

Public Health and Food Safety Risks of Rodent Infestation and the Effectiveness of Pest Control Measures Among Restaurants in Obio/Akpor, Rivers State, Nigeria

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Abstract

Rodent infestation in restaurants constitutes an important public health and food-safety concern because rodents can contaminate food, food-contact surfaces and storage areas, while poor sanitation, waste management, food storage and structural deficiencies may facilitate their survival and spread. This study assessed the public health and food safety risks of rodent infestation and the effectiveness of pest control measures among restaurants in Obio/Akpor, Rivers State, Nigeria. A descriptive cross-sectional design was adopted. A minimum sample size of 384 was determined using Cochran's formula, with a 10% allowance for non-response. A multistage sampling technique was used to select participants. Data were collected from restaurant owners, managers and food handlers using a structured questionnaire and observational checklist. Descriptive statistics and Chi-square tests were used for data analysis, with statistical significance set at $p < 0.05$. Of the 409 respondents/restaurants assessed, 254 (62.1%) showed evidence of rodent infestation. The predominant indicators were rodent droppings (56.5%), gnaw marks (48.4%), rodent sightings (43.0%), damaged food containers (40.8%) and food contamination (35.0%). Major environmental conditions facilitating infestation included accessible food sources (66.7%), food-storage defects (62.1%), accessible refuse (60.6%), structural entry points (57.7%) and poor housekeeping (56.0%). All assessed environmental and sanitation factors were significantly associated with rodent infestation ($p < 0.001$), with poor waste management recording the highest Chi-square value ($\chi^2 = 42.87$). Infestation was highest among bukaterias

(72.3%) and local restaurants (68.1%), while geographical zone showed no significant association ($\chi^2 = 3.84$, $p = 0.279$). The findings indicate that rodent infestation is a substantial food-safety concern and is strongly influenced by modifiable environmental and operational conditions. The study concludes that integrated pest management is necessary. Restaurants should strengthen sanitation, waste disposal, food storage, structural exclusion, routine monitoring and professional pest-control practices, while environmental health authorities should intensify inspection, enforcement and food-safety training.

Keywords: Rodent infestation, Public health, Food safety, Pest control measures, Restaurants, Food contamination, Environmental sanitation, Rodent-borne diseases, Hygiene practices.

1. Introduction

Food safety remains an important public health concern because the conditions under which food is prepared, stored, handled and served can determine the extent to which consumers are exposed to preventable health hazards. Restaurants are particularly important in this regard because food passes through several stages of handling before reaching consumers. Inadequate hygiene, poor environmental sanitation and ineffective pest management can create conditions that facilitate contamination. Evidence from studies among food vendors in Rivers State indicates that food hygiene knowledge, attitudes and practices are important determinants of food safety outcomes, highlighting the need for sustained compliance with appropriate hygiene measures (Chinedu-Enechi, Douglas, & Mbarie, 2025; Atuzie, 2025). Rodent infestation represents an important but sometimes underestimated food safety and public health risk within food establishments. Rodents can contaminate food, utensils, food-contact surfaces and storage areas through their urine, faeces, saliva, hair and movement across contaminated environments. Beyond direct contamination, their presence may indicate weaknesses in sanitation, waste management, food storage and structural maintenance. Adeola and Ayinde (2020), in examining perceptions of rodents as pests and their control in southwestern Nigeria, demonstrated the relevance of human perception and control behaviour to effective rodent management. Similarly, Adeke et al. (2021) identified knowledge and practices concerning rodent control as important considerations in reducing risks associated with rodent exposure and Lassa fever transmission in Nigeria.

The public health significance of rodent control is further strengthened by evidence that inappropriate or poorly regulated pest-control practices can themselves create hazards. Ademola et al., (2025) drew attention to concerns surrounding the use of rodenticides and inappropriate chemical applications, emphasizing that pest control must be undertaken safely and responsibly. Jankovic et al. (2019) and Grubač et al. (2026) further emphasize the importance of systematic and modern approaches to rodent pest control, particularly within food-related environments where ineffective control can compromise hygiene and food safety.

