consistent waste collection, and hygiene enforcement are critical in reducing pests and promoting healthier eatery environments (Ojo et al., 2022).

**Table 22: Measures to Improve Waste Management and Reduce Pests in Eateries**

1.	Improve Waste Management and Reduce Pests	SA	A	D	SD	Total	SWV	Mean	Remarks	Rank	x-x <sup>-</sup>	(x-x <sup>-</sup> ) <sup>2</sup>
		4	3	2	1							
1	Providing adequate and covered waste bins will improve waste management in eateries.	436	348	98	26	300	908	3	Accepted	6 <sup>th</sup>	0.14	0.02
2	Regular and timely waste collection services will reduce pest infestation in eateries	528	357	78	10	300	973	3.2	Accepted	2 <sup>nd</sup>	0.34	0.116
3	Training the eatery staff on proper waste handling practices will minimize waste-related problems	476	363	104	8	300	951	3.2	Accepted	4 <sup>th</sup>	0.34	0.116
4	Routine fumigation and pest control are necessary to reduce pests in eateries	428	387	114	7	300	936	3.1	Accepted	5 <sup>th</sup>	0.24	0.058

5	Segregating waste into categories (organic, plastic, paper, etc.) will enhance waste management efficiency.	356	393	94	33	300	876	2.9	Accepted	7 <sup>th</sup>	0.04	0.002
6	Strict enforcement of hygiene regulations by health authorities will improve waste management	492	354	104	7	300	957	3.2	Accepted	3 <sup>rd</sup>	0.34	0.116
7	Public awareness campaigns will encourage better waste management in eateries	28	171	214	129	300	542	1.8	Rejected	10 <sup>th</sup>	-1.1	1.124
8	Collaboration with private waste management companies can enhance waste disposal efficiency.	92	201	254	83	300	630	2.1	Rejected	9 <sup>th</sup>	-0.8	0.578
9	Installing designated waste disposal points near eateries will reduce improper waste dumping	520	426	30	13	300	989	3.3	Accepted	1 <sup>st</sup>	0.44	0.194
10	Providing incentives (e.g., reduced levies) for eateries that maintain proper waste management will encourage compliance	408	267	114	52	300	841	2.8	Accepted	8 <sup>th</sup>	-0.1	0.004
								28.6				2.324
								2.86				

## Conclusion

This study established that improper waste handling in urban eateries significantly contributes to the proliferation of insects and rodents, thereby increasing the risk of food contamination and disease transmission. The findings revealed that measures such as installing designated waste disposal points, ensuring timely waste collection, training eatery staff on proper waste handling, and enforcing hygiene regulations are effective strategies for improving waste management and reducing pest infestation. However, initiatives like public awareness campaigns and collaboration with private waste management companies were perceived as less effective, highlighting the need for stronger institutional and infrastructural interventions. Overall, effective waste management practices remain crucial in safeguarding public health and ensuring sustainable urban sanitation in Port Harcourt.

## Recommendations

- Strengthen Infrastructure: Government and municipal authorities should install designated waste disposal points and provide adequate, covered waste bins near eateries to discourage indiscriminate dumping.
- Enhance Waste Collection Services: Waste management agencies should implement regular and timely collection schedules to prevent waste accumulation, which serves as a breeding ground for pests.
- 

- Capacity Building: Eatery owners should prioritize continuous staff training on proper waste handling and sanitation practices.
- Regulatory Enforcement: Health authorities should intensify inspections and enforce hygiene regulations to ensure compliance among food establishments.
- Incentivize Compliance: Policymakers should consider providing incentives, such as reduced levies or recognition awards, to eateries that demonstrate effective waste management practices.
- Integrated Pest Control: Routine fumigation and pest control should be mandated as part of standard hygiene requirements in urban eateries.

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