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FOOD SAFETY KNOWLEDGE AMONG FOOD HANDLERS IN CALABAR CROSSRIVER STATE NIGERIA

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ABSTRACT

Background: Food safety remains a major public health concern in developing countries, where foodborne illnesses are common due to poor infrastructure, limited regulation, and inadequate training of food handlers.

Objective: This study aimed assess the knowledge and hygiene practices of food handlers in Calabar, Nigeria, to identify gaps that may contribute to the spread of foodborne diseases.

Methods: Data were collected using a structured questionnaire and analyzed with the Statistical Package for the Social Sciences (SPSS) employing descriptive and inferential statistics, including chi-square tests, regression, and correlation analysis. A descriptive cross-sectional survey was conducted among 385 food handlers selected from restaurants, hotels, eateries, and street vendors across urban and peri-urban areas of the city.

Results: The results revealed that 20.8% of respondents demonstrated poor knowledge of food safety, 44.2% had fair knowledge, while only 35.0% exhibited good knowledge. In terms of

hygiene practices, 18.2% of respondents had poor practices, 36.4% fair, and 45.4% good. High compliance (71.4%) was observed in areas such as checking expiry dates, separation of raw and cooked foods (68.8%), and equipment cleaning (66.8%). However, significant gaps were identified in technical areas, including proper temperature control, frequent handwashing after handling money, cleaning of storage areas, and consistent use of separate cutting boards.

Conclusion: These findings demonstrate that although many food handlers in Calabar possess moderate awareness of food safety, critical lapses persist in areas most strongly associated with bacterial contamination and foodborne disease transmission. The study concludes that there is an urgent need for continuous, structured training programs for food handlers, strict enforcement of food hygiene regulations, and regular monitoring of food establishments. Strengthening these measures will not only improve the knowledge and practices of food handlers but also help reduce foodborne diseases and promote public health in Calabar.

Keywords: Food safety, Food handlers, Hygiene practices, Knowledge, Foodborne diseases, Calabar, Public health

INTRODUCTION

Food safety is a fundamental component of public health and refers to the conditions and practices required to ensure that food is safe for consumption throughout the food chain. Unsafe food can contain biological, chemical, or physical hazards and may cause a wide range of illnesses, from acute gastrointestinal infections to more severe and potentially fatal conditions. Food safety is therefore not only a health concern but also an important component of food-system sustainability, consumer protection, and economic development (WHO, 2025). The World Health Organization (WHO) continues to identify food safety as a shared responsibility involving governments, food businesses, food handlers, and consumers, with safe handling practices representing an important point of prevention.

Foodborne diseases remain a substantial global public health burden. WHO estimates that contaminated food causes approximately 600 million illnesses and 420,000 deaths annually, with children under five years of age bearing a disproportionately high share of the burden (WHO, 2019). Although foodborne diseases occur worldwide, their prevention is particularly challenging in low- and middle-income countries because of inadequate sanitation infrastructure, limited access to safe water, weaknesses in food-safety surveillance and enforcement, and the substantial contribution of informal food businesses. In these settings, food prepared outside the home may represent an important source of exposure to foodborne hazards. Consequently, improving food safety at the point of preparation and service remains an important public health strategy.

Food handlers occupy a critical position in the food-safety chain because their activities directly influence the likelihood of food contamination during preparation, cooking, storage, transportation, and service. Their knowledge and routine practices can determine whether food-safety principles are effectively translated into behaviour. The WHO Five Keys to Safer Food—keeping clean, separating raw and cooked foods, cooking thoroughly, keeping food at safe temperatures, and using safe water and raw materials—provide a practical framework for

preventing contamination during food handling (WHO, 2025). Inadequate hand hygiene, inappropriate temperature control, insufficient cooking, poor cleaning of food-contact surfaces, and cross-contamination between raw and ready-to-eat foods can create opportunities for pathogens to enter or multiply in food. Thus, food handlers require adequate knowledge of foodborne hazards and the practical skills necessary to apply preventive measures consistently.

Food safety knowledge is particularly important because awareness of hazards and their routes of transmission provides the basis for appropriate preventive behaviour. However, knowledge alone does not necessarily guarantee safe practice, as food-handling behaviour may also be affected by training, workplace conditions, availability of water and sanitation facilities, workload, supervision, regulatory enforcement, and individual attitudes. Evidence from sub-Saharan Africa demonstrates the continuing challenge of translating food-safety knowledge into consistent hygienic practice. A 2025 systematic review and meta-analysis involving 42 studies and 12,367 food handlers estimated that only 50.68% of food handlers had good food hygiene practices. The review also identified food-safety training, attitudes toward hygiene, and regular medical check-ups as important factors associated with food hygiene practices (Atalay et al., 2025).

Recent Nigerian studies further demonstrate the continuing relevance of food-handler knowledge and hygiene to food safety. Fayemi et al. (2026), in a study of meat handlers in Ogun State, examined food-safety knowledge and hygiene practices in relation to abattoir sanitation and regulatory awareness. Similarly, Falade et al. (2026) assessed food hygiene knowledge and practices among 220 food handlers in Ondo West Local Government Area and examined factors associated with knowledge, practices, and training status. These recent Nigerian investigations indicate that food safety remains an important area for continued assessment, particularly because food handlers operate across diverse workplace environments with different levels of infrastructure, training, supervision, and regulatory oversight.

The characteristics of food establishments may also influence food-safety conditions. Restaurants, hotels, street-vending operations, and local eateries differ in their organizational structures, resources, food volumes, equipment, access to water and sanitation, and degree of regulatory oversight. Recent evidence from food-service establishments in Ibadan, Nigeria, illustrates this complexity. A 2026 study of boarding-school food-service establishments reported relatively good food-safety knowledge among handlers but identified important deficiencies in temperature control, food storage, handwashing, and environmental hygiene. The study also found differences in hygiene compliance between private and public establishments (Adebayo et al., 2026). These findings emphasize that food-safety knowledge should be examined within the context in which food handlers work rather than considered independently of workplace conditions.

Food-safety training is another important component of foodborne disease prevention. Training can provide food handlers with knowledge of foodborne hazards and reinforce appropriate practices such as hand hygiene, prevention of cross-contamination, safe cooking, appropriate storage, and temperature control. However, the availability and frequency of training may vary substantially between food establishments, particularly within informal or smaller-scale food businesses. The evidence from sub-Saharan Africa indicates that inadequate food-safety training is associated with poorer hygiene practices, reinforcing the importance of continuous capacity

building alongside appropriate workplace facilities and regulatory supervision (Atalay et al., 2025).

In Calabar, food is prepared and sold through a range of formal and informal establishments, including restaurants, hotels, local eateries, and street-vending businesses. These establishments serve substantial numbers of consumers and therefore represent important points at which food contamination can either be prevented or introduced. Despite the public health importance of food handlers, locally generated evidence on their food-safety knowledge across different types of food establishments remains necessary. Understanding existing knowledge levels and identifying areas of deficiency can provide evidence for targeted food-safety education, regulatory interventions, and continuing training programmes.

Therefore, this study assessed food safety knowledge among food handlers in Calabar, Cross River State, Nigeria**.** The study specifically examined food handlers' knowledge of important food-safety concepts, including foodborne pathogens, cross-contamination, hand hygiene, cooking temperatures, safe storage, thawing, and temperature control. The findings are intended to provide evidence for strengthening food-safety education and preventive measures among food handlers and supporting efforts to reduce foodborne health risks in Calabar.