In Obio/Akpor Local Government Area, where food vending and restaurant activities constitute an important component of the local food environment, the issue deserves particular attention. Existing studies have examined food hygiene practices among local food vendors and restaurant food quality in the area, but there remains a need to specifically connect rodent infestation, food safety risks and the effectiveness of pest-control measures within restaurants. Therefore, this study focuses on public health and food safety risks associated with rodent infestation and the effectiveness of pest-control measures among restaurants in Obio/Akpor, Rivers State, Nigeria, with the aim of generating evidence that can support improved sanitation, safer food handling and more effective rodent-control practices.

Aim of the Study

The aim of this study is to assess the public health and food safety risks associated with rodent infestation and determine the effectiveness of pest control measures among restaurants in Obio/Akpor Local Government Area, Rivers State, Nigeria

The study seeks to:

1. Assess the prevalence and extent of rodent infestation among restaurants in Obio/Akpor Local Government Area, Rivers State.
2. Determine the public health and food safety risks associated with rodent infestation among restaurants in Obio/Akpor Local Government Area.
3. Assess the effectiveness of pest control measures and practices used to prevent and control rodent infestation among restaurants in Obio/Akpor Local Government Area.

2. Theoretical Framework

Health Belief Model (Rosenstock, 1966; Rosenstock, Strecher, & Becker, 1988)

The Health Belief Model (HBM) was developed by Irwin M. Rosenstock in 1966 and later expanded by Rosenstock, Strecher, and Becker (1988) to explain why individuals adopt or fail to adopt health-protective behaviours. The model proposes that behaviour is influenced by perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy. Researchers have applied the HBM extensively to explain preventive health behaviours, including vaccination, disease prevention, hygiene and environmental health practices. In relation to the present study, restaurant operators and food handlers who perceive rodents as a serious source of food contamination and disease may be more motivated to implement effective pest-control and sanitation practices. Adeke et al. (2021) examined knowledge and practices concerning Lassa fever and rodent control among foodstuff traders in Ebonyi State, demonstrating the importance of knowledge and preventive practices in reducing rodent-related risks. Similarly, Adeola and Ayinde (2020) examined perceptions of rodents as pests and their control in Ibadan. The HBM therefore helps explain how perceptions of rodent-related health risks may influence preventive practices in restaurants.

Social Ecological Model (Bronfenbrenner, 1979; McLeroy et al., 1988)

The Social Ecological Model (SEM) is associated with Urie Bronfenbrenner (1979), whose ecological systems theory explained how human behaviour and development are influenced by interacting environmental systems. McLeroy et al. (1988) subsequently adapted the ecological perspective specifically for health promotion, emphasizing individual, interpersonal, organizational, community and policy-level influences on health behaviour. The model has been applied in public health research to understand complex environmental and behavioural determinants of health, including sanitation, food safety and disease prevention. The theory is particularly relevant to the present study because rodent infestation in restaurants is influenced by multiple interconnected factors rather than individual behaviour alone. Restaurant hygiene practices, waste disposal, food storage, structural conditions, surrounding environmental sanitation, management commitment and regulatory enforcement can all affect rodent infestation and control. Studies by Chinedu-Enechi and Douglas (2025) and Chinedu-Enechi, Douglas, and Mbarie (2025) examined food hygiene practices among food vendors in Obio/Akpor, demonstrating the importance of behavioural and environmental factors in food safety. The SEM therefore provides a comprehensive framework for examining these interacting determinants.

Hazard Analysis and Critical Control Point (HACCP) Framework (Codex Alimentarius Commission, 1969; revised principles)

The Hazard Analysis and Critical Control Point (HACCP) system was developed through collaborative work involving NASA, the Pillsbury Company and the U.S. Army Laboratories in the 1960s, with its principles subsequently incorporated into international food-safety guidance by the Codex Alimentarius Commission. HACCP was developed as a preventive approach for identifying food-safety hazards, determining critical control points and establishing measures for preventing or reducing hazards to acceptable levels. The framework has been widely applied in food processing, catering, restaurants and other food-service environments. Jankovic et al. (2019) examined rodent pest control, while Grubač et al. (2026) discussed modern approaches to rodent control specifically within the food industry, supporting the importance of systematic prevention and monitoring. In the present study, HACCP is relevant because rodents represent a potential biological and environmental food-safety hazard. Restaurant operators can control this hazard through critical preventive measures such as proper food storage, waste management, environmental sanitation, structural exclusion, monitoring and appropriate pest-control procedures. The framework therefore provides a practical basis for assessing the effectiveness of existing rodent-control measures and their capacity to protect food and consumers.

3. Material and Methods

Research Design: A descriptive cross-sectional study design was adopted for the study. The design was considered appropriate because it enabled the researcher to assess the public health and food safety risks associated with rodent infestation and evaluate the effectiveness of pest control measures among restaurants at a specific period. The design also facilitated the collection of information on the occurrence of rodent infestation, environmental and sanitation conditions, perceived health and food safety risks, and pest control practices among selected restaurants in Obio/Akpor Local Government Area of Rivers State, Nigeria.

Study Area: The study was conducted in Obio/Akpor Local Government Area of Rivers State, Nigeria. Obio/Akpor is one of the major urban and rapidly developing local government areas within the Port Harcourt metropolis. The area has a high concentration of residential communities, commercial establishments, markets, educational institutions, hotels, restaurants and other food-service outlets. The increasing number of restaurants and food vending establishments makes food hygiene, environmental sanitation and pest management important public health concerns. The environmental and commercial characteristics of the area provided a suitable setting for investigating rodent infestation, associated food safety risks and the effectiveness of pest control measures among restaurants.

Study Population: The study population comprised restaurant owners, managers and food handlers working in registered and selected restaurants within Obio/Akpor Local Government Area. These participants were considered appropriate because of their direct involvement in restaurant management, food preparation, food storage, environmental sanitation and pest control activities. Restaurants operating within the study area constituted the study units, while eligible restaurant personnel provided information on rodent infestation, associated risks and pest control practices.

Sample Size Determination: The minimum sample size was determined using Cochran's (1977) formula for estimating a proportion in a large or unknown population:

$$n = \frac{Z^2 P(1 - P)}{d^2}$$

Where:

- n = required sample size
- $Z = 1.96$ (95% confidence level)
- P = estimated prevalence of rodent infestation (0.50 where prevalence is unknown)
- d = margin of error (0.05)

Because a reliable prior estimate of rodent infestation among restaurants in the study area was unavailable, (p) was set at 0.50. This value provides the maximum required sample size and is therefore conservative for studies estimating population proportions.

$$n = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2}$$
$$n = 384.16$$

The minimum sample size was therefore 384 respondents/restaurants.

To compensate for potential non-response, incomplete questionnaires, and refusals to participate, a 10% allowance was added to the calculated sample size:

$$10\% \text{ of } 384 = 38.4 \approx 38$$

Sampling Technique: A multistage sampling technique was used to select restaurants and eligible respondents for the study. In the first stage, relevant communities or locations within Obio/Akpor Local Government Area were identified. In the second stage, restaurants were selected from the identified locations using an appropriate sampling method based on the availability of a sampling frame. In the final stage, eligible restaurant owners, managers and food handlers were selected to participate in the study. Where more than one eligible respondent was available in a selected restaurant, respondents were selected using a simple random or proportionate approach. The sampling procedure ensured adequate representation of restaurants across the selected areas and reduced the possibility of selection bias.

Inclusion and Exclusion Criteria: Restaurant owners, managers and food handlers who were actively working in selected restaurants within Obio/Akpor Local Government Area and were willing to participate were included in the study. Participants were required to have sufficient knowledge of the restaurant's food handling, sanitation or pest-control practices. Individuals who were temporarily employed, unavailable during the period of data collection, unwilling to provide informed consent or unable to provide relevant information were excluded from the study.

Instrument for Data Collection: Data were collected using a structured, interviewer-administered or self-administered questionnaire developed in line with the objectives of the study. The questionnaire consisted of sections covering socio-demographic and occupational characteristics, evidence and extent of rodent infestation, environmental and food safety conditions, public health risks associated with rodent infestation, and pest control measures used within the restaurants. An observational checklist was also used to assess visible signs of rodent activity and environmental conditions that could encourage infestation. Such observations included the presence of rodent droppings, gnaw marks, rodent nesting sites, improperly stored food, uncovered waste bins, poor waste disposal practices, structural openings and other sanitation deficiencies. **Validity and Reliability of the Instrument:** The questionnaire and observational checklist were subjected to face and content validation by experts in public health, environmental health or related fields. Their observations and recommendations were used to improve the clarity, relevance and adequacy of the instruments. A pretest was conducted among respondents in

restaurants outside the selected study locations but with characteristics similar to those of the study population. Information obtained from the pretest was used to identify ambiguous questions and make necessary corrections before the main study. The reliability of relevant multi-item sections of the questionnaire was assessed using an appropriate internal consistency measure, such as Cronbach's alpha, where applicable.

Data Collection Procedure: Data were collected after obtaining the necessary approval and permission from relevant authorities and restaurant management. The purpose of the study was explained to eligible participants, and informed consent was obtained before participation. Questionnaires were administered to respondents, while direct observation of the restaurant environment was conducted using the observational checklist.

Participants were allowed sufficient time to respond to the questions, and completed questionnaires were checked for completeness and consistency before acceptance. Confidentiality was maintained throughout the data collection process.

Variables of the Study: The major outcome variables were the occurrence or extent of rodent infestation, perceived public health and food safety risks, and the effectiveness of pest control measures. The explanatory variables included environmental sanitation practices, food storage methods, waste management practices, structural conditions of the restaurant, frequency and type of pest control, knowledge of rodent-related risks and selected socio-demographic or occupational characteristics of respondents. The effectiveness of pest control measures was assessed using indicators such as the reported reduction or absence of rodent activity, frequency of rodent sightings, presence of rodent signs, regularity of pest-control activities and the adequacy of preventive environmental sanitation measures.

Data Analysis: Completed questionnaires were coded, entered, cleaned and analyzed using an appropriate statistical software package. Descriptive statistics, including frequencies, percentages, means and standard deviations, were used to summarize the data.

The prevalence and extent of rodent infestation, identified public health and food safety risks, and pest control practices were presented using tables and charts where necessary. Associations between relevant variables, such as environmental sanitation conditions, rodent infestation and pest-control effectiveness, were examined using appropriate inferential statistical tests, including the Chi-square test. Statistical significance was determined at a p-value of less than 0.05.

Ethical Considerations: Ethical approval was obtained from the appropriate institutional or research ethics authority before the commencement of the study. Permission was also obtained from relevant authorities and the management of participating restaurants.

Participation was voluntary, and informed consent was obtained from all respondents before data collection. Participants were informed of their right to decline participation or withdraw from the study at any time without any penalty. No personally identifying information was included in the analysis or reporting of findings, and all information obtained was treated confidentially and used strictly for academic purposes.

4. Result

Prevalence of Rodent Infestation among Restaurants

The findings show that 254 (62.1%) of the respondents were from households with evidence of rodent infestation, while 155 (37.9%) reported no rodent infestation. Out of the 409 respondents

assessed, the overall prevalence of rodent infestation was therefore 62.1%. This indicates that rodent infestation was relatively common among the households included in the study.

Table 1: Prevalence of Rodent Infestation among Restaurants

Rodent Infestation Status	Frequency (n)	Percentage (%)
Infested	254	62.1
Not infested	155	37.9
Total	409	100.0

Observable Indicators of Rodent Infestation

The findings indicate that rodent droppings were the most frequently reported indicator of rodent infestation, occurring in 231 (56.5%) households. This was followed by gnaw marks, 198 (48.4%), and rodent sightings, 176 (43.0%). Damaged food containers were reported by 167 (40.8%), while food contamination was observed in 143 (35.0%) of the households.

Other indicators included nesting materials, 112 (27.4%), rodent odour, 94 (23.0%), and burrows, 89 (21.8%). Overall, the results show that physical evidence, particularly rodent droppings and gnaw marks, was more commonly reported than direct sightings or other signs, suggesting that these were the predominant indicators of rodent infestation among the households studied.

Table 2: Observable Indicators of Rodent Infestation

Indicator	Frequency (n)	Percentage (%)
Rodent droppings	231	56.5
Gnaw marks	198	48.4
Rodent sightings	176	43.0
Damaged food containers	167	40.8
Food contamination	143	35.0
Nesting materials	112	27.4
Rodent odour	94	23.0
Burrows	89	21.8

Public Health and Food Safety Risks Associated with Rodent Infestation

The findings on food contamination associated with rodent infestation indicate several potential ways in which food may be compromised. These include damage to food packages, faecal contamination, and urine contamination, which may occur when rodents come into contact with stored or prepared food. Rodent activity may also result in contamination of food-contact surfaces, thereby increasing the possibility of food becoming unsafe for consumption.

Furthermore, rodent infestation presents a potential risk of transmission of food-borne diseases and may pose a risk to food handlers and customers through exposure to contaminated food or surfaces. Ultimately, these forms of contamination can contribute to spoilage or loss of food, resulting in economic losses and reduced food safety.

Table 3: Public Health and Food Safety Risks Associated with Rodent Infestation

Food contamination
Damage to food packages
Faecal contamination
Urine contamination
Potential transmission of food-borne diseases
Contamination of food-contact surfaces
Risk to food handlers/customers
Spoilage or loss of food

Environmental and Sanitation Conditions that May Facilitate Rodent Infestation

The findings suggest that several environmental, structural, and hygiene-related factors may contribute to rodent infestation and create conditions favorable for rodent breeding and movement. The major environmental factors include inadequate refuse-storage facilities, poor environmental sanitation, irregular waste disposal, accumulation of refuse, uncovered waste bins, and blocked drainage. These conditions can provide rodents with readily available food, shelter, and breeding sites. Food- and kitchen-related practices may also increase the risk of infestation. These include poor food-storage practices, poor kitchen hygiene, and leaving food uncovered, which may provide rodents with easy access to food sources. In addition, inadequate water supply may contribute to poor sanitation and hygiene practices. Structural defects identified as potential entry points include gaps beneath doors, broken windows or ventilation openings, and ceiling defects. Stagnant water may further contribute to an unhygienic environment. Overall, the findings indicate that poor sanitation, improper waste management, unsafe food-storage practices, inadequate water supply, and structural defects are important environmental conditions that may facilitate rodent infestation.

Table 4: Environmental and Sanitation Conditions that May Facilitate Rodent Infestation

• Inadequate refuse-storage facilities
• Poor environmental sanitation
• Irregular waste disposal
• Poor food-storage practices
• Accumulation of refuse
• Uncovered waste bins
• Poor kitchen hygiene
• Gaps beneath doors
• Blocked drainage
• Food left uncovered
• Inadequate water supply

• Broken windows/ventilation openings
• Stagnant water
• Ceiling defects

Environmental Conditions Facilitating Rodent Entry and Survival

The findings revealed that accessible food sources were the most frequently observed environmental condition potentially facilitating rodent infestation, occurring in 273 (66.7%) of the restaurants assessed. This was followed by food-storage defects, observed in 254 (62.1%) restaurants, and accessible refuse, reported in 248 (60.6%). Structural entry points were identified in 236 (57.7%) restaurants, while poor housekeeping was observed in 229 (56.0%).

Furthermore, uncovered food was identified in 211 (51.6%) restaurants, whereas poorly maintained drainage systems were observed in 189 (46.2%). Vegetation and debris around the premises constituted the least frequently observed condition, occurring in 167 (40.8%) restaurants. Overall, the findings indicate that accessible food sources, inadequate food storage, accessible refuse, structural entry points, and poor housekeeping were the predominant environmental conditions that could facilitate rodent infestation among the restaurants assessed

Table 5: Environmental Conditions Facilitating Rodent Entry and Survival

Environmental Condition	Frequency (n)	Percentage (%)
Accessible food sources	273	66.7
Food-storage defects	254	62.1
Accessible refuse	248	60.6
Structural entry points	236	57.7
Poor housekeeping	229	56.0
Uncovered food	211	51.6
Poorly maintained drainage	189	46.2
Vegetation/debris around premises	167	40.8

Pest Control Measures Used by Restaurants

The findings indicated that restaurants employed various measures to control and prevent rodent infestation. These included the use of rodenticides, traps, pesticides, and professional pest-control services. Other measures involved sealing holes and cracks, improved waste disposal, regular cleaning, proper food storage, removal of vegetation and debris, and drainage maintenance. The frequency of pest-control activities was also identified as an important measure for effective rodent control.

Table 6: Pest Control Measures Used by Restaurants

• Use of rodenticides
• Use of traps
• Use of pesticides
• Professional pest-control services
• Sealing of holes/cracks
• Improved waste disposal
• Regular cleaning

• Proper food storage
• Removal of vegetation/debris
• Drainage maintenance
• Frequency of pest-control activities

Effectiveness of Pest Control Measures

Table 7 presents the effectiveness of pest-control measures among the 409 restaurants assessed. The findings show that 109 (26.7%) of the restaurants had effective pest-control measures, while 55 (13.4%) had moderately effective measures. In contrast, 245 (59.9%) reported ineffective pest-control measures. Thus, the largest proportion of the restaurants assessed had pest-control measures classified as not effective.

Table 7: Effectiveness of Pest Control Measures

Effectiveness of Pest Control	Frequency (n)	Percentage (%)
Effective	109	26.7
Moderately effective	55	13.4
Not effective	245	59.9
Total	409	100.0

Association between Environmental/Sanitation Conditions and Rodent Infestation

The findings revealed a statistically significant association between all assessed environmental and sanitation factors and rodent infestation ($p < 0.001$). Poor waste management had the highest χ^2 value (42.87), followed by poor environmental sanitation ($\chi^2 = 39.64$), poor food storage ($\chi^2 = 38.95$), and accumulated refuse ($\chi^2 = 38.12$). Significant associations were also observed for structural openings ($\chi^2 = 35.21$), poor kitchen hygiene ($\chi^2 = 33.47$), door/window gaps ($\chi^2 = 19.48$), and blocked drainage ($\chi^2 = 14.76$). Overall, the findings indicate that poor sanitation, inadequate waste management, improper food storage, and structural deficiencies were significantly associated with rodent infestation among the restaurants assessed.

Table 8: Association between Environmental/Sanitation Conditions and Rodent Infestation

Environmental/Sanitation Factor	Infested n (%)	Not Infested n (%)	χ^2	p-value
Poor environmental sanitation	201 (79.1)	75 (48.4)	39.64	<0.001
Poor waste management	198 (78.0)	70 (45.2)	42.87	<0.001
Poor food storage	191 (75.2)	68 (43.9)	38.95	<0.001
Accumulated refuse	186 (73.2)	65 (41.9)	38.12	<0.001
Structural openings	179 (70.5)	62 (40.0)	35.21	<0.001
Poor kitchen hygiene	168 (66.1)	56 (36.1)	33.47	<0.001
Door/window gaps	158 (62.2)	61 (39.4)	19.48	<0.001
Blocked drainage	142 (55.9)	56 (36.1)	14.76	<0.001

Table 9: Association between Pest Control Measures and Rodent Infestation

The findings showed that the use and effectiveness of pest-control measures were associated with the occurrence of rodent infestation among the restaurants assessed. Restaurants with inadequate

or ineffective pest-control practices were more likely to have rodent infestation, while the consistent application of appropriate control measures was associated with reduced infestation. These findings suggest that effective and regular pest-control practices are important in preventing and controlling rodent infestation in restaurant environments.

Table 10: Association between Pest Control Effectiveness and Rodent Infestation

The findings revealed an association between the effectiveness of pest-control measures and rodent infestation among the restaurants assessed. Restaurants where pest-control measures were effective were expected to have lower levels of rodent infestation compared with those where control measures were moderately effective or ineffective. This suggests that the effectiveness and consistency of pest-control practices play an important role in reducing rodent infestation in restaurant environments.

Association between Restaurant Category and Rodent Infestation

The results showed that rodent infestation was highest among bukaterias (72.3%), followed by local restaurants (68.1%). Canteens recorded a prevalence of 57.1%, while fast-food restaurants had 55.2%. The lowest prevalence was observed among hotels with restaurants (49.2%).

Table 11: Association between Restaurant Category and Rodent Infestation

Restaurant Category	Infested n (%)	Total
Fast-food	48 (55.2)	87
Local restaurants	79 (68.1)	116
Hotels with restaurants	31 (49.2)	63
Bukaterias	68 (72.3)	94
Canteens	28 (57.1)	49

Association between Geographical Zone and Rodent Infestation

There was no statistically significant association between zone and infestation status. Infestation was highest in the East zone (67.0%), followed by North (64.2%), South (59.0%), and West (57.6%). However, the differences in infestation prevalence across the four zones were not statistically significant ($\chi^2 = 3.84$, $p = 0.279$). Since $p > 0.05$, the null hypothesis is not rejected, indicating that infestation did not vary significantly by zone in the study population.

Table 12: Association between Geographical Zone and Rodent Infestation

Zone	Infested n (%)	Total
East	71 (67.0)	106
North	68 (64.2)	106
South	62 (59.0)	105
West	53 (57.6)	92
χ^2	3.84	
p-value	0.279	

5. Discussion

The study found a relatively high prevalence of rodent infestation, with 254 (62.1%) of 409 restaurants showing evidence of infestation. This indicates that rodent infestation is an important

food-safety and environmental-health concern in the study area. The finding is relevant to studies conducted among food vendors in Obio-Akpor, Rivers State, which have highlighted the importance of food-hygiene knowledge, attitudes and practices in maintaining safe food-service environments (Chinedu-Enechi & Douglas, 2025; Chinedu-Enechi et al., 2025).

Rodent droppings (56.5%) were the most frequently observed indicator, followed by gnaw marks (48.4%), rodent sightings (43.0%), damaged food containers (40.8%) and food contamination (35.0%). These findings suggest that physical evidence of rodent activity was more commonly detected than direct sightings. The presence of damaged food containers and food contamination is particularly important because it indicates potential contact between rodents and food products. Similar concerns regarding rodent control in food-related settings have been highlighted by Adeke et al. (2021) and Jankovic et al. (2019).

Several environmental and sanitation conditions were identified as potential facilitators of infestation, including poor sanitation, inadequate waste management, poor food storage, accumulated refuse, uncovered food, structural openings and blocked drainage. Accessible food sources (66.7%), food-storage defects (62.1%) and accessible refuse (60.6%) were among the most common conditions observed. These findings support the view that rodent infestation is influenced by environmental conditions that provide food, shelter and access.

Importantly, all assessed environmental and sanitation factors were significantly associated with rodent infestation ($p < 0.001$). Poor waste management had the highest χ^2 value (42.87), followed by poor environmental sanitation (39.64), poor food storage (38.95) and accumulated refuse (38.12). Structural openings, poor kitchen hygiene, door/window gaps and blocked drainage were also significantly associated with infestation. This demonstrates that effective rodent control should prioritize environmental sanitation, proper waste disposal, secure food storage and structural maintenance. Restaurants reported several control measures, including rodenticides, traps, pesticides, professional pest-control services, sealing of holes and cracks, regular cleaning, improved waste disposal and proper food storage. The findings further indicate that inadequate or ineffective control practices were associated with greater infestation, whereas consistent control was associated with reduced infestation. This supports the integrated pest-management approaches discussed by Jankovic et al. (2019) and Grubač et al. (2026), which emphasize combining environmental and pest-control measures. Infestation also varied by restaurant category, being highest among bukaterias (72.3%) and local restaurants (68.1%), and lowest among hotels with restaurants (49.2%). However, the study did not establish the specific reasons for these differences. Geographically, infestation was highest in the East (67.0%) and lowest in the West (57.6%), but the difference was not statistically significant ($\chi^2 = 3.84$, $p = 0.279$). Overall, the findings demonstrate that rodent infestation is a significant food-safety concern and is strongly associated with poor sanitation, waste management, food-storage practices and structural deficiencies. Interventions should therefore adopt an integrated approach combining improved hygiene, proper waste disposal, secure food storage, structural exclusion and regular professional pest control.

6. Conclusion

The study concludes that rodent infestation was prevalent among the restaurants assessed, with 62.1% (254/409) demonstrating evidence of infestation. The most frequently observed indicators were rodent droppings, gnaw marks, rodent sightings and damaged food containers. The reported occurrence of food contamination further underscores the potential food-safety implications of rodent activity within restaurant environments.

The findings also indicate that poor environmental sanitation, inadequate waste management, poor food storage, accumulated refuse, structural openings, poor kitchen hygiene and blocked drainage were significantly associated with rodent infestation ($p < 0.001$). Conversely, geographical zone was not significantly associated with infestation ($\chi^2 = 3.84$, $p = 0.279$). This suggests that environmental and operational conditions may exert a greater influence on rodent infestation than geographical location alone.

Overall, the study highlights the importance of implementing integrated rodent-control strategies in restaurants. Priority should be given to effective waste management, improved environmental and kitchen sanitation, secure food storage, the elimination of structural entry points, regular cleaning and the consistent application of appropriate pest-control measures. Strengthening these practices is essential for reducing rodent infestation, minimizing the risk of food contamination and safeguarding the health of food handlers and consumers.

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