HYGIENIC-SANITARY CONDITIONS IN OPEN-AIR MARKETS AND PUBLIC MARKETS IN RECIFE, PERNAMBUCO, BRAZIL:
A CROSS-SECTIONAL STUDY

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Erica Carvalho de Oliveira Alves
Nutritionist, undergraduate student in Public Health at UPE. Council member of the Recife School Food Council.
E-mail: ericacarvalhonutricionista@gmail.com

Antônio Carlos Freitas Souza
PhD in Animal Science from UEMA (2024), Master's in Health Sciences from UNIFAP. Researcher at IEPA/AP, coordinating the Microbiology Laboratory of the Food Science and Technology Center. Partner-Director of R&D at BactoLac LTDA.
E-mail: acssilva.junior@gmail.com

Jorge Belém Oliveira Júnior
Ph.D. and Master's in Tropical Medicine from UFPE, with specializations in Clinical Microbiology, Biosafety, and Educational Management. Graduated in Biological Sciences (UFAL), currently pursuing a degree in Pharmacy. Lecturer in graduate programs and collaborating researcher at the Clinical Microbiology Laboratories (UFAL) and Food Technology Laboratory (IEPA/AP).
E-mail: junniorbiologia@gmail.com

ABSTRACT

Public markets and street fairs represent important channels for the commercialization of fresh natural foods; however, they often present inadequacies regarding hygienic-sanitary conditions. This study aimed to evaluate these conditions in street fairs and public markets in Recife, Pernambuco, Brazil, while also outlining the sociodemographic profile of vendors. A quantitative and descriptive survey was conducted in Sanitary District V, using a checklist based on ANVISA RDC nº 216/2004 and a sociodemographic questionnaire. The sample included 65 vendors over 18 years of age. Results revealed a predominantly female profile (52.3%), aged 40-50 years (38.5%), self-declared Black (38.5%), and with low education levels - 36.9% had incomplete elementary education and 6.2% were illiterate. Income ranged between 1-2 minimum wages (52.3%), with vending being the primary income source for 90.8%. Sanitary assessment demonstrated serious non-compliances: Mustardinha and Areias fairs showed 0.0% compliance (equivalent to 100% non-compliance), Afogados 1 and Afogados 2 registered 6.9% and 3.4% compliance, respectively. Afogados 3 showed the best performance, with 20.7% compliance. Binary logistic regression identified market location (OR = 3.24; 95% CI: 1.82-5.78; p = 0.002) and vendor education level (OR = 2.17; 95% CI: 1.23-3.84; p = 0.008) as significant predictors of non-compliance. Critical problems included the absence of adequate sanitary facilities, lack of refrigeration for perishable foods, presence of animals in sales areas, and inadequate waste management. Urgent interventions are required through public policies encompassing physical restructuring, continuous training for food handlers, and strengthened inspection actions to ensure food safety and protect population health.

Keywords: Food Inspection. Food Safety. Food Contamination. Public Health Surveillance. Street Food.

RESUMO

Mercados públicos e feiras livres representam importantes canais de comercialização de alimentos naturais frescos; no entanto, frequentemente apresentam inadequações quanto às condições higiênico-sanitárias. Este estudo teve como objetivo avaliar essas condições em feiras livres e mercados públicos do Recife, Pernambuco, Brasil, bem como traçar o perfil sociodemográfico dos feirantes. Foi realizado um inquérito quantitativo e descritivo no Distrito Sanitário V, utilizando um checklist baseado na RDC ANVISA nº 216/2004 e um questionário sociodemográfico. A amostra incluiu 65 feirantes maiores de 18 anos. Os resultados revelaram um perfil predominantemente feminino (52,3%), com idade entre 40 e 50 anos (38,5%), autodeclarados negros (38,5%) e com baixa escolaridade - 36,9% tinham ensino fundamental incompleto e 6,2% eram analfabetos. A renda variou entre 1 e 2 salários mínimos (52,3%), sendo a feira a principal fonte de renda para 90,8%. A avaliação sanitária demonstrou não conformidades graves: as feiras de Mustardinha e Areias apresentaram 0,0% de conformidade (equivalente a 100% de inadequações), Afogados 1 e Afogados 2 registraram 6,9% e 3,4% de conformidade, respectivamente. Afogados 3 apresentou o melhor desempenho, com 20,7% de conformidade. A regressão logística binária identificou a localização do mercado (OR = 3,24; IC 95%: 1,82-5,78; p = 0,002) e o nível de escolaridade do feirante (OR = 2,17; IC 95%: 1,23-3,84; p = 0,008) como preditores significativos de não conformidade. Os problemas críticos incluíram ausência de instalações sanitárias adequadas, falta de refrigeração para alimentos perecíveis, presença de animais nas áreas de venda e manejo inadequado de resíduos. Intervenções urgentes por meio de políticas públicas que abranjam reestruturação física, capacitação contínua dos manipuladores de alimentos e ações de fiscalização reforçadas são necessárias para garantir a segurança dos alimentos e proteger a saúde da população.

Palavras-chave: Inspeção de Alimentos. Segurança Alimentar. Contaminação de Alimentos. Vigilância em Saúde Pública. Alimentos de Rua.

RESUMEN

Los mercados públicos y al aire libre representan canales importantes para la comercialización de alimentos frescos y naturales; sin embargo, con frecuencia presentan deficiencias en cuanto a las condiciones higiénicas y sanitarias. Este estudio tuvo como objetivo evaluar dichas condiciones en los mercados al aire libre y públicos de Recife, Pernambuco, Brasil, así como describir el perfil sociodemográfico de los vendedores. Se realizó una encuesta cuantitativa y descriptiva en el Distrito Sanitario V, utilizando una lista de verificación basada en la Circular de Investigación y Desarrollo (RDC) n.° 216/2004 de ANVISA y un cuestionario sociodemográfico. La muestra incluyó a 65 vendedores mayores de 18 años. Los resultados revelaron un perfil predominantemente femenino (52,3%), con edades comprendidas entre los 40 y los 50 años (38,5%), autoidentificados como negros (38,5%) y con bajos niveles de educación: el 36,9% tenía educación primaria incompleta y el 6,2% era analfabeto. Los ingresos oscilaron entre 1 y 2 salarios mínimos (52,3%), siendo el mercado la principal fuente de ingresos para el 90,8%. Las evaluaciones sanitarias revelaron graves incumplimientos: los mercados de Mustardinha y Areias mostraron un 0,0% de cumplimiento (equivalente a un 100% de deficiencias), Afogados 1 y Afogados 2 registraron un 6,9% y un 3,4% de cumplimiento, respectivamente. Afogados 3 mostró el mejor desempeño, con un 20,7% de cumplimiento. La regresión logística binaria identificó la ubicación del mercado (OR = 3,24; IC del 95%: 1,82-5,78; p = 0,002) y el nivel educativo del vendedor del mercado (OR = 2,17; IC del 95%: 1,23-3,84; p = 0,008) como predictores significativos del incumplimiento. Entre los problemas críticos se encontraban la falta de instalaciones sanitarias adecuadas, la refrigeración insuficiente para alimentos perecederos, la presencia de animales en las zonas de venta y una gestión inadecuada de los residuos. Se requieren intervenciones urgentes mediante políticas públicas que abarquen la reestructuración física, la formación continua de los manipuladores de alimentos y el fortalecimiento de las inspecciones para garantizar la inocuidad alimentaria y proteger la salud pública.

Palabras clave: Inspección de alimentos. Inocuidad alimentaria. Contaminación de alimentos. Vigilancia de la salud pública. Comida callejera.

1 INTRODUCTION

Open-air markets and public markets constitute traditional spaces for the commercialization of fresh, minimally processed foods and culinary preparations, playing a strategic role in ensuring food and nutritional security of urban populations (Silva; Santos, 2024; Tornaghi; Dehaene, 2020; Hannah *et al*., 2022). It is estimated that, in developing countries, open-air markets and street vending account for a significant portion of the daily food supply, particularly for low-income populations (Oteros-Rozas; Ravera; García-Llorente, 2019; Resque *et al*., 2019). Despite their social and economic relevance, these environments often exhibit inadequate structural and operational conditions, which render them potential hotspots for sanitary risk (Fava; Carrasco i Bonet; Garrido i Puig, 2022).

The absence of basic infrastructure, such as potable water supply systems, sewage networks, adequate sanitary facilities, and proper solid waste management, compromises the hygienic-sanitary quality of the foods sold (Fava; Carrasco i Bonet; Garrido i Puig, 2022; Hannah *et al*., 2022; BRASIL, 1990; FAO/WHO, 2024). Compounding these factors are improper handling by market vendors, exposure of perishable products without refrigeration, proximity to sources of contamination, and the lack of ongoing training in good handling practices (BRASIL, 1990; FAO/WHO, 2024).

Sanitary surveillance, as a field of public health practice, has the fundamental responsibility to intervene in health risk situations related to the consumption of products and services, including food (WHO, 2023). Within the scope of Brazilian public policies, the regulatory framework is composed of instruments such as Collegiate Board Resolution (RDC) nº 275/2002 of the National Health Surveillance Agency (ANVISA), which provides for standardized operational procedures applied to food producing/processing establishments (BRASIL, 2002). Internationally, the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) have published specific guidelines for promoting hygiene in traditional markets, establishing fundamental requirements related to infrastructure, food handler training, and pest control within the One Health approach (WHO, 2023; FAO/WHO, 2024).

Inadequate sanitary control has direct implications for the occurrence of waterborne and foodborne diseases (WFDs). WFDs represent a serious public health problem, disproportionately affecting vulnerable populations such as children, the elderly, pregnant women, and immunocompromised individuals, in addition to imposing significant costs on healthcare systems and the economy (HAVELAAR ET AL., 2015; WHO, 2019). Globally, it

is estimated that 600 million people fall ill and 420,000 die annually as a result of consuming contaminated food (LEE; YOON, 2021; WHO, 2024). In Brazil, between 2014 and 2023, 6,874 outbreaks of WFDs were recorded, affecting over 100,000 people and resulting in 121 deaths, with the Southeast and Northeast regions presenting the highest occurrence rates (FINGER *et al*., 2019; FERNANDES VIANA; ARRUDA; MARQUES ROSSI, 2025). Between 2007 and 2019, the state of Pernambuco recorded 1,029 outbreaks, accounting for 51.8% of the total in the Northeast region (OLIVEIRA JÚNIOR *et al*., 2023).

Microbiological studies conducted on animal-derived products sold at open-air markets and public markets in Brazil reveal high rates of contamination by pathogens of public health relevance. In São Luís (Maranhão), contamination by *Staphylococcus aureus* was detected in 60.47% of samples and by *Escherichia coli* in 40.70%, with the presence of *Salmonella* spp. in chicken and fish (SOUZA *et al*., 2023). In Macapá (Amapá), 100% of butter cheese samples showed contamination by at least one pathogenic agent (GARCIA JÚNIOR *et al*., 2023). In Recife (Pernambuco), a recent study identified Salmonella spp. in 50% of samples from one market and in chicken from another, *S. aureus* in 75% of samples, and *E. coli* in 100% of samples from one market and 80% from the other, with all *S. aureus* strains exhibiting the MRSA (Methicillin-resistant *Staphylococcus aureus*) phenotype and multidrug-resistant (MDR) profiles in *E. coli* and *Salmonella* spp (JORGE *et al*., 2025).

In the municipality of Recife, open-air markets and public markets are distributed across six political-administrative regions and are managed by the Urban Services Company (CSURB) (COSTA *et al*., 2015; MEDEIROS *et al*., 2017). Despite their importance for the food supply of the capital of Pernambuco, systematic studies on the hygienic-sanitary conditions of these spaces remain scarce. The identification of existing inadequacies is essential to support the activities of sanitary surveillance, guide sectoral public policies, and implement educational actions aimed at market vendors. Given the above, this study aimed to evaluate the hygienic-sanitary conditions in open-air markets and public markets in Recife, Pernambuco, as well as to characterize the sociodemographic profile of the market vendors working in these establishments.

2 MATERIALS AND METHODS

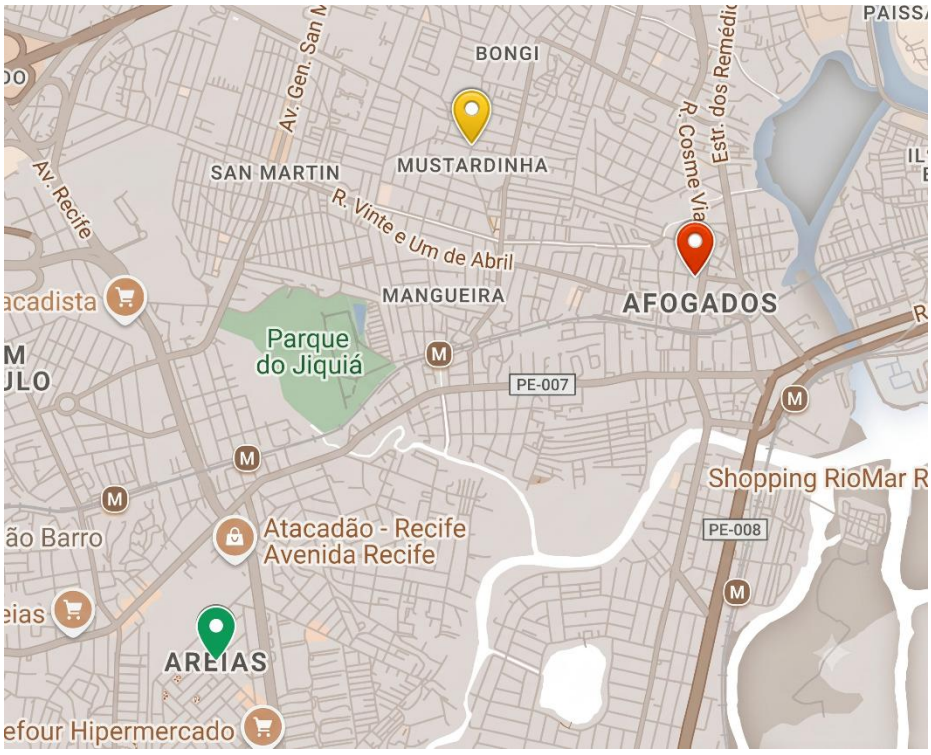
2.1 STUDY DESIGN

This is an observational, exploratory, descriptive cross-sectional study with a quantitative approach.

2.1.2 Study area

Daily visits were conducted at three street markets in the city of Recife/Pernambuco, Brazil. One was located in the Afogados neighborhood and was subdivided into three parts: Afogados Public Market, the New Afogados Street Market, and the New Afogados Street Market (another section). The second market was located in the Mustardinha neighborhood, and the third was at the Areias public market (Figure 1).

Figure 1 - Geographic context of the study area, highlighting the position of the neighborhoods Afogados and Mustardinha in the West and North zones of the city of Recife, Pernambuco/Brazil



Source: The map contextualizes the location of the study's municipalities.

2.1.3 Study population end sampling

Street vendors in the municipality of Recife, Pernambuco state, were included in the research between November and December 2024. The study population consisted of all active street vendors (N = 120) working at the Afogados, Mustardinha, and Areias markets during the data collection period. Included in the study were self-employed professionals over 18 years of age, without restrictions of race or gender, who were actively working at their place of work at the Afogados, Mustardinha, and Areias markets. Professionals who did not work at the aforementioned markets, who were not active, and who were under 18 years of age were excluded.

The sample size was calculated using the formula for finite populations: $n = [Z^2 \times p \times (1-p) \times N] / [Z^2 \times p \times (1-p) + e^2 \times (N-1)]$, where Z = 1.96 (95% confidence level), p = 0.50 (estimated prevalence of inadequacy), e = 0.10 (10% margin of error), and N = 120 (total active vendors in the five market sectors). This calculation resulted in a minimum sample of 65 participants. This sample was proportionally distributed across the five market sectors based on the number of active vendors per location. Thus, the sampling strategy was non-probabilistic and convenience-based, limited by the number of vendors available and willing to participate during the data collection period.

2.1.4 Data collection and studied variables

A questionnaire was administered through interviews to obtain information pertaining to sociodemographic data and local hygienic-sanitary conditions. The latter involved food handling, hygiene and storage of utensils, adequate environmental conditions, an analysis of the handlers' conditions, physical structure, storage of raw materials and marketed products, as well as the socioeconomic situation of the handlers.

The checklist items are presented in supplementary material (Appendix A). The checklist was prepared according to RDC nº. 216 of the ANVISA (BRASIL, 2004) and the Technical Standard of the Health Department (SESAU) nº. 01 of June 1, 2017 (SESAU, 2017). The response options for completing the checklist were: compliant (C), non-compliant (NC), or not applicable (NA). The unit of analysis for the checklist was each market sector (n = 5), where each sector's compliance was calculated based on the evaluation of applicable items. For

vendor-level analyses (sociodemographic profile and individual practices), the unit of analysis was each individual vendor (n = 65).

2.1.5 Checklist validation

The checklist was validated for content by three experts in food safety and sanitary surveillance. Content Validity Index (CVI) was calculated, with items achieving a CVI ≥ 0.80 retained. The validation process involved experts independently rating each item on a 4-point Likert scale regarding relevance, clarity, and representativeness of the hygienic-sanitary constructs. Inter-rater reliability was assessed using Cohen's kappa coefficient ($\kappa = 0.85$), indicating strong agreement.

2.1.6 Data Analysis Method

Data were tabulated in Microsoft Excel 2017® and analyzed using IBM SPSS Statistics, version 28. Non-parametric statistical tests were employed due to the categorical and ordinal nature of the variables.

The dependent variable for regression analysis was "non-compliance," defined as the presence of any non-compliant item in the checklist assessment at the market level. For vendor-level analyses, compliance with good handling practices was defined as the proportion of compliant items per vendor. The association between nominal categorical variables (market location vs. compliance, gender vs. ethnicity) was assessed using Pearson's chi-square test. When more than 20% of contingency table cells had expected frequencies below 5, Fisher's exact test was applied. To compare distributions of ordinal variables (education level, income bracket, time in profession) between two independent groups, the Mann-Whitney U test was used; for three or more groups, the Kruskal-Wallis test was applied, followed by Dunn's post-hoc test with Bonferroni correction for multiple comparisons when significant differences were found. A p-value < 0.05 was considered statistically significant.

Binary logistic regression analysis was performed to identify predictors of non-compliance at the market level. The dependent variable was non-compliance (dichotomous: compliant vs. non-compliant per item, aggregated per market). Independent variables included market location (categorical: Afogados 1, Afogados 2, Afogados 3, Mustardinha, Areias) and vendor education level (dichotomized: incomplete elementary education or less vs. complete elementary education or higher). Variables were selected for entry into the model based on their

significance in univariate analyses ($p < 0.20$). Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test and the Nagelkerke R^2. Odds ratios (OR) with 95% confidence intervals (CI) were reported.

2.1.7 Compliance calculation

The compliance percentage per market was calculated as the ratio between the number of compliant items and the total number of applicable items, multiplied by 100. Markets were categorized as having high compliance (>75%), moderate compliance (50-75%), or low compliance (<50%). For vendor-level analysis, an individual compliance score was calculated as the percentage of compliant items per vendor.

2.1.8 Ethical Statement

This study was conducted in accordance with the ethical principles outlined in Resolution nº 466/2012 of the Brazilian National Health Council (CNS). The research protocol was reviewed and approved by the Human Research Ethics Committee of the responsible institution under CAAE nº 65148822.4.0000.5193. All participants were informed about the objectives, procedures, risks, and benefits of the study and provided written informed consent prior to data collection. Confidentiality and anonymity of all personal information were guaranteed throughout the research process. Participation was entirely voluntary, and participants could withdraw at any time without any penalty or loss of benefits.

3 RESULTS

3.1 SOCIODEMOGRAPHIC PROFILE OF MARKET VENDORS

The profile of the 65 interviewed market vendors is detailed in Table 1. Regarding gender, the majority of participants identified as female (52.3%; n=34), followed by male (42%; n=27) and other genders (6%; n=4). Age distribution showed a predominantly working-age population, with a concentration in the 40 to 50-year-old range (38%; n=25), followed by 29-39 years (28%; n=18), 51-61 years (18%; n=12), 18-29 years (14%; n=9), and over 61 years (2%; n=1). Regarding ethnic-racial composition, the predominant self-declaration was Black

(38%; n=25), followed by Mixed-race/Pardo (31%; n=20), White (26%; n=17), and Indigenous (5%; n=3).

Table 1 - Sociodemographic and professional characterization of the interviewed market vendors (N=65). Recife, Pernambuco, 2024

Variable	Category	n	%
Gender	Male	27	41,5
	Female	34	52,3
	Others	4	6,2
Age Group (years)	18-29	9	13,8
	30-39	18	27,7
	40-50	25	38,5
	51-61	12	18,5
	> 61	1	1,5
Ethnicity/Race	White	17	26,2
	Black	25	38,5
	Mixed-race/Pardo	20	30,8
	Indigenous people	3	4,6
Time as a Market Vendor (in years)	< 1	1	1,5
	1 - 3	13	20,0
	3 - 5	30	46,2
	5 - 7	8	12,3
	> 7	13	20,0
Education Level	Illiterate	4	6,2
	Incomplete Elementary	24	36,9
	Complete Elementary	14	21,5
	Incomplete Secondary	11	16,9
	Complete Secondary	12	18,5
Education Level (dichotomized)	Incomplete Elementary or less	28	43.1
	Complete Elementary or higher	37	56.9
Income Range (in minimum wages)	< 1	1	1,5
	1	11	16,9
	1 - 2	34	52,3
	2 - 3	14	21,5
	> 3	3	4,6
Do you have another profession?	Yes	6	9,2
	No	59	90,8

The analysis of professional characteristics revealed a population with significant experience in informal commerce. Most respondents (46.2%; n=30) have worked as market vendors for 3 to 5 years, while 20.0% (n=13) have more than 7 years of experience, 20.0% (n=13) have worked for 1-3 years, 12.3% (n=8) for 5-7 years, and only 1.5% (n=1) have been active for less than one year.

Educational gaps were significant: 36.9% (n=24) did not complete elementary education, 21.5% (n=14) completed elementary education, 18.5% (n=12) completed high school, 16.9% (n=11) did not complete high school, and 6.2% (n=4) were illiterate. For the purpose of regression analysis, education level was dichotomized into “incomplete elementary education or less” (43.1%; n=28) and “complete elementary education or higher” (56.9%; n=37). Income distribution showed a concentration in the lower brackets: 52.3% (n=34) earn between 1-2 minimum wages, 21.5% (n=14) earn between 2-3 minimum wages, 16.9% (n=11) earn one minimum wage, 4.6% (n=3) earn more than three minimum wages, and 1.5% (n=1) earn less than one minimum wage. Among the respondents, only 9.2% (n=6) reported having another profession or occupation besides their work as market vendors, highlighting the economic dependence on this activity.

3.2 HYGIENIC-SANITARY CONDITIONS IN THE MARKETS

The assessment of hygienic-sanitary conditions, based on a 29-item checklist distributed across six categories, revealed a predominantly non-compliant scenario in all establishments studied. Table 2 presents the compliance profile by category and market sector.

Table 2 - Compliance profile by checklist category and market sector. Data expressed as percentage of compliant items (%)

(continue)

Category	Total Items	Afogados 1 (%)	Afogados 2 (%)	Afogados 3 (%)	Mustardinha (%)	Areias (%)
Building and facilities	2	0.0	0.0	50.0	0.0	0.0
Flooring	2	0.0	0.0	50.0	0.0	0.0

(conclusion)

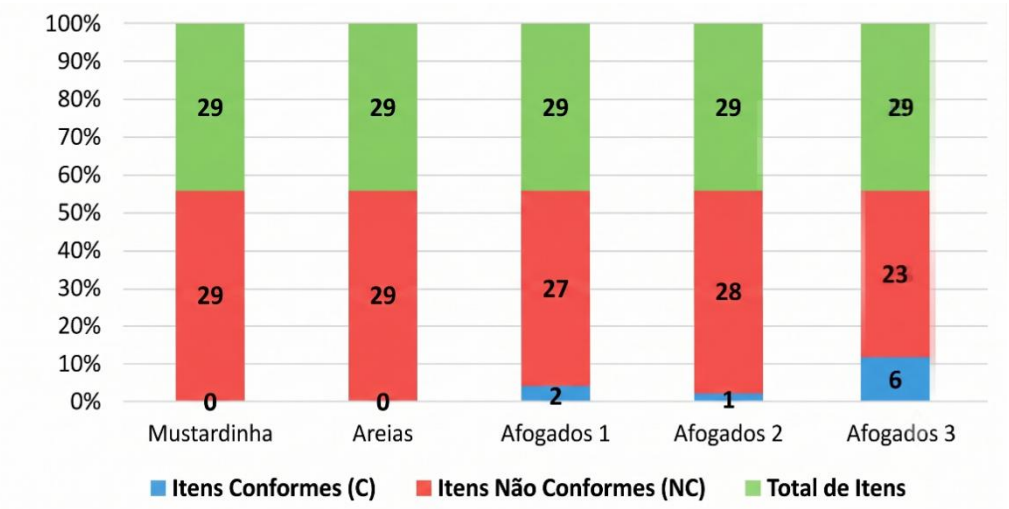
Category	Total Items	Afogados 1 (%)	Afogados 2 (%)	Afogados 3 (%)	Mustardinha (%)	Areias (%)
Sanitary facilities and changing rooms	7	14.3	0.0	28.6	0.0	0.0
Cleaning of facilities, equipment, utensils	4	0.0	0.0	25.0	0.0	0.0
Integrated control of vectors and pests	2	0.0	0.0	50.0	0.0	0.0
Food storage, stocking, and display	9	0.0	11.1	11.1	0.0	0.0
Total compliance (%)	**29**	**6.9**	**3.4**	**20.7**	**0.0**	**0.0**

The Mustardinha and Areias markets showed the highest level of inadequacy, with 0% compliance across all evaluated items. The Afogados Public Market (Afogados 1) recorded 6.9% compliance (2/29 items). The only compliance identified at this location related to item 3.7, which assesses the availability of restroom facilities for visitors. The Afogados Open-Air Market - New Section (Afogados 2) showed 3.4% compliance (1/29 items). In contrast, the New Afogados Open-Air Market (Afogados 3) exhibited the best relative performance, though still with a low compliance rate of 20.7% (6/29 items). The compliant items at this location (1.2, 2.1, 3.2, 3.3, 4.3, and 5.2) indicate specific points of adequacy in the areas of hygiene, storage, and physical infrastructure.

Disaggregated analysis by checklist category revealed that the most critical areas were “sanitary facilities and changing rooms for handlers” (0% compliance in four of five markets) and “food storage, stocking, and display conditions” (mean compliance 4.4%). The category with the highest relative compliance was “building and facilities” (mean compliance 10.0%), though still critically low. When comparing compliance rates across food categories, significant differences were observed ($\chi^2 = 8.92$; $p = 0.030$). Products of animal origin (meat, fish, cheese)

presented the lowest compliance rates (mean 12.3%), while non-perishable goods (grains, packaged products) showed higher compliance (mean 34.7%). Figure 2 presents the overall compliance profile per market.

Figure 2 - Hygienic-sanitary compliance profile in open-air markets and public markets of Recife, Pernambuco-Brazil. Data expressed as number of compliant (C) and non-compliant (NC) items



Source: The graph shows the number of compliant (C) and non-compliant (NC) items evaluated per market. The total number of items assessed per market is displayed above each pair of bars.

2.4 STATISTICAL ANALYSIS

To verify the association between market location and compliance, Pearson's chi-square test was applied, revealing a statistically significant difference between markets ($\chi 2 = 12.47$; $p = 0.014$), indicating that hygienic-sanitary conditions vary by establishment, with Afogados 3 showing superior performance.

The Kruskal-Wallis test revealed significant associations between vendors' education level and compliance with good handling practices ($H = 8.64$; $p = 0.013$). Median compliance scores (percentage of compliant items per vendor) were: incomplete elementary education or less: median = 8.5% (IQR: 3.8-14.2); complete elementary or higher: median = 18.2% (IQR: 10.5-24.6). Dunn's post-hoc test with Bonferroni correction confirmed that the difference between these groups was statistically significant ($p = 0.012$). Vendors with complete elementary education or higher demonstrated better compliance with hand hygiene and food storage requirements compared to those with incomplete elementary education or illiteracy. No

significant association was found between compliance and gender (Mann-Whitney U = 485.5; p = 0.421) or time in profession (Kruskal-Wallis H = 3.21; p = 0.201).

Table 3 - Binary logistic regression analysis of predictors of non compliance

Predictor Variable	β Coefficient	SE	Wald χ^2	p-value	OR	95% CI
Market location (Afogados 3 as reference)	1.176	0.384	9.38	0.002	3.24	1.82 - 5.78
Education level (Incomplete elementary or less vs. complete elementary or higher)	0.774	0.291	7.07	0.008	2.17	1.23 - 3.84

Source: Model fit: Hosmer-Lemeshow $\chi^2 = 6.21$; p = 0.624; Nagelkerke $R^2 = 0.342$; Overall correct classification = 74.8%. SE = Standard Error; OR = Odds Ratio; CI = Confidence Interval.

A binary logistic regression was performed in order to identify predictors of non-compliance at the market level. As shown in Table 3, the model was statistically significant ($\chi^2 = 18.42$; p = 0.001) and correctly classified 74.8% of cases. Market location (Afogados 3 as reference) was a significant predictor (OR = 3.24; 95% CI: 1.82–5.78; p = 0.002), with Mustardinha and Areias markets showing 3.2 times higher odds of non-compliance compared to Afogados 3.

Vendor education level was also a significant predictor (OR = 2.17; 95% CI: 1.23-3.84; p = 0.008), with vendors having incomplete elementary education or less showing 2.2 times higher odds of non-compliance with good handling practices compared to those with complete elementary education or higher. The Hosmer-Lemeshow test indicated good model fit ($\chi^2 = 6.21$; p = 0.624), and the Nagelkerke R^2 value of 0.342 suggested that the model explained approximately 34% of the variance in non-compliance.

4 DISCUSSION

The findings of this study reveal a critical scenario of hygienic-sanitary inadequacies in open-air markets and public markets in Recife, Pernambuco, with compliance rates ranging from 0% to 20.7% across the five evaluated market sectors. These results are consistent with international evidence demonstrating that traditional markets, despite their socioeconomic importance, frequently present structural and operational deficiencies that compromise food safety (HANNAH *et al*., 2022; FAVA; CARRASCO i BONET; GARRIDO i PUIG, 2022).

4.1 SOCIOECONOMIC RELEVANCE AND VENDOR VULNERABILITY

The sociodemographic profile identified in this study, predominantly female vendors (52.3%), aged 40-50 years, with low education levels (43.1% with incomplete elementary education or less) and income concentrated between one and two minimum wages, corroborates the findings from other contexts. Hannah *et al*. (2022), analyzing 18 secondary cities in Kenya and Zambia, observed that open-air markets serve as the primary food source for low- and middle-income households, with vendors frequently facing precarious working conditions and limited access to training and infrastructure.

The economic dependence on vending activity, observed in 90.8% of respondents, reinforces the notion that these markets are not merely commercial spaces but essential livelihood strategies for vulnerable populations. This finding aligns with the perspective of Navapan & Charoenkit (2021), who recognize local markets as “ordinary public spaces” that, beyond their economic function, promote social inclusion and strengthen community ties through short supply chains that reduce greenhouse gas emissions while offering fresh, nutritious products at affordable prices.

While studies in Asian and African contexts highlight the resilience and adaptive capacity of these spaces (NAVAPAN; CHAROENKIT, 2021; KUBOKA M. *et al*., 2024), the Recife case reveals a scenario of structural abandonment that compromises food safety, suggesting that precariousness assumes distinct contours depending on the sociopolitical context and the degree of state intervention.

The review conducted by Wallace *et al*. (2022) in low- and middle-income countries demonstrated that low levels of compliance with food safety standards are often associated with vendors’ limited awareness of existing regulations or a lack of knowledge on how to implement

them. This finding corroborates the results of the present study, in which low educational attainment (43.1% with incomplete elementary education or less) constituted a significant predictor of non-compliance (OR = 2.17; p = 0.008), reinforcing the need for continuous and accessible training for food handlers in public markets.

In a qualitative study conducted in Kenya, Kuboka *et al*. (2024) observed that consumers and vendors confuse quality attributes, particularly freshness, with food safety, prioritizing sensory aspects over safe handling practices. This conceptual confusion, also identified in Brazilian markets, contributes to the perpetuation of risky behaviors. Furthermore, the authors highlighted that the absence of consumer demand for food safety reduces incentives for vendors to adopt better practices, an aspect that warrants attention in intervention strategies for public markets.

Additionally, Guimarães & Doula (2023) identified that markets often lack adequate management and maintenance by public authorities, presenting physical structures in a critical state of disrepair, which supports the findings of the present study regarding the structural and operational inadequacies in Recife.

4.2 STRUCTURAL AND OPERATIONAL INADEQUACIES

The absence of basic infrastructure identified in this study, including inadequate sanitary facilities, improper waste management, lack of refrigeration for perishable foods, and the presence of animals in sales areas, reflects a pattern documented across various geographic contexts. Fava, Carrasco i Bonet, Garrido i Puig (2022) demonstrated that open municipal markets in rural Spain face similar challenges, including aging vendor populations, limited product diversity, and lack of adaptation to consumer demands, such as restricted operating hours. The authors point out that the absence of a recognized “brand” that values marketed products and the lack of organized vendor associations contribute to the weakening of these spaces, hindering their competitiveness against other food retail formats.

The disaggregated analysis by checklist category revealed that the most critical areas were “sanitary facilities and changing rooms for handlers” (0% compliance in four of five markets) and “food storage, stocking, and display conditions” (mean compliance 4.4%). These findings are particularly concerning given that the Codex Alimentarius guidelines on hygiene in traditional markets (FAO/WHO, 2024) establish that market infrastructure must provide basic conditions for good hygiene practices, including physical separation of high-risk areas, adequate drainage systems, and sufficient potable water supply. The WHO manual *Five Keys*

for Safety Traditional Food Markets (WHO, 2023) reinforces the need for practical actions such as regular facility disinfection and zoning systems to prevent cross-contamination, along with animal contact control through species separation and ensuring animal health and welfare.

These international recommendations are particularly relevant given one of the most critical inadequacies observed in the present study: the presence of animals in sales areas, which constitutes a direct violation of these guidelines and significantly increases the risk of zoonotic diseases and cross-contamination. The Codex Alimentarius document (WHO, 2023) explicitly states that "any food found to have become contaminated/infested by animals and/or pests should be hygienically disposed of in a manner to prevent contamination/infestation of other foods."

The study by Rosa & Lobato (2021) corroborates the findings of the present study by demonstrating a historical trend of structural inadequacies and poor handling practices in open-air and public markets in Brazil, with 75% of the studies concentrated in the Northeast Region. The authors highlight that the absence of basic infrastructure and non-compliance with Good Handling Practices are recurring factors that expose consumers to the risk of WFDs. Oliveira *et al*. (2021), in the same public markets in Recife evaluated in the present research, revealed similar inadequacies in the hygienic-sanitary conditions for the sale of ready-to-eat foods. The authors identified that only 29.1% of establishments-maintained foods at adequate temperatures, 17.3% labeled manufacturing and expiration dates, and 59.1% of stalls exhibited animal circulation in sales areas.

Additionally, it was observed that 59.8% of food handlers wore adornments and 38.6% presented inadequate hygiene. These findings reinforce the need for coordinated interventions to improve structural conditions and provide training for market vendors.

A recent study demonstrated that vendor compliance in wholesale markets is influenced in an opportunistic manner, with adherence to required practices decreasing when there is a lower perceived risk of inspection or sampling (ZHOU *et al*., 2025). This evidence aligns with the findings of the present study, in which significant variation in compliance among different markets ($p = 0.014$) and the increased risk of non-compliance in specific locations (OR = 3.24) suggest that the effective presence of sanitary surveillance and the regularity of inspection actions may play a decisive role in maintaining hygienic-sanitary conditions.

4.3 MICROBIOLOGICAL CONTAMINATION AND ANTIMICROBIAL RESISTANCE

Although the present study did not perform microbiological analyses, the structural inadequacies documented here align with findings from previous research conducted in similar contexts. For instance, Souza *et al*. (2023) in São Luís (Maranhão) detected contamination by *S. aureus* in 60.47% of samples and by *E. coli* in 40.70%, with *Salmonella* spp. present in chicken and fish samples. Similarly, Garcia Junior et al. (2023) in Macapá (Amapá) found 100% of butter cheese samples contaminated by at least one pathogenic agent, with thermotolerant coliforms in 98% and *S. aureus* in 61% of samples.

Particularly relevant to the context of Recife is the study by Jorge *et al*. (2025), which analyzed animal-derived products from public markets in the southern zone of the city and identified *Salmonella* spp. in 50% of samples from one market and in chicken from another; S. aureus in 75% of samples from both markets; and *E. coli* in 100% of samples from one market and 80% from the other. Additionally, all *S. aureus* strains exhibited the MRSA phenotype, and MDR profiles were detected in *E. coli* and *Salmonella* spp. These findings suggest that the structural inadequacies observed in the present study may contribute to the contamination patterns reported in the literature, reinforcing the need for integrated interventions that address both infrastructure and microbiological quality.

In addition to the microbiological contamination identified in animal-derived products, studies conducted in other low- and middle-income country contexts demonstrate that fresh fruits and vegetables sold in open-air markets also constitute important vehicles for pathogens of public health relevance. In Dakar, Senegal, Sane *et al*. (2024) detected contamination by *E. coli* in 50.83% of fruit and vegetable samples analyzed, with bacterial levels ranging from 1.3×10^{3} to 6×10^{6} CFU/g, values significantly exceeding acceptable limits for human consumption. Lettuce and mint presented the highest contamination rates (97.5% and 100%, respectively), whereas *Salmonella* spp., although not isolated by culture, was identified in 93.47% of samples subjected to metagenomic analysis. These findings reinforce that the structural inadequacies observed in public markets, such as the absence of adequate sanitary facilities and improper waste management, may compromise not only the safety of animal-derived products but also that of plant products consumed raw, thereby broadening the spectrum of health risk to the population.

4.4 PREDICTORS OF NON-COMPLIANCE

The binary logistic regression analysis identified two significant predictors of non-compliance: market location (OR = 3.24; p = 0.002) and vendor education level (OR = 2.17; p = 0.008). These findings suggest that establishment-specific factors and vendor training significantly influence sanitary conditions.

The fact that vendors with incomplete elementary education or less showed 2.2 times higher odds of non-compliance with good handling practices highlights the importance of educational interventions. This finding is consistent with studies demonstrating that food handler training significantly improves hygiene practices and reduces contamination risks (YOUNG *et al*., 2019; OLIVEIRA *et al*., 2021). The significant variation between markets, with Mustardinha and Areias showing 3.2 times higher odds of non-compliance compared to Afogados 3, suggests that market management practices and infrastructure investments also play essential roles, reinforcing the importance of differentiated approaches tailored to each establishment's specific conditions.

4.5 IMPLICATIONS FOR URBAN PLANNING AND PUBLIC POLICY

The findings reinforce the need for integrated urban planning approaches that recognize traditional markets as essential components of urban food systems (Silva; Santos, 2024). Fava; Carrasco i Bonet; Garrido i Puig (2022) argue that municipal governments play an essential role in managing the transition of open municipal markets, enhancing the social dimension of agroecology and providing spaces for local food policies. This requires not only normative aspects, such as defining the proportion of producer-retailers and establishing quality and price standards, but also public communication of the added value of buying in traditional markets.

The Codex Alimentarius guidelines emphasize the need for multi-stakeholder committees involving food business operators, competent authorities, consumer associations, and market authorities to advise on regular market cleaning, repairs, and access to critical services such as potable water and waste management. The WHO manual (WHO, 2023) complements this guidance by highlighting three essential pillars for the effectiveness of safety measures: (i) strengthening health regulations and public policies, with the adoption of a conceptual regulatory framework; (ii) risk communication and community engagement; and

(iii) continuous training of all involved actors. Such participatory governance structures remain absent in the Recife context.

The experience of Irituia, described by Resque *et al*. (2019), demonstrates that the formation of cooperatives and articulation between different institutions, rural extension services, universities, unions, can strengthen state-mediated markets and promote agrobiodiversity. In Recife, the absence of such networks and the fragility of vendor associations constitute significant obstacles to transitioning toward more sustainable practices and improving hygienic-sanitary conditions, indicating the need to foster social organization among these actors.

5 LIMITATIONS

This study presents several limitations that must be acknowledged. The sample of 65 vendors, while adequate for exploratory analyses, may not fully represent the diversity of vendors across all markets in Recife. Data collection was limited to Sanitary District V, preventing generalization to other districts with potentially different socioeconomic and infrastructural conditions.

The checklist-based assessment, while based on official norms, captures structural and procedural aspects but does not include microbiological analyses of food samples, which would provide direct evidence of contamination levels. The cross-sectional design does not allow for analysis of temporal trends or the effectiveness of past interventions. Additionally, the use of a convenience sample may introduce selection bias, as vendors who agreed to participate may differ from those who declined. Future studies should incorporate longitudinal designs, microbiological analyses, and broader geographic coverage.

6 CONCLUSION

This study evaluated the hygienic-sanitary conditions in open-air markets and public markets in Recife, Pernambuco, and characterized the sociodemographic profile of market vendors. The results reveal a critical scenario of structural and operational inadequacies, with compliance rates ranging from 0% to 20.7% across the five evaluated market sectors. The critical problems identified include the absence of adequate sanitary facilities, lack of refrigeration for perishable foods, presence of animals in sales areas, inadequate waste management, and precarious structural conditions that compromise food safety.

The sociodemographic profile, predominantly female (52.3%), aged 40-50 years, self-declared Black (38.5%), with low education levels (43.1% with incomplete elementary education or less) and income concentrated between one and two minimum wages, reflects the vulnerability of vendors who depend on this activity as their primary source of livelihood (90.8%). This economic dependence, combined with precarious working conditions, underscores the urgency of coordinated interventions.

The findings are aligned with international evidence demonstrating that traditional markets, despite their socioeconomic importance, frequently face structural deficiencies that compromise food safety. However, the Recife case presents higher levels of inadequacy compared to other contexts, particularly in waste management and sanitation infrastructure. The binary logistic regression analysis identified market location (OR = 3.24; p = 0.002) and vendor education level (OR = 2.17; p = 0.008) as significant predictors of non-compliance, highlighting the importance of establishment-specific factors and educational interventions.

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MINI CURRÍCULO E CONTRIBUIÇÕES AUTORES

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AUTOR 1	
PRONOME DE TRATAMENTO	Ms.
NOME COMPLETO	Erica Carvalho de Oliveira Alves
INSTITUIÇÃO/AFILIAÇÃO	University of Pernambuco
CIDADE	Recife
ESTADO	Pernambuco
PAÍS	Brazil
RESUMO DA BIOGRAFIA	Nutritionist, undergraduate student in Public Health at UPE. Council member of the Recife School Food Council. Served as local supporter for GEPPAAS/UFMG in municipalities of Pernambuco. Participated in research in rural settlements through the project "Healthy and Sustainable Territories." Experience in food policies, health promotion, nutrition education, and good food manufacturing practices.
CONTRIBUIÇÃO DO(S) AUTOR(ES) NO ARTIGO	Conceptualization, Investigation, Data curation, Writing - original draft.
AUTOR 2	
PRONOME DE TRATAMENTO	Dr.
NOME COMPLETO	Antônio Carlos Freitas Souza
INSTITUIÇÃO/AFILIAÇÃO	Institute of Scientific and Technological Research of the State of Amapá
CIDADE	Macapá
ESTADO	Amapá
PAÍS	Brazil
RESUMO DA BIOGRAFIA	Ph.D. in Animal Science from UEMA (2024), Master's in Health Sciences from UNIFAP (2013). Researcher at IEPA/AP, coordinating the Microbiology Laboratory of the Food Science and Technology Center. Partner-Director of R&D at BactoLac LTDA. Works in the areas of Aquaculture, Food Microbiology, Food Technology, and Agribusiness.
CONTRIBUIÇÃO DO(S) AUTOR(ES) NO ARTIGO	Methodology, Validation, Data curation, Formal analysis, Writing - review & editing.
AUTOR 3	
PRONOME DE TRATAMENTO	Dr.
NOME COMPLETO	Jorge Belém Oliveira Júnior
INSTITUIÇÃO/AFILIAÇÃO	Altino Ventura Foundation
CIDADE	Recife
ESTADO	Pernambuco
PAÍS	Brazil
RESUMO DA BIOGRAFIA	Ph.D. and Master's in Tropical Medicine from UFPE, with specializations in Clinical Microbiology, Biosafety, and Educational Management. Graduated in Biological Sciences (UFAL), currently pursuing a degree in Pharmacy. Lecturer in graduate programs and collaborating researcher at the Clinical Microbiology Laboratories (UFAL) and Food Technology Laboratory (IEPA/AP). Co-author of the book "Biossegurança e Controle de Infecções Risco Sanitário Hospitalar" (2023). Works in the areas of clinical microbiology, food

	microbiology, molecular biology, biosafety, infection control, and phytotherapy.
CONTRIBUIÇÃO DO(S) AUTOR(ES) NO ARTIGO	Conceptualization, Project administration, Methodology, Investigation, Validation, Data curation, Formal analysis, Supervision, Writing - original draft, Writing - review & editing.

Endereço de Correspondência dos autores	Jorge Belém Oliveira Júnior, PhD. Address: Department of Scientific Research, Altino Ventura Foundation, Recife/Pernambuco, Brazil.