METHODS

Study Design

A descriptive cross-sectional study design was employed to assess food safety knowledge and hygiene practices among food handlers in Calabar, Cross River State, Nigeria. The cross-sectional design enabled data on participants' sociodemographic characteristics, food safety knowledge, hygiene practices, food safety training, and awareness of food safety standards to be collected at a single point in time. The design was appropriate for describing the prevailing level of food safety knowledge and practices and for examining associations between selected characteristics of food handlers and their food safety practices.

Study Population

The population of study consists all food handlers working in various food establishments within Calabar, specifically those employed in eateries, hotels, restaurants, and food vending locations.

Sampling and Sampling Technique

Sample Size Determination

The minimum sample size was determined using Cochran's formula for estimating a population proportion in a cross-sectional study:

$$n_0 = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$$

where:

Where:

- n_0 = required sample size
- Z = Z-value (the Z-score corresponding to the desired confidence level, e.g., 1.96 for 95% confidence)
- p = estimated proportion of the population (if unknown, p is taken as 0.5 to ensure maximum sample size)
- e = margin of error (e.g., 0.05 for 5%)

For a confidence level of 95% ($Z = 1.96$) and a margin of error of 5% ($e = 0.05$), assuming $p = 0.5$ for maximum variability, the sample size calculation would be as follows:

$$n_0 = \frac{1.96^2 \cdot 0.5 \cdot (1 - 0.5)}{0.05^2}$$

$$n_0 = \frac{3.8416 \cdot 0.25}{0.0025} = 384.16$$

The calculated sample size was therefore rounded up to 385 food handlers, who constituted the final sample for the study.

A stratified sampling procedure was used to recruit participants from different categories of food establishments in Calabar. Food establishments were classified according to their type, including restaurants, hotels, street-food vending locations, local eateries, and other eligible food-service establishments. Within the identified establishments, eligible food handlers were approached and recruited according to the predetermined sampling procedure. The sampling process was designed to ensure representation of food handlers working across different food-service settings and to permit comparison of food safety knowledge and hygiene practices between establishment types. Participants who met the eligibility criteria and provided informed consent were enrolled until the required sample size of 385 respondents was achieved.

Ethical declarations

Informed Consent/ Ethical Approval

Ethical approval for this study was obtained from the Research Ethics Committee, University of Calabar Teaching Hospital. This study was conducted in accordance with the guidelines and regulations set forth by the University of Calabar Teaching Hospital Research Ethics Committee and in accordance with the principles of the Declaration of Helsinki. All participants were fully informed about the purpose of the study, the nature of their involvement, and how their data would be used. Written informed consent was obtained from each participant before completing the questionnaire. Participation was voluntary, and participants were informed of their right to withdraw at any time without consequences.

Inclusion Criteria

- Food handlers working in both formal establishments (e.g., restaurants, hotels) and informal settings (e.g., street food vendors).
- Food handlers who have been employed in their respective roles for at least 6 months to ensure they have sufficient exposure to food safety practices and handling procedures.
- Food handlers who are willing to participate in the survey and provide informed consent.

Exclusion Criteria

- Food handlers who are temporary workers or have been employed for less than 6 months may not have acquired adequate experience or knowledge related to food handling.
- Food handlers who are not actively involved in food preparation or service, such as administrative staff or maintenance workers.

Data Collection

Validity of the Instrument

The questionnaire was subjected to content and face validation before its use for the main study. Content validity was established through review by professionals with relevant expertise in food safety, nutrition, public health, and research methodology. The reviewers assessed the questionnaire for relevance, clarity, appropriateness, comprehensiveness, and consistency with the study objectives. The questionnaire was subsequently pretested among food handlers who were not included in the final study sample. The pretest was used to identify ambiguous, repetitive, or poorly understood questions and to assess the suitability of the response options. Necessary modifications were made before the final questionnaire was administered. The content of the knowledge and hygiene-practice sections was also reviewed against established food safety principles, particularly the WHO Five Keys to Safer Food (WHO, 2025).

Data were collected using a well structured questionnaire developed from relevant food-safety principles and previous food-handler assessment instruments. The questionnaire was designed around the major domains of food safety knowledge and hygiene practices reflected in the WHO Five Keys to Safer Food. The questionnaire consisted of four sections.

Sociodemographic and Occupational Characteristics: This section obtained information on participants' age, sex, educational level, marital status, type of food establishment, occupational role, duration of food-handling experience, location of operation, size of establishment, and duration of employment in the current establishment.

Food Safety Knowledge: This section assessed participants' knowledge of fundamental food safety concepts. Items covered knowledge of foodborne pathogens, recommended cooking temperatures, safe storage of perishable foods, cross-contamination, hand hygiene, food temperature danger zones, thorough cooking, food spoilage indicators, safe thawing, and separation of raw and cooked foods. Knowledge items were scored according to the correctness of each response. Correct responses were assigned one point, whereas incorrect or inappropriate responses were assigned zero points. The resulting scores were summed to obtain an overall food safety knowledge score ranging from 0 to 10. Knowledge scores were categorized as:

- Poor knowledge: 0–4 points;
- Fair knowledge: 5–7 points; and
- Good knowledge: 8–10 points.

(Getyeza et al., 2026)

Food Hygiene Practices: This section assessed reported hygiene practices during food preparation, handling, storage, and service. Items included handwashing after different food-handling activities, use of gloves when handling raw meat, handwashing after handling money, cleaning of food-contact surfaces, cleaning of storage areas, separation of raw and cooked foods, appropriate use of utensils, use of separate cutting boards, checking food expiry dates, and cleaning of food-handling equipment. Responses were scored according to the reported frequency or adherence to the specified hygiene practice. Individual scores were summed to obtain an overall hygiene-practice score, which was subsequently categorized into poor, fair, and good practice according to the predetermined scoring criteria.

Food Safety Training, Standards, and Confidence: This section assessed participants' exposure to formal food safety training, frequency of training, awareness of relevant Nigerian food safety standards, confidence in applying food safety practices, and attitudes toward mandatory food safety training. The questionnaire content was informed by internationally recognized food safety principles, including the WHO Five Keys to Safer Food, which emphasize personal cleanliness, prevention of cross-contamination, adequate cooking, temperature control, and safe water and raw materials.

Data analysis

Before analysis, completed questionnaires were screened for completeness and consistency. Data were checked for missing values, coding errors, duplicate entries, and implausible values. Where discrepancies were identified, the original questionnaire was consulted where possible to verify the recorded response. Data were coded, entered, cleaned, and analyzed using IBM Statistical Package for the Social Sciences (SPSS), version 24.0. Descriptive statistics were used to summarize participants' characteristics and responses to individual questionnaire items. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means and standard deviations where appropriate. Food safety knowledge

and hygiene-practice scores were summarized using appropriate descriptive statistics and categorized according to the predetermined scoring criteria.

Statistical analysis

Inferential Analysis

The chi-square test of independence was used to examine associations between categorical variables. In particular, the association between receipt of formal food safety training and categorized hygiene-practice scores was assessed. The association between type of food establishment and categorized hygiene-practice scores was also examined. One-way analysis of variance (ANOVA) was used to compare mean food safety knowledge scores across different types of food establishments. Where ANOVA indicated a statistically significant difference, appropriate post-hoc comparisons would be considered where required. The level of statistical significance was set at $p < 0.05$.

