


ORIGINAL ARTICLE

Food safety in Brazilian popular public restaurants: Food handlers' knowledge and practices

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Abstract

This study aims to assess food safety knowledge and practices of food handlers in popular public restaurants in Brazil. A questionnaire has been applied with 70 food handlers in different municipalities, with questions related to food safety knowledge and food safety self-reported practices, and observed practices. To check hygienic-sanitary conditions of restaurants, a checklist has been applied. Regarding food safety knowledge, an average of 72.64% of correct answers has been observed. Food safety self-reported practices presented 80.71% of adequacy, while observed practices were 75.40%. A positive correlation has been observed between food safety knowledge and self-reported practices of handlers. The observed food safety practice of handlers presented no correlation with food safety knowledge and self-reported practices. The average adequacy of hygienic-sanitary conditions was 68.08%, classifying the units as "regular." Despite satisfactory results related to the handlers' food safety knowledge and practices, the hygienic-sanitary conditions of the restaurants are of concern.

Practical applications

The Popular Restaurant Program in Brazil aims to provide proper food from a nutritional and hygienic-sanitary aspect at affordable prices. The assessment of food handlers' food safety knowledge and practices and the assessment of hygienic-sanitary conditions of these units are key in supporting actions aimed at improving the quality of the meals served, as food handlers are the essential agents in the production of meals and can become a source for food contamination if necessary care is not taken. Therefore, conducting this assessment can be an important tool for quality management in these units and can provide improvements in the process of food handling, in addition to ensuring compliance with the objectives proposed by the Popular Restaurant Program.

1 | INTRODUCTION

An increase in the amount of meals prepared outside of the home in recent years has occurred due to significant changes triggered by several factors, including urbanization, industrialization, professionalization of women, and reduction of time for food preparation and/or consumption, among other factors as socio-economic and cultural differences, changes in the family model, and increased costs with domestic workers (Akutsu, Botelho, Camargo, Sávio, & Araújo, 2005; Anjos, Santana, Souza, & Oliveira, 2014). Data from the Survey of Family Budget in Brazil show that between 2008 and 2009, expenses

for food prepared out of the home accounted for 31.1% of total food expenses (Instituto Brasileiro De Geografia E Estatística IBGE et al., 2010). In Brazil, the estimate is that one in every five meals is prepared out of the home.

With these findings, Popular Restaurants has been operating since 2006 in Brazil as a public tool for the promotion of Food and Nutrition Security. These restaurants provide quality meals from a nutritional and sanitary point of view at affordable prices, in comfortable environments, for a target audience in unsafe food zones (Brazil, 2012). In the state of RN, the target audience for this program is industrial workers, trade, street vendors, and unemployed (Secretaria

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de Estado do Trabalho, da Habitação e da Assistência Social (Sethas, 2017). Currently, approximately 23,000 meals/day are produced in RN, serving those in unsafe food zones and supplying menus adjusted to the eating habits and customs of the population (Sethas, 2017; Silva, 2008).

During the preparation of food products, food handlers play a key role in hygienic-sanitary control and may be responsible for the promotion of food-borne disease episodes (Muller, 2011). Training programs for these handlers can provide hygienic-sanitary quality assurance through specific training, as there are associations between food contamination, lack of knowledge, and/or negligence in food preparation (Lange, Gonçalves, Caçador, Zago, & Maeda, 2008; Saccol, Rubim, Mesquita, & Welter, 2006).

A study of food handlers in different types of sectors has shown that 62.2% of the participants had pathogenic bacteria on their nails, identified as several microorganisms, such as *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella*, and *Pseudomonas*. According to the data, the authors have observed that the contamination relates to the educational level of handlers, the habit of washing hands after using the toilet, and income (Nasrolahei, Mirshafiee, Kholdi, Salehiana, & Nasrolahei, 2017).