RESULTS

Table 1 shows the socio-demographic data of respondents. 33.8% of respondents were aged between 21–30 years while 26.0% were aged between 31–40 years, suggesting that most food handlers in Calabar are young adults in their productive years. A slightly higher proportion (52.0%) of respondents were male and 44.2% were female, indicating a nearly balanced gender distribution. Educational attainment varied, with the 39.0% having at least secondary education, 31.2% tertiary education**,** while only 6.5% reported no formal education. This reflects a relatively literate sample, which may positively influence their capacity to acquire food safety knowledge. In terms of marital status, 46.8% were married and 36.4% single, showing that the respondents were mainly adults with family responsibilities. The types of establishments where they worked were diverse with 28.6% working in restaurants**,** 26.0% street vendors**,** 23.4% hotels, and 18.2% local eateries**,** reflecting both formal and informal food service outlets.

Job positions were dominated by chefs/cooks (33.8%) and owners/managers (23.4%)**,** groups that are critical in enforcing food safety protocols. Respondents also demonstrated substantial work experience, with 22.1% each having 4–6 years or >10 years of experience, suggesting a workforce with established routines and exposure. 54.5% of respondents operated in urban areas**,** 23.4% in peri-urban and 22.1% in rural areas, indicating that food service in Calabar is largely concentrated in urban centers. Establishments were mainly small-scale (44.2%)**,** with fewer medium (36.4%) and large businesses (19.5%). Finally, 36.4% of respondents had been in their current workplace for more than 2 years, reflecting stability and likely familiarity with existing practices.

Table 1: Socio-Demographic Characteristics of Respondents

Characteristics`	Category	Frequency (n)	Percentage (%)
Age	Below 20	45	11.7

Characteristics`	Category	Frequency (n)	Percentage (%)
	21–30	130	33.8
	31–40	100	26.0
	41–50	70	18.2
	Above 50	40	10.3
Gender	Male	200	52.0
	Female	170	44.2
	Prefer not to say	15	3.8
Educational Level	None	25	6.5
	Primary	80	20.8
	Secondary	150	39.0
	Tertiary	120	31.2
	Other	10	2.5
Marital Status	Single	140	36.4
	Married	180	46.8
	Divorced	35	9.1
	Widowed	20	5.2
	Other	10	2.5
Type of Food Establishment	Restaurant	110	28.6
	Hotel	90	23.4
	Street Vendor	100	26.0
	Local Eatery	70	18.2
	Other	15	3.8
Job Position	Owner/Manager	90	23.4
	Chef/Cook	130	33.8
	Waiter/Server	60	15.6
	Food Vendor	80	20.8

Characteristics`	Category	Frequency (n)	Percentage (%)
	Other	25	6.4
Years of Experience	<1 year	55	14.3
	1–3 years	95	24.7
	4–6 years	85	22.1
	7–10 years	65	16.9
	>10 years	85	22.0
Area of Operation	Urban	210	54.5
	Peri-urban	90	23.4
	Rural	85	22.1
Size of Establishment	Small (≤10 employees)	170	44.2
	Medium (11–50)	140	36.4
	Large (>50)	75	19.4
Duration in Current Establishment	<6 months	60	15.6
	6–12 months	80	20.8
	1–2 years	105	27.3
	>2 years	140	36.3

Table 2 and fig 1 presents respondents' knowledge of specific food safety concepts. The results indicate varying levels of understanding across different domains. In terms of high knowledge of specific food safety concept, majority (80.5%, 77.9% & 71.4%) correctly identified the importance of separating cooked food, proper hand sanitizing using soap and water, and the meaning of cross-contamination. Similarly, 68.8% recognized unusual odor as a sign of unsafe food, and 67.5% correctly identified Salmonella as a foodborne pathogen. Knowledge was weaker regarding thorough cooking as a preventive practice (62.3%), the correct cooking temperature for poultry (59.7%), and proper thawing in a refrigerator (57.1%). Respondents struggled most with the concept of the "danger zone" temperature range (50.6%) and safe room temperature storage duration (54.5%), both of which are critical for preventing bacterial growth.

Table 2: Responses to Food Safety Knowledge Questions

Question Focus	Correct Answer	Frequency Correct (n)	% Correct	% Incorrect
Foodborne pathogen	Salmonella	260	67.5	32.5
Cooking temp poultry	70°C	230	59.7	40.3
Safe room temp storage	2 hours	210	54.5	45.5
Cross-contamination meaning	Mixing raw & cooked	275	71.4	28.6
Best hand sanitizing method	Soap & water	300	77.9	22.1
Danger zone temp range	5°C–60°C	195	50.6	49.4
Prevention practice	Cook thoroughly	240	62.3	37.7
Sign unsafe food	Unusual odor	265	68.8	31.2
Proper thawing method	Refrigerator	220	57.1	42.9
Separation importance	Very important	310	80.5	19.5

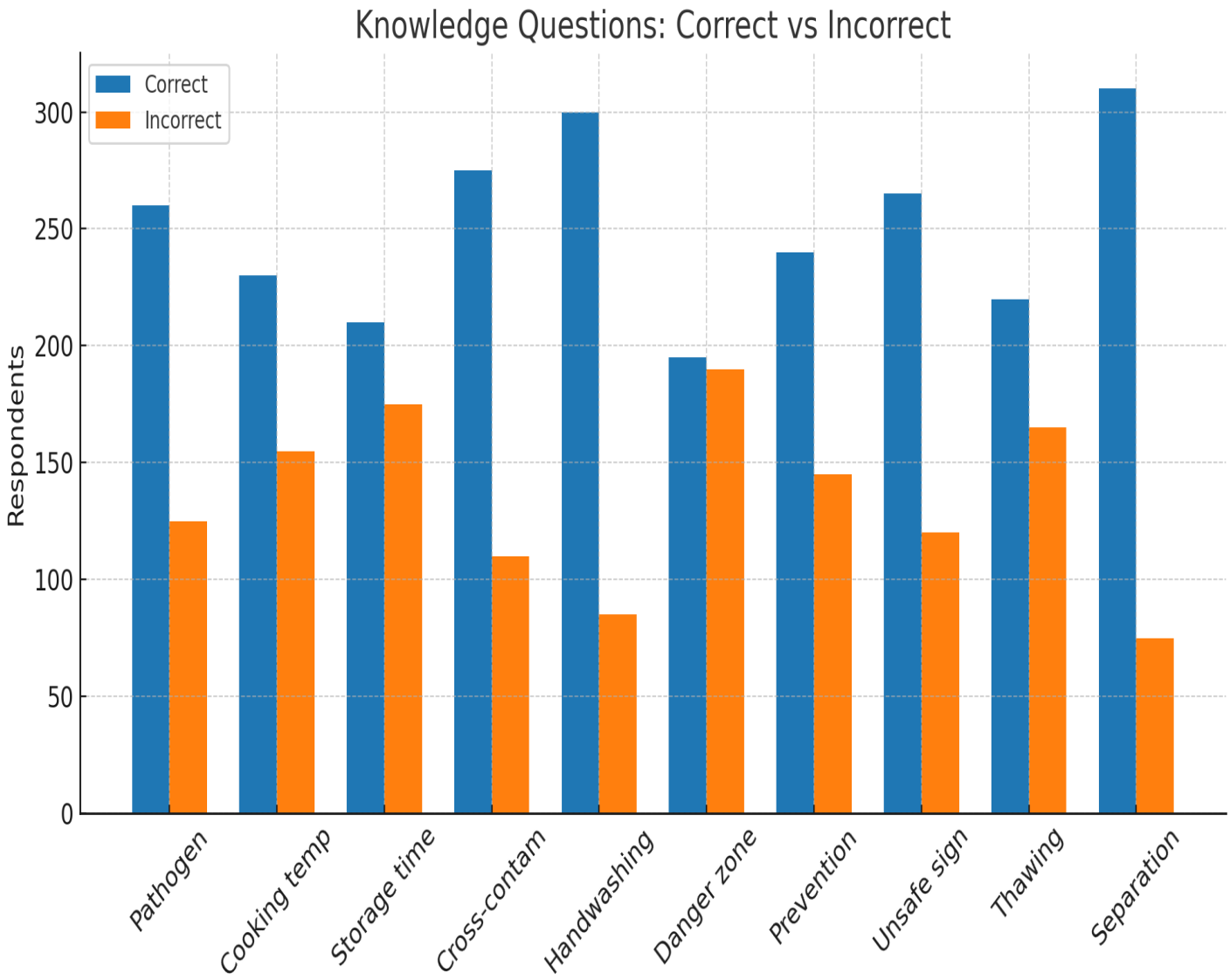


Fig 1: Bar Chart representing Responses to Food Safety Knowledge Questions (n = 385)

Table 3 presents the aggregated knowledge scores out of 10. The distribution shows that 20.8% of respondents had poor knowledge (scores 0-4), 44.2% had fair knowledge (scores 5-7), and 35.0% demonstrated good knowledge (scores 8-10).

Table 3: Food Safety Knowledge Scores (n = 385)

Knowledge Level	Score Range (out of 10)	Frequency (n)	Percentage (%)
Poor	0 – 4	80	20.8

Knowledge Level	Score Range (out of 10)	Frequency (n)	Percentage (%)
Fair	5 – 7	170	44.2
Good	8 – 10	135	35.0
Total	-	385	100.0

Table 4 and fig 2 assessed how frequently respondents adhered to recommended hygiene practices. Majority (71.4%) of the respondents reported that they always comply in checking expiry dates**,** 68.8% separates raw and cooked food, and 66.8% cleans equipment. Similarly, more than half (64.9%, 62.3%) of respondents reported to clean surfaces after every use, and wearing gloves when handling raw meat. Also**,** more than half (59.7%) reported always washing hands after handling money or after every task. While these are majority responses, the fact that about 40% do not consistently wash hands highlights a critical gap. The least adherence was seen in cleaning storage areas daily (52.7% always) and using separate cutting boards (57.1% always). In these cases, nearly half reported doing so "sometimes," "rarely," or "never."

Table 4: Responses to Food Hygiene Practice Questions

Question Focus	Best Practice	% Always	% Sometimes	% Rarely	% Never
Handwashing frequency	After every task	59.7	18.2	16.9	5.2
Gloves for raw meat	Always	62.3	20.0	12.7	5.0
Handwash after money	Always	55.8	22.1	14.3	7.8
Cleaning surfaces	After every use	64.9	18.2	10.4	6.5
Cleaning storage areas	Daily	52.7	24.7	15.6	7.0
Separate raw/cooked food	Always	68.8	18.2	8.1	4.9
Use of proper utensils	Always	60.5	20.8	13.0	5.7
Separate cutting boards	Yes	57.1	21.6	14.3	7.0
Check expiry dates	Always	71.4	16.1	8.1	4.4
Cleaning equipment	Always	66.8	18.2	9.1	5.9

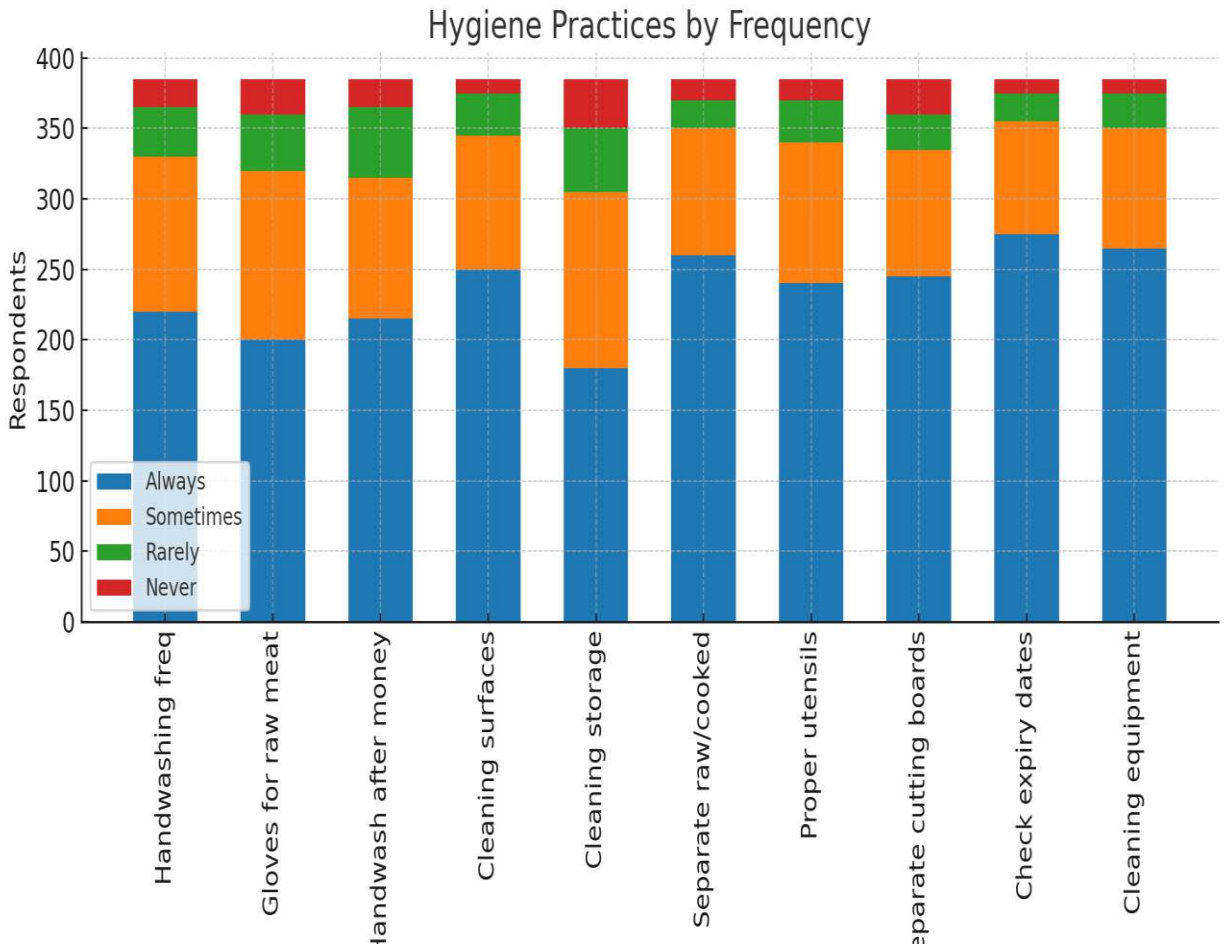


Fig 2: Bar Chart representing Responses to Food Hygiene Practice Questions (n = 385)

Table 5 shows the food hygiene practice. The distribution of overall hygiene practice scores reveals that 18.2% of respondent's demonstrated poor practice (scores 0–4)**,** 36.4% had fair practice (scores 5–7), and 45.4% exhibited good practice (scores 8–10). The largest group was those with good practice, indicating that nearly half of the food handlers consistently follow recommended hygiene protocols.

Table 5: Food Hygiene Practice Scores

Practice Level	Score Range (out of 10)	Frequency (n)	Percentage (%)
Poor	0 – 4	70	18.2
Fair	5 – 7	140	36.4
Good	8 – 10	175	45.4
Total	-	385	100.0

Table 6 and fig 3 highlights respondents' exposure to food safety training and their attitudes toward regulation. More than half (57.1%) had received some form of formal food safety training, while 42.9% had not. Among those trained, the most common frequency was annual (31.2%), followed by rarely (33.8%), and every 6 months (18.2%). Notably, 16.9% had never received any training. More than (62.3%) were aware of Nigerian food safety standards, while 37.7% were not. Only 26.0% felt "very confident," with most respondents reporting moderate confidence (41.6% confident, 23.4% somewhat confident). 9.1% admitted they were not confident in applying food safety principles. Strong support was evident, with 39.0% strongly supporting and 36.4% supporting compulsory training. Only 11.6% were neutral or opposed.

Table 6: Food Safety Training and Education Responses

Question Focus	Response	Frequency (n)	Percentage (%)
Ever received formal training?	Yes	220	57.1
	No	165	42.9
Training frequency	Annually	120	31.2
	Every 6 months	70	18.2
	Rarely	130	33.8
	Never	65	16.9
Aware of Nigerian standards?	Yes	240	62.3
	No	145	37.7
Confidence in applying safety	Very confident	100	26.0
	Confident	160	41.6
	Somewhat confident	90	23.4
	Not confident	35	9.1
Support mandatory training	Strongly support	150	39.0
	Support	140	36.4
	Neutral	50	13.0
	Do not support	30	7.8
	Strongly oppose	15	3.8

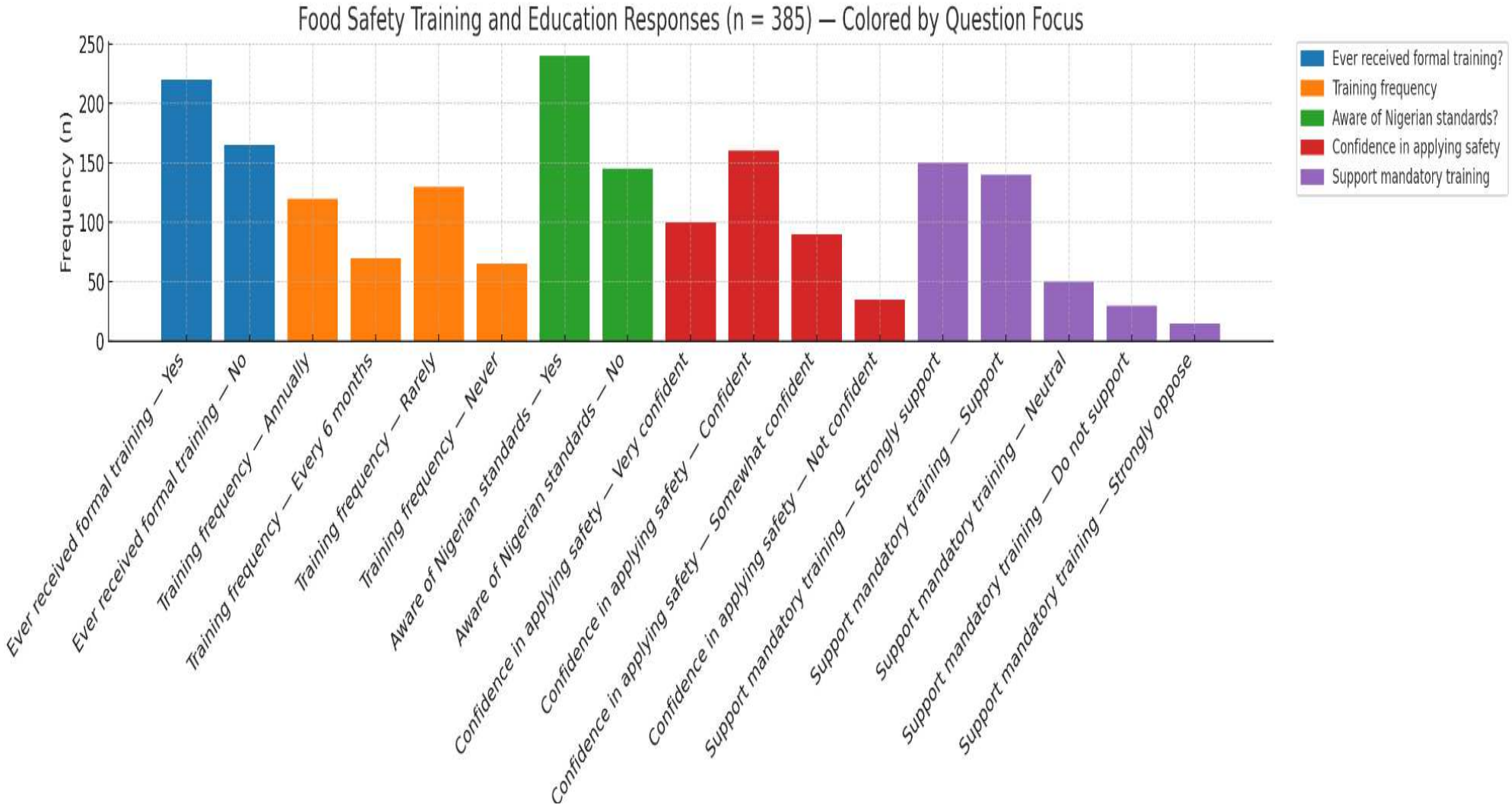


Fig 3: Bar Chart representing Food Safety Training and Education Responses (n = 385)

Table 7 presents food safety knowledge score by educational level and hygiene practice by type of food establishment. 60.0% had poor knowledge, with very few (12.0%) in the "good" category. 56.3% scored fair, with only 18.7% good. Distribution improved, with 46.7% fair and 33.3% good. Tertiary education showed the strongest profile 62.5% good, 29.2% fair, and only 8.3% poor while other education, 65.0% fair but weak at the good level (10.0%). The chi-square test ($\chi^2 = 42.6$, df = 8, $p < 0.001$) indicates a statistically significant relationship between education level and knowledge scores.

Regarding hygiene practice levels across establishment types. In restaurants, the strongest performance, with 59.1% good, 31.8% fair, and only 9.1% poor, in hotels, half of the respondents (50.0%) good, 33.3% fair, and 16.7% poor. Street vendors: Weaker profile, with 35.0% good, 40.0% fair, and 25.0% poor. Local eateries: Similar to vendors, with 42.9% good, 35.7% fair, and 21.4% poor. Other establishments: Performed worst overall, with 66.7% fair, 33.3% poor, and none in the good category.

The chi-square test ($\chi^2 = 16.2$, df = 8, $p = 0.04$) indicates that the differences are statistically significant.

Table 7: Hygiene Practice Score by Training Received

Training Received	**Poor (%)**	**Fair (%)**	**Good (%)**	**χ^2 (p-value)**
Yes (n = 220)	20 (9.1)	80 (36.4)	120 (54.5)	
No (n = 165)	50 (30.3)	60 (36.4)	55 (33.3)	
Total	70 (18.2)	140 (36.4)	175 (45.4)	$\chi^2 = 19.4$, df = 2, $p < 0.001$
Establishment Type	**Poor (%)**	**Fair (%)**	**Good (%)**	**χ^2 (p-value)**
Restaurant (n = 110)	10 (9.1)	35 (31.8)	65 (59.1)	
Hotel (n = 90)	15 (16.7)	30 (33.3)	45 (50.0)	
Street Vendor (n = 100)	25 (25.0)	40 (40.0)	35 (35.0)	
Local Eatery (n = 70)	15 (21.4)	25 (35.7)	30 (42.9)	
Other (n = 15)	5 (33.3)	10 (66.7)	0 (0.0)	
Total (n = 385)	70 (18.2)	140 (36.4)	175 (45.4)	$\chi^2 = 16.2$, df = 8, $p = 0.04$

Table 8 shows knowledge score by type of food establishment. Mean knowledge scores varied by establishment type. Restaurant staff had the highest average score (7.3 ± 1.5), followed closely by hotel workers (7.0 ± 1.6). Street vendors (6.0 ± 1.8) and local eateries (6.2 ± 1.7) recorded lower averages, with "other" establishments scoring the lowest (5.8 ± 1.9).
The ANOVA test result ($F(4,380) = 6.85$, $p < 0.001$) confirms a statistically significant difference in knowledge scores across establishment types.

Table 8: Knowledge Score by Type of Food Establishment

Establishment Type	Mean Score	Std. Dev.	p-value
Restaurant (n = 110)	7.3	1.5	
Hotel (n = 90)	7.0	1.6	
Street Vendor (n = 100)	6.0	1.8	
Local Eatery (n = 70)	6.2	1.7	
Other (n = 15)	5.8	1.9	
ANOVA Result	-	-	$F(4,380) = 6.85$, $p < 0.001$

DISCUSSION

The socio-demographic profile indicates that food handling in Calabar involves a relatively diverse workforce operating across formal and informal food-service settings. The predominance of young and middle-aged adults is consistent with the age structure commonly reported among food handlers in Nigeria, where food service provides an important source of employment for economically active populations. Recent Nigerian studies have similarly documented predominantly young adult food-handling workforces, including among institutional food handlers and vendors (Adefala et al., 2026; Barnabas et al., 2024). The broad representation of both men and women in the present study is also noteworthy because gender composition can vary considerably according to the type of food service and cultural context. For example, Barnabas et al. (2024) reported a predominantly female food-vendor workforce in the Nigerian Home-Grown School Feeding Programme, reflecting the important role of women in food preparation in some Nigerian settings.

The educational profile of the respondents provides an important context for interpreting subsequent findings. Education has been repeatedly identified as a determinant of food safety knowledge because it can influence the ability to understand written instructions, interpret regulatory information and assimilate technical concepts such as microbial contamination and temperature control. In a recent Nigerian tertiary-institution study, educational attainment was significantly associated with food safety knowledge, supporting the relevance of formal education in developing food safety competence (Adefala et al., 2026). Similarly, Barnabas et al. (2024) found that increased education was positively associated with food safety knowledge among Nigerian food vendors.

The distribution of respondents across restaurants, hotels, street vending and local eateries is particularly relevant because food safety conditions may differ according to the organizational structure, resources, supervision and regulatory oversight of an establishment. Informal food businesses may have fewer resources for refrigeration, dedicated handwashing facilities, equipment sanitation and structured staff training than larger establishments. Recent research from Nigeria has continued to identify workplace setting as an important contextual factor in food safety performance. A 2026 study among food-service establishments in Ibadan, for example, found differences in hygiene compliance according to institutional setting and highlighted the contribution of infrastructure and organizational support to food safety performance.

The considerable representation of experienced food handlers should not necessarily be interpreted as evidence of adequate food safety competence. Experience can facilitate the development of practical routines, but long-standing routines may also become habitual and may not be consistent with current food safety recommendations. This distinction is important because food safety competence requires not only experience but also continuing education, supervision and adaptation to updated standards. Barnabas et al. (2024) similarly identified years of vending experience as relevant to food safety attitudes, while recent Nigerian evidence indicates that training remains important even among experienced handlers.

Result outcome suggests that respondents were more familiar with highly visible or routinely encountered food hygiene concepts than with technical aspects of temperature control. Stronger recognition of the importance of separating raw and cooked foods and the meaning of cross-contamination is consistent with the WHO Five Keys to Safer Food, which identify separation of raw and cooked foods as a fundamental preventive measure. The same framework emphasizes keeping food at safe temperatures and cooking food thoroughly, demonstrating that food safety requires simultaneous attention to several interconnected control points rather than reliance on personal cleanliness alone (WHO, 2024).

The comparatively weaker knowledge of poultry cooking temperature, refrigeration-based thawing and the temperature danger zone is important from a food safety perspective. These are technical concepts that are less readily recognized through everyday experience than visible indicators such as odour or cleanliness. The WHO specifically identifies the 5°C–60°C range as a temperature zone in which microorganisms can multiply rapidly and recommends adequate cooking, including reaching approximately 70°C for foods requiring thorough cooking. The present pattern therefore indicates that food safety education should move beyond general messages about cleanliness and incorporate practical instruction on time-temperature control, refrigeration, thawing and cooking temperatures.

This observation is strongly supported by recent Nigerian evidence. A 2026 study among food handlers in boarding-school food-service establishments in Ibadan reported generally adequate knowledge but substantial deficiencies concerning temperature control and food storage, particularly recognition of the danger zone. The investigators consequently emphasized practical training and improved food-service infrastructure rather than relying on knowledge acquisition alone. Similar concerns have been reported among Nigerian meat handlers, where substantial awareness of food safety regulations coexisted with important gaps in knowledge of pathogens and cross-contamination (2026).

The finding concerning pathogen recognition also has implications for food safety education. Awareness of *Salmonella* is useful, but food handlers require broader understanding of how

pathogenic microorganisms are transmitted through contaminated hands, utensils, surfaces, raw foods and inadequate temperature control. Recent research among Nigerian food handlers has shown that knowledge may be relatively strong in general terms while important pathogen-specific and contamination-control gaps persist (Adefala et al., 2026; Ogun State meat-handler study, 2026).

The findings are also comparable with evidence from Calabar itself. Okon et al. (2022), studying food handlers in Calabar Municipal, reported generally good food safety knowledge but observed continuing weaknesses in food-handling environments and practices. More recent work among food vendors in Calabar likewise reported that general knowledge was better than food-storage practice, suggesting that technical knowledge concerning storage and temperature control remains an important area for intervention.

The overall distribution of knowledge scores in Table 3 indicates that knowledge was not uniformly high across the sample. The concentration of respondents in the intermediate category is particularly important because it suggests that many food handlers may possess basic awareness without having mastered all components required for consistently safe food handling. Such an intermediate knowledge profile can arise when handlers understand broad hygiene principles but have limited exposure to more technical areas such as temperature control, pathogen transmission and safe storage.

The finding differs from the substantially higher proportion of good knowledge reported by Okon et al. (2022) among food handlers in Calabar Municipal. That study involved 156 handlers and reported good knowledge among 86.6% of respondents. Differences in sample composition, establishment types, questionnaire construction, scoring thresholds and study period may account for the contrasting estimates. The present study includes restaurants, hotels, street vendors, local eateries and other establishments, whereas differences in workplace composition can substantially influence opportunities for training and supervision.

Recent Nigerian evidence suggests that variation in knowledge between occupational settings remains common. A 2026 study at a Nigerian tertiary institution reported good knowledge among approximately three-fifths of food handlers, while a recent study in Ondo West also found generally good knowledge but emphasized differences between workplace settings and continuing limitations in formal training. These findings reinforce the importance of interpreting food safety knowledge within the organizational and regulatory context in which food handlers work.

The study findings demonstrate that reported adherence was strongest for readily observable routine practices such as checking expiry dates, separating raw and cooked foods, cleaning equipment and surfaces, while less consistent adherence occurred for storage-area sanitation and the use of separate cutting boards. This pattern is consistent with the concept that food hygiene behaviour is multidimensional: food handlers may comply with highly visible practices while neglecting less visible controls that require additional time, equipment or organizational support.

Hand hygiene deserves particular attention because hands can provide a direct pathway for transferring microorganisms from contaminated surfaces, money, raw foods or other sources to ready-to-eat foods. The WHO Five Keys framework places maintaining cleanliness at the centre of food safety and recommends appropriate hand hygiene alongside separation, thorough cooking and temperature control (WHO, 2024). The reported inconsistency in handwashing

therefore represents an important behavioural gap even where respondents demonstrate awareness of other hygiene requirements.

The findings are consistent with the wider sub-Saharan African evidence. A recent systematic review and meta-analysis of 42 studies involving 12,367 food handlers estimated the pooled prevalence of good food hygiene practices at approximately 50.7%. The review identified lack of food safety training, unfavourable attitudes and absence of regular medical check-ups among factors associated with poorer hygiene practices (2025). The relatively stronger practice profile observed in some domains of the present study should therefore not obscure the persistence of specific behaviours that can facilitate cross-contamination.

Recent Nigerian studies similarly demonstrate a gap between general awareness and consistent implementation. In boarding-school food-service establishments in Ibadan, only a small proportion of handlers were observed washing their hands before touching ready-to-eat foods despite generally adequate knowledge. The investigators concluded that knowledge alone was insufficient and that infrastructure, supervision and practical training were required to sustain safe practices. Likewise, a 2025 study of Calabar food vendors found that although general knowledge of hygienic preparation was relatively good, only about half demonstrated good food-storage practices.

The findings of the study suggests a somewhat more favourable practice profile than the corresponding knowledge profile. This apparent difference is important because food handlers may develop practical routines through workplace experience even when their understanding of the scientific rationale underlying those routines is incomplete. Conversely, self-reported practice may overestimate actual compliance because respondents may provide socially desirable answers.

The finding is consistent with evidence from Calabar, although the magnitude differs from previous reports. Okon et al. (2022) reported that 86% of food handlers had good hygiene practices, whereas the present study identifies a smaller proportion in the good-practice category. The discrepancy may reflect differences in measurement approaches, study populations and, importantly, the inclusion of multiple establishment types in the present study. The earlier Calabar investigation incorporated direct observation, whereas the current findings appear to rely on self-reported frequency categories; therefore, direct numerical comparison should be made cautiously.

The broader evidence supports this cautious interpretation. The recent sub-Saharan African meta-analysis estimated good food hygiene practice at only about half of food handlers, indicating that inconsistent implementation remains widespread across the region. The coexistence of relatively favourable self-reported practices with specific weaknesses in hand hygiene, storage-area cleaning and separation of utensils therefore supports the need for observational monitoring alongside questionnaire-based assessment.

Finding highlights an important institutional dimension of food safety. Formal training had reached a substantial proportion of respondents, but training exposure was not universal or necessarily regular. This is important because food safety competence can deteriorate when training is infrequent, especially where staff turnover, changing regulations or informal workplace routines are present.

Recent evidence from Nigeria supports the value of structured and continuing training. Barnabas et al. (2024) found that access to food safety information through formal institutions and mass media was associated with food safety knowledge among Nigerian food vendors. Their findings suggest that training should be complemented by accessible information channels rather than treated as a one-time intervention. A 2026 study among Nigerian meat handlers similarly found that training was significantly associated with improved knowledge and hygienic practices, despite persistent gaps among trained workers.

The level of awareness of Nigerian food safety standards is encouraging, but awareness of regulations does not necessarily demonstrate the ability to operationalize them. Recent research at a Nigerian tertiary institution found that food handlers could have generally favourable knowledge and attitudes while still requiring continuous education. Similarly, the 2026 Ibadan study demonstrated that knowledge did not automatically translate into safe temperature control and storage practices. Food safety programmes should therefore assess competency through demonstrations, observation and workplace audits rather than relying solely on whether handlers report having received training.

The relatively strong support for compulsory training is particularly relevant to food safety governance. WHO guidance encourages food operators to maintain food safety management systems and provide regular staff training. In the Nigerian context, this could support a system in which food handlers receive standardized training before commencing food-handling duties and periodic refresher training thereafter. A 2025 protocol from Cross River State specifically proposes evaluating the effect of a structured food safety and hygiene training programme among restaurant and canteen handlers, demonstrating continuing local interest in training as an intervention.

The significant association between educational attainment and knowledge scores in Table 7 is consistent with the broader literature. Formal education may improve comprehension of food safety terminology, written regulations and technical information, while also increasing access to information through digital and other media. Barnabas et al. (2024) reported that higher education was positively associated with food safety knowledge among Nigerian food vendors. Likewise, Adefala et al. (2026) found a statistically significant association between education and food safety knowledge among food handlers in a Nigerian tertiary institution.

The relationship should not, however, be interpreted as meaning that food safety competence can be achieved through formal education alone. Food handling is a practical occupation, and even highly educated workers require workplace-specific instruction on sanitation procedures, temperature monitoring, cross-contamination prevention and emergency responses. The recent evidence from Ibadan illustrates this point: despite generally adequate knowledge, practical deficiencies persisted in temperature control, food storage and hand hygiene. Thus, workplace training should be designed to accommodate handlers with different educational backgrounds and should use practical demonstrations, visual materials and locally understandable examples.

The significant association between establishment type and hygiene practice indicates that food safety behaviour is influenced by the setting in which food handling occurs. Restaurants and hotels may have greater access to formal operating procedures, dedicated kitchens, refrigeration, cleaning materials, managerial oversight and staff training than smaller informal establishments. Conversely, street vendors and small eateries may face structural constraints involving water availability, storage facilities, waste disposal and workspace design.

This interpretation is supported by recent Nigerian evidence. The 2026 Ibadan study found substantial differences in hygiene compliance between food-service settings and identified kitchen design, handwashing facilities and sanitation resources as important constraints. Recent research among food handlers in Ikom, Cross River State, also identified significant relationships between food safety training and food safety practices and emphasized the need for continuous structured training. These findings indicate that differences between establishments should not be attributed exclusively to individual motivation or knowledge; the physical and managerial environment can enable or constrain safe behaviour.

The particularly weak practice profile among smaller or less formal establishments is also consistent with findings from Calabar vendors. Akpet et al. (2025) reported that although most vendors had good general knowledge of hygienic food preparation, safe food-storage practice remained substantially weaker and highlighted inadequate monitoring and supervision by relevant authorities. Strengthening routine inspection, registration and supervisory support may therefore be important components of improving food safety among informal food businesses.

The significant difference in mean knowledge scores across establishment types in Table 8 further indicates that workplace context is associated not only with hygiene behaviour but also with food safety knowledge. The higher knowledge scores observed among restaurant and hotel workers may reflect greater exposure to standardized operating procedures, professional kitchen structures, managerial supervision or formal training opportunities. Conversely, lower scores among street vendors and workers in smaller informal establishments may reflect fewer opportunities for structured education and limited access to food safety information.

Comparable patterns have been documented in recent Nigerian research. The 2026 Ondo West study found variation in food safety knowledge according to workplace setting and emphasized the need for structured training and workplace supervision. Barnabas et al. (2024) likewise showed that access to food safety information and educational resources was associated with knowledge among Nigerian food vendors. A recent Nigerian tertiary-institution study also demonstrated that educational level was significantly associated with food safety knowledge, reinforcing the contribution of both individual educational characteristics and institutional learning environments.

The establishment-level differences are particularly important because they suggest that a single intervention may not be equally appropriate for all food handlers in Calabar. Formal restaurants and hotels may benefit from competency-based refresher training and routine internal audits, whereas street vendors and small eateries may require more accessible community-based training, simplified visual materials, periodic environmental health visits and practical support for achieving basic sanitation requirements. The WHO recommends that food operators provide regular staff training and maintain food safety management plans, providing an appropriate framework for such workplace-based interventions.

The present study indicates that food safety competence among food handlers in Calabar is multidimensional. General awareness of basic hygiene concepts does not necessarily extend to technical areas such as time-temperature control, and favourable reported practices do not guarantee consistent application of all recommended measures. The findings are therefore consistent with the broader food safety literature showing that knowledge, training, workplace resources, supervision and organizational context interact in determining food safety behaviour.

The distinction between knowledge and practice is particularly important. A recent systematic review and meta-analysis of food handlers in sub-Saharan Africa found that training, attitudes and regular health monitoring were associated with hygiene practices, while recent Nigerian studies have demonstrated that workplace infrastructure and supervision can influence whether knowledge is translated into behaviour. The findings from Calabar consequently support an approach that combines competency-based training with routine supervision, environmental improvements and regulatory monitoring.

The results also extend the evidence from Calabar by examining food handlers across multiple types of food establishments and by demonstrating significant differences in knowledge according to educational level and establishment type. Previous Calabar research has documented generally favourable knowledge and practice among food handlers, while more recent work among local vendors has continued to identify deficiencies in storage and monitoring. The present findings therefore suggest that food safety interventions in Calabar should be sufficiently broad to cover both formal and informal food-service environments while giving particular attention to technical knowledge, temperature control, hand hygiene, food separation, storage and continuous training.

Overall, the evidence supports a shift from one-time food safety sensitization toward continuous, competency-based and establishment-specific food safety management. Such an approach is consistent with WHO recommendations and with recent Nigerian evidence showing that training is most useful when accompanied by supportive infrastructure, supervision and regular reinforcement of safe food-handling behaviours.

Conclusion

The study demonstrates that food safety knowledge and hygiene practices among food handlers in Calabar were mixed, with substantial room for improvement. Although respondents showed relatively good knowledge of several important food-safety principles, including hand hygiene, prevention of cross-contamination, separation of raw and cooked foods, and recognition of foodborne pathogens, knowledge was less consistent for critical issues such as safe temperature control, storage, and thawing. Overall, 35.0% of respondents had good food safety knowledge, 44.2% had fair knowledge, and 20.8% had poor knowledge, indicating that a considerable proportion of food handlers did not demonstrate a high level of comprehensive food-safety knowledge. Reported hygiene practices followed a broadly similar pattern. While some practices, particularly checking expiry dates, separating raw and cooked foods, cleaning equipment, and maintaining clean food-contact surfaces, were commonly reported, adherence was less consistent for handwashing after specific activities, cleaning storage areas, and use of separate cutting boards. Overall, 45.4% of respondents demonstrated good hygiene practices, 36.4% had fair practices, and 18.2% had poor practices. These findings suggest that knowledge does not necessarily translate into consistent implementation of safe food-handling behaviours. Importantly, receipt of formal food-safety training was significantly associated with hygiene-practice scores ($\chi^2 = 19.4$, $df = 2$, $p < 0.001$), with trained food handlers showing a greater proportion of good practices than those without training. Hygiene practices also differed significantly according to establishment type ($\chi^2 = 16.2$, $df = 8$, $p = 0.04$), while mean food-safety knowledge differed significantly across establishment types ($F(4,380) = 6.85$, $p < 0.001$). These findings indicate that both individual training and the food-service environment may be relevant to food-safety performance. Recent Nigerian evidence similarly indicates that food safety knowledge and practices vary across workplace settings and that training and workplace conditions remain important considerations in improving food hygiene.

Overall, the findings highlight the need for continuous, structured food-safety training, regular monitoring, and stronger implementation of food hygiene standards across food establishments in Calabar. Training should particularly address areas where knowledge and reported practices were less consistent, while interventions should also consider workplace resources and operational conditions. This is particularly relevant because recent evidence from Calabar indicates that structural and organizational barriers, including inadequate supplies, equipment, enforcement, and established hygiene standards, can constrain food handlers' ability to maintain appropriate hygiene practices. The study therefore concludes that improving food safety among food handlers in Calabar requires an approach that combines knowledge development, practical training, supportive workplace conditions, routine supervision, and effective enforcement of food-safety standards. Such measures could strengthen food-handling practices and contribute to reducing the risk of foodborne illness among consumers in the city.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are proposed for policy, practice, and future research:

- Government and regulatory agencies such as the National Agency for Food and Drug Administration and Control (NAFDAC) and local government health departments should make food safety training mandatory for all food handlers, including those in the informal sector.
- A biannual certification system should be introduced, requiring food handlers to demonstrate competence in critical areas such as hand hygiene, cross-contamination control, temperature monitoring, thawing, and cleaning protocols.
- Risk-based inspections should be intensified, prioritizing high-risk groups such as street vendors, local eateries, and handlers in peri-urban and rural markets.
- Training modules should be redesigned to emphasize practical, skill-based learning using demonstrations, role-play, and scenario-based exercises rather than purely theoretical lectures.
- Training materials should be developed in simple language and local dialects**,** supplemented with visual aids (posters, pictograms, and pocket guides) to improve retention among less-educated handlers.
- Local governments should ensure the provision of basic infrastructure for food hygiene, including potable water supply, waste disposal systems, and sanitation facilities in food markets and vending areas.
- Food establishments should implement standard operating procedures (SOPs) for critical hygiene behaviors such as handwashing after money handling, cleaning of storage areas, and separation of raw and cooked foods.
- Consumer awareness campaigns should be conducted to sensitize the public to demand and reward safe food-handling practices, thereby exerting positive pressure on vendors.
- Future studies should include microbiological assessments of food samples and preparation environments to link self-reported practices with actual contamination levels.
- Longitudinal research should be conducted to assess the sustainability of training interventions and their impact on reducing foodborne disease incidence.
- Comparative studies across Nigerian cities and rural settings are recommended to identify regional variations and tailor interventions accordingly.

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Author Contributions
C.V.E: Conception, methodology, investigation, data curation, writing original draft, manuscript preparation and revision.
D.C.F: Conception, methodology, investigation, data curation, writing original draft.
A.F.O: Conception, methodology, investigation, data curation, writing original draft.
U.B.I: Investigation, resources
E.M.O: Investigation, resources

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AI was used to comprise and correct grammatical. CHATGPT and quillbot was used.

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