Assessing food safety knowledge and practices of food handlers is essential for making improvements in food quality, because they have been considered primarily responsible for food-borne diseases (Cunha, Stedefeldt, & Rosso, 2014a). According to Frewer, Shepherd, and Saparks (1994), food safety knowledge is important in the perception of risks, as the increase of food safety knowledge provides improvements in the control and regulation of food-borne illnesses. Additionally, the authors state that risk perception can guide decisions, implying changes in human behavior. Moreover, the evaluation of self-reported practices provides a useful and cost-effective approach, both to assess current hygiene status and to determine the training needs for employees. Good hygiene practices in food services are elementary for the prevention of foodborne illnesses and can control risks to consumers' health and overall public health (Wambui, Karuri, Lamuka, & Matofari, 2017).

Some studies have sought to clarify matters related to food safety knowledge and the practices of food handlers (Al-Shabib, Mosilhey, & Husain, 2016; Cunha, Stedefeldt, & Rosso, 2014b; Mello, Gama, Marin, & Colares, 2010; Zanin, Cunha, Stedefeldt, & Capriles, 2015). Demonstrating these practices seem to provide assistance in the development of new strategies for food handlers' training (Rossi, Stedefeldt, Cunha, & Rosso, 2017) and improve food safety (Latorres, Rancatti, Lasta, & Queiroz, 2016). Therefore, this research aims to assess the observed and self-reported practices of safety and food safety knowledge of food handlers working in Popular Restaurants in the state of RN.

2 | METHODOLOGICAL PROCEDURES

2.1 | General research data

Data collection was made locally through the application of a questionnaire with food handlers of Popular Restaurants in RN, as well as

the application of a checklist to assess their compliance with good food safety handling practices in the units.

The Ethics and Research Committee (CEP) of the Onofre Lopes University Hospital/Federal University of RN has approved this research in accordance with CAAE N^o. 51,180,115.0.0000.5292. The acknowledgement occurred spontaneously, with the handlers having signed the Term of Free and Informed Consent, through which they were informed about the risks and benefits of the study.

Popular Restaurants in RN that was considered for sampling consisted of 24 units (total units distributed in 20 municipalities in the year 2016). For the sampling plan, we have chosen the conglomerate method (Popular Restaurant Units in RN). A random lottery of 5 units was carried out, where all the food handlers of all the restaurants were approached (Bolfarine & Bussab, 2005). At this stage, the questionnaire tested in a pilot study was applied to check whether the scores of "food safety knowledge" variable presented variations between them. Five units were picked, each from a different municipality and among those that carried out production in loco, there were only 19. After the results of the assessment of the "knowledge" score, a sample calculation was carried out, totaling 10 restaurants for the research (Figure 1).

2.2 | Assessment of food handlers' self-reported food safety practices and knowledge

To carry out the socio-demographic characterization of food handlers, a questionnaire was prepared based on the studies of Liu et al. (2015), Freitas, Calazans and Alchiere (2014), Santos et al. (2008), and Cunha, Stedefeldt and Rosso (2012). To evaluate the food safety knowledge and self-reported practices of food handlers, a questionnaire based on Brazilian legislation for proper food safety handling practices (Brazil, 2004) and the study of Santos et al. (2008) were utilized.

Aimed at improving the questionnaire, we have conducted a pilot study with handlers of a Popular Restaurant. During the application, an assessment of the participants on possible difficulties in understanding the matters and providing the information was required. Accordingly, researchers have discussed and defined the changes deemed necessary for the final version of the questionnaire. This questionnaire is divided into three stages: socio-demographic evaluation, assessment of food safety knowledge and proper food safety handling practices, and assessment of self-reported food safety practices of food handlers.

Socio-demographic classification was obtained through information provided by the food handlers and documentation of evidence provided by the unit manager. The following information was collected for the food handlers' classification: age, gender, education, occupation, professional experience, and participation in training on proper food safety handling practices.

For the assessment of food handlers' food safety knowledge, the questionnaire presented 31 questions subdivided into three parts, according to the subjects required under current legislation for food handlers training (Brazil, 2004), namely foodborne diseases, hygienic handling, and personal hygiene. The questionnaire has presented three options for answers—True, False, and I don't know. The first

two are assigned a point if the answer is correct, and the last one is zero in all cases.

To assess food handlers' self-reported food safety practices, 18 questions were presented to identify said actions of research participants regarding the activities performed daily in the production of meals and related to food safety. The answers varied between always, sometimes, and never, with a point assigned for each correct answer, in accordance with the legislation in practice on proper food safety handling practices (Brazil, 2004).

2.3 | Assessment of hygienic-sanitary conditions of the units and observed food safety practices of food handlers

A checklist based on Brazilian legislation on good handling practices (Sacco, Stangarlin, & Hecktheuer, 2013) was used to check the hygienic-sanitary aspects of the units. The sanitary conditions of the units were classified by percentage, where "Very good" ranged from 91 to 100%; "Good" from 70 to 90%; "Regular" from 50 to 69%; "Bad" from 20 to 49%; and "Very bad" from 0 to 19%.

The checklist comprised of items related to "buildings, facilities, furniture, and utensils"; "hygiene of facilities, equipment, furniture, and fixtures"; "integrated control of vectors and urban pests"; "water supply"; "waste management"; "handlers"; "raw materials, ingredients and packaging"; "food preparation"; "storage and transportation of prepared food"; "exposure to consumption of prepared food"; "documentation and records"; "standard operating procedures" (SOP); and finally, "responsibility." This list was filled out through the observation "in loco" of the units, the production of the meals, and consultation of available operational documents and records.

The item "handlers" for this checklist was specifically used to assess food handlers' observed food safety practices during the meals' production and distribution stages.

2.4 | Data analysis

First, descriptive statistics of the study were carried out. A percentage of 60% correct was used as a cut-off point to classify as satisfactory/appropriate for food safety knowledge, self-reported food safety practices and the observed food safety practices of the handlers (Vo, Le, Le, Minh, & Nuorti, 2015). Statistical analysis was carried out using software R version 3.2.4, and a significance level of 5% was adopted. A Spearman test was performed to verify the existence of correlation between "food safety knowledge" and "self-reported food safety practices" of food handlers. This test was also used to check the correlation between "knowledge" and "observed practices" per restaurant; "self-reported practices" and "observed practices" per unit; "hygienic-sanitary conditions" and "knowledge"; and between "hygienic-sanitary conditions" and "self-reported practices". Finally, a Chi-square test was performed to check the association between knowledge and socio-demographic variables, and between self-reported practices and socio-demographic variables.

TABLE 1 Social demographic characteristics of food handlers

	Frequency (%)
Sex	
Male	74.3
Female	25.7
Age	
<20	1.4
20–29	31.2
30–40	48.6
>40	18.6
Schooling	
Unfinished elementary school	28.6
Elementary school	5.7
Unfinished high school	21.4
High school	42.9
Technical level	1.4
Professional category	
Cook	11.4
Kitchen porter	48.6
Magareff	11.4
Stockroom clerk	5.7
Assistant of general services	22.9
Time of service	
< 1 year	8.6
1–5 year	48.6
6–10 year	27.4
> 10 year	15.7
Time of training	
6 months or less	30.0
6 months to 1 year	34.3
> 1 year	25.7
Never trained	10.0

3 | RESULTS AND DISCUSSION

3.1 | Socio-demographic data

As shown in Table 1, among the food handlers participating in the research ($n = 70$), most of them were male, aged between 30 and 40 years, and have completed high school. Although nobody reported to be illiterate, it was observed that more than half of the food handlers (55.7%) presented an education level lower than a high school, from unfinished elementary education to unfinished secondary education. The level of education completed proves to be an important factor in regards to food safety, as food handlers need to understand the SOPs, as well as record their activities. According to Freitas, Calazans, and Alchieri (2014), the level of education completed is an important indicator of work quality, quality of life, and growth potential of employees. Regarding the professional characteristics, most of the participants worked as kitchen porters (48.6%) and worked in the field for 1–5 years (48.6%). We have observed that the highest frequency of food handlers' training had occurred within a period of 6 months to 1 year (Table 1). However, a significant portion of the food handlers had been trained for over a year (25.7%), whereas 10.0% of the food

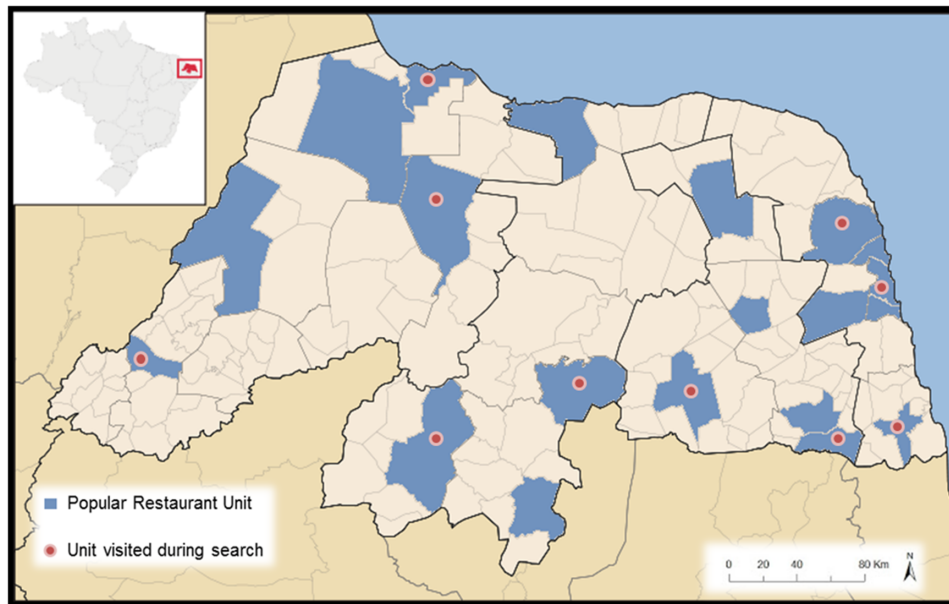


FIGURE 1 Popular restaurants in Rio Grande do Norte and municipalities visited for data collection

handlers had never received good handling practices training, and yet were performing food-handling activities. The current legislation recommends that training in the proper food safety practices (Brazil, 2004) is regularly carried out; therefore, 35.7% of food handlers were noncompliant with the legislation.

A study from the University of Saudi Arabia involving restaurant handlers, where all the participants were men, with an average age of 26–35 years, and 63.4% of the respondents were high school students (Al-shabib et al., 2016), identified similar professional characteristics. Moreover, the authors further observed that approximately 36.8% of the sample did not present a satisfactory reading level.

Freitas et al. (2014) have observed, among food handlers in hotels, a female majority, within the ages of 20–30 years, and with a high school. Most of these food handlers were salespeople, followed by kitchen assistants, working in the field for up to 5 years. Although the study was carried out in the same state as the present study, the results have differed in some areas, as it involved food handlers in hotel service.

3.2 | Assessment of food handlers' food safety knowledge

When assessing food handlers' food safety knowledge on good handling practices, an average of 72.76% (± 14.24) correct answers was obtained, thus demonstrating satisfactory/appropriate food safety knowledge according to the established cut-off point ($> 60.0\%$). A significant dispersion of the results near the average was observed for both food handlers' self-reported food safety knowledge and food safety practices and for hygienic-sanitary conditions of the units. This can be attributed to the fact that in Brazil, the public procurement model allows different companies to provide meals in popular restaurants and these companies have different quality standards. In some units, food safety training and supervision of food handlers are likely to occur more regularly, whereas others have not provided the

minimum implementation of adequate food safety practices recommended by current legislation (Brazil, 2004).

Although the overall result was satisfactory, we have observed that only 32.86% of the food handlers are aware of the inadequacy of washing hands with soap and water. Other food safety knowledge matters related to direct food contamination also presented low percentages, such as the proper practice of meat defrosting and meat temperature, and the proper measure to take in cases of hand injuries and the cooling of leftovers. These factors are closely associated with the proliferation of microorganisms and can trigger Foodborne Diseases scenarios. The food handlers also failed to demonstrate that they knew proper cleaning and sanitation concepts, with stages often ignored, and failures were observed in the implementation of SOPs. The highest percentage of correct answers per matter in this study was observed in the item related to chemical contamination of foods (97.14%) (Table 2). Cunha et al. (2014) have evaluated the knowledge of food handlers **from street food kiosks, beach kiosks, restaurants, hospitals and school meal services** in the city of Santos, Brazil, observing participants' knowledge level at 64%, which is lower than that of the findings of this study.

A positive correlation was observed between the variables "knowledge" and "self-reported food safety practices" of food handlers ($r = .364$; $p = .001941$). According to the estimated regression ($54,921 + 0.345 \times \text{knowledge}$), it is estimated that, for every 1% added to food safety knowledge, the self-reported food safety practices increase by an average of 0.345%. Cunha et al. (2014a) have also observed a positive association between these variables. Regarding the socio-demographic data, it was observed that there has been no association between the "knowledge" and "socio-demographic and occupational characteristics" of participants ($p > .05$) (Table 3). Others researches presented similar results (Ferreira et al., 2013; Gonzalez et al., 2009; Kunadu, Ofosu, Aboagyie, & Tano-Debrah, 2016; Osaili et al., 2013). No significant correlation was verified between food

TABLE 2 Percentage of correct answers due the assessment on food handlers knowledge

Questions	% Correct answers
1. Fresh eggs may contain salmonella bacteria, so they should not be eaten raw or undercooked	71.43
2. Bacteria can be on the skin, nose, and mouth of healthy people, thus contaminating food	88.57
3. Lettuce and other raw vegetables may have microorganisms that cause food-borne diseases	90.00
4. Microorganisms responsible for food-borne diseases grow at room temperature	67.14
5. Bacteria can multiply when a food is kept at room temperature for longer periods	81.43
6. Food prepared too much in advance is more susceptible to the growth of microorganisms	74.29
7. Storing prepared foods close to raw foods favors cross-contamination, which, in turn, can cause food-borne diseases	85.71
8. Storing food near close to cleaning materials may favor chemical contamination	97.14
9. The presence of physical contamination such as nails, hair, or screws in the food does not present a health hazard	70.00
10. Bandages and gloves should be correctly used before handling food in the event of cuts/wounds and burns.	
11. Food served raw (such as salads) shall not be sanitized	84.29
12. Improper handling of food increases the risk of contamination, because the handler may transmit microorganisms to the food	92.86
13. Food can be contaminated by bacteria when in contact with other food that have already been contaminated	94.29
14. Working surfaces, like boards and benches can be responsible for food contamination	94.29
15. When wearing gloves you can handle cooked food after having handled raw meat	85.71
16. During cooking, the food must reach at least 70 °C to ensure that microorganisms are removed.	82.86
17. Once prepared, cooked food must be kept above 60 °C	74.29
18. Stored leftovers must contain the following information: Name, date of preparation, and shelf life	84.29
19. Cooked food can be safely stored when refrigerated below 5 °C	64.29
20. Food must be cooled to room temperature before storage in a refrigerator	37.14
21. Defrosting can reduce but cannot destroy all bacteria that can cause food-borne diseases	74.29
22. After defrosting, the meat may be kept at room temperature for up to 5 hr	57.14
23. Food hygiene consists in the removal of unwanted solid residues such as dust, dirt, grease, and similar.	15.71
24. The cleaning process takes place in two stages: Disinfection and sanitization	4.29
25. After handling raw meat, the hands must be sanitized only with soap and running water	32.86
26. Always wash hands with soap, running water, and sanitizers after using the bathroom.	92.86
27. After sneezing, hands should be properly sanitized.	94.29

TABLE 2 (Continued)

Questions	% Correct answers
28. There is no need for men to remove mustache, because the contamination is lower	85.71
29. Nail polish in light colors may be used	92.86
30. Uniforms must be washed once a week	91.43
31. Not to use adornments (earrings, rings, necklace) during handling to avoid contamination	90.00

safety knowledge and observed food safety practices per restaurant in this study ($r = .142$, $p = .6965$).

3.3 | Assessment of food handlers' self-reported food safety practices

With regards to food handlers' self-reported food safety practices, an average of 80.71% (± 15.15) of correct answers was achieved, reaching the cut-off point established in the study. The percentage of correct answers per matter is shown in Table 4. The highest percentage was attributed to the absence of smoking habits in UAN's premises, where 98.57% have stated never to do this practice. Additionally, questions related to hand washing and disinfection have presented satisfactory results, because a few food handlers have stated that they always wash their hands with soap and water (17.14%). According to Codex Alimentarius Commission (2003), improper food handling is one of the main causes of food contamination, with poor hand hygiene representing a major risk factor. Thus, food handlers must always properly wash their hands at all stages of food production, before and after eating, after touching contaminated materials, and after using the toilet, among others (Al-Shabib et al., 2016). When assessing food handlers' self-reported food safety practices, UAN school in the municipality of Camaraçá, Brazil Soares, Almeida, Cerqueira, Carvalho, and Nunes (2012) have also identified a satisfactory percentage, where 70% of the questions were correct. Although the result is lower than the one observed in this research, the score of their study has reached the established cut-off point.

When correlating self-reported food safety practices and observed food safety practices per unit, no significant correlation was observed ($r = .234$, $p = .5155$). Rebouças et al. (2017) observed adequate self-reported food safety practices by food handlers; however, some unsatisfactory hygiene practices were observed. Likewise, this

TABLE 3 Results of Chi-square test for association (p value) between knowledge, self-reported practices, and social-demographic characteristics

Social and Demographic variables	Knowledge p value	Self-reported practices p value
Sex	.8553	.5959
Age	.2826	.724
School level	.2514	.1333
Professional category	.8056	.3415
Experience time as food handler	.4349	.5432
Training	.4338	.7144

TABLE 4 Percentage of correct answers to each question in the assessment of self-reported practices of food handlers

Questions	% correct answers
1. Are you removed from your labor activities when you are sick?	52.24
2. Do you wear the uniform outside the food and nutrition facilities?	91.43
3. Do you change uniforms when they get dirty?	92.86
4. Do you wash hands when you arrive at work?	88.57
5. Do you forget to wash hands to handle a prepared food when you have been handling raw food before?	74.29
6. If you eventually touch the garbage or cleaning products, do you wash your hands properly?	97.14
7. Do you wash your hands only with soap and running water?	17.14
8. Do you wash your hands after going to the toilet?	91.43
9. Do you smoke in the food and nutrition facilities?	98.57
10. Do you talk, sing, whistle, sneeze, spit, cough, eat or handle money during your activities?	82.86
11. Do you work without a bouffant?	91.43
12. Do you keep your nails short?	90.00
13. Do you work with adornments (earrings, bracelets, rings), make-up and perfumes?	90.00
14. Do you clean the countertops and sterilize with alcohol before start using it?	91.43
15. Do you sanitize packaging, such as cans, before using the product?	77.61
16. Do you sanitize boards and knives already used for raw foods before using them for other types of food?	90.00
17. Do you leave the leftovers at room temperature for a few hours and then freeze them?	65.63
18. When preparing fresh foods, such as vegetables and fruits, do you wash it only with running water?	53.03

study has also shown no association between self-reported food safety practices and socio-demographic characteristics of the participants ($p > .05$) (Table 2). In a study by Tan, Bakar, Karim, Lee, and Mahyudin (2013), there was no significant association between the average of "self-reported practices" and variables such as "age", "gender", "education level", "work experience" and "training". Although the results of this study presented no association of socio-demographic variables both with self-reported food safety practices and food safety knowledge, the relevance of these socio-demographic characteristics is acknowledged as an influencer in this process, especially in regards to the education level of individuals, once it was also observed that the increase of food safety knowledge leads to an increase in the self-reported food safety practices.

3.4 | Hygienic-sanitary conditions of restaurants

It was observed that the hygienic-sanitary conditions of the restaurant units reached an overall average of 68.08% (± 13.63), which classifies them as Regular (Saccol et al., 2013). In general, "buildings, facilities, furniture and utensils" was the category with the lowest percentage (58.8%), which could compromise food quality (Table 5). The result of hygienic-sanitary inadequacies in Popular Restaurants of RN has been

reproduced even years after the program has been in place, and can be corroborated when compared to the data obtained from the research conducted by Silva (2008), as well as to the case study of Souza, Calazans, and Bagni (2016), where the units were, similarly, classified as Regular.

Regarding the buildings and facilities of the units under this study, we have found that most of the buildings leased for the operation of Popular Restaurants were planned for another purpose. Some physical structures are residences adapted to produce meals, while others are sheds without the required divisions to allow an adequate flow of food, as determined by the current legislation (Brazil, 2004). A study carried out at Popular Restaurants in the state of Rio de Janeiro has found that 70% of the investigated Popular Restaurants were adapted sites that have been built for another purpose (Mello, Sales, Jaeger, & Colares, 2013), thus demonstrating that such a fact may be common to the other units in the program. When evaluating the hygienic and sanitary conditions of these restaurants, the same authors have observed inadequacies, all of which have been classified as partially adequate, with a percentage between 51 and 76% (Mello et al., 2013). These results are in line with the present study.

The subject "documentation and registration of activities" has also presented a low adequacy percentage (62.9%) (Table 5). Current legislation requires food services to have a Manual of Good Practices and SOP and these should be available to service staff and health authorities upon request (Brazil, 2004). In the present study, we have observed units that failed to present a Manual of Good Practices, and some had not implemented the SOP recommended by law. In this sense, it was possible to observe that there is a failure in the daily activities records, especially those related to hygiene, thus compromising the quality and freshness of the food served in the unit, as it disagrees with current legislation. Based on consumers' reports, the absence of the Technical Manager was observed in one of the units under study, which represents a relevant inadequacy.

TABLE 5 Hygienic-sanitary conditions of popular restaurants in Rio Grande do Norte

Blocks assessed	Average	DP (Standard Deviation)
1. Buildings, facilities, equipment, furniture, and fixtures	58.80	16.69
2. Sanitation of facilities, equipment, furniture, and fixtures	78.24	12.10
3. Integrated control of vectors and urban pests	75.00	28.60
4. Water supply	69.62	38.37
5. Waste management	82.50	23.72
6. Handlers	74.62	17.78
7. Raw materials, ingredients, and packaging	77.31	18.17
8. Preparation of food	69.40	18.32
9. Storage and transport of prepared food	94.44	9.62
10. Exposure to consumption of prepared food	75.75	21.51
11. Documentation and records	62.92	45.19
12. Liability	70.00	42.16

According to the term of reference governing the hiring of outsourced companies responsible for the provision of meals to Popular Restaurants in Brazil, each company must present in its permanent staff a nutritionist that holds a certification of legal technical responsibility to produce meals, and who shall monitor operations to ensure the quality of meals produced (Sethas, 2016). The nutritionist is the professional qualified to perform activities of planning, organizing, directing, and controlling of activities in food services (Brazil, 1991), being fundamental in the process of quality control of meals served.

Although the item “food preparation” has presented an overall adequate percentage, there were still inadequate practices regarding essential items, such as absence of temperature control, meat defrosting at room temperature, and perishable foods exposed to room temperature for longer periods, and so on. These are essential items to guarantee food quality, because a noncompliance with adequate practices in this stage can directly influence the contamination of food, enabling the growth of microorganisms that can lead to the occurrence of DTA.

The highest percentage related to the “storage and transportation of prepared food”, reaching 94.4% (Table 5). However, this block has been applied to a few units, as only three of them transported the food prepared for distribution to other Popular Restaurant units in the same municipality or in neighboring municipalities. It is extremely important to obtain satisfactory results in this category, considering the relevance of temperature control in this process to avoid microbial growth, thus avoiding DTA.

When correlating the hygienic-sanitary conditions data with food handlers' food safety knowledge, no significant result was observed ($r = .103$, $p = .785$). Furthermore, no significant correlation was found between hygienic-sanitary conditions and “self-referred practices” ($r = .503$; $p = .143$). The general hygienic-sanitary conditions seem not to be influenced by the food handlers' food safety knowledge and self-reported food safety practices, as they involve items that do not depend directly on the food handler, such as “buildings, facilities, furniture and utensils” and “documentation and records”, which in both cases presented the lowest percentages. The results of the study by Rebouças et al. (2017) corroborate with these findings. Olmedo, Stangarlin-Fiori, Medeiros, Tondo, and Ferreira (2017), analyzing the results of sanitary inspections in food services located in Curitiba-Brazil, demonstrated that 70% of the inspections showed nonconformities with the requirements of the current legislation concerning good handling practices. The main irregularities found were related to work procedures and processes, sanitary conditions, and physical structure, which reinforce the importance that legislators and inspection teams reevaluate their goals, strategies, and work processes to prioritize food safety.

On the grounds of the objective proposed by the Popular Restaurant Program regarding the hygienic-sanitary conditions of meals, which aims to provide appropriate meals (Brazil, 2004), the results of this study show that the units are noncompliant with the provisions of the program policy. Additionally, the relevance of the search for improvements in these conditions is evident, as these units are aimed at serving an audience that are in unsafe food zones (Brazil, 2004).

3.5 | Assessment of observed food safety practices

The practices of food handlers were observed and evaluated per restaurant, conducting punctual observations of handlers during their daily activities. The average score was 75.40% (± 18.76). According to Medeiros, Carvalho, and Franco (2017), it is worth checking the correlation between the instruction and the actual practice of good handling practices, which assures the quality in food preparations and/or meals.

The main inadequacies found in the present study were the non-removal of the food handler in cases of injuries, maintenance and cleanliness of uniforms, daily change of uniforms, use of uniforms outside the restaurant's premises, as well as the size and cleanliness of nails. In a study by Rebouças et al. (2017), it was found that self-reported food safety practices have demonstrated a good outcome, the results of the checklist have identified that most food handlers (91.3%) failed to perform proper hand hygiene.

According to Cunha et al. (2014a), there are other reasons that may influence the failure of food handlers to adopt appropriate practices, such as low perception of risk with regards to hand hygiene, inappropriate infrastructure of units or work overload. In view of these factors, food handlers prioritize other activities (Cunha et al., 2014a).

The findings of this study demonstrate that the level of food safety knowledge of food handlers has a direct influence on the answers given with regards to food safety practices in the workplace. However, in statistical terms, such a phenomenon is not observed in food safety practices hereunder, and although the food handlers defend that they meet the standards, it has not been observed for some items. In this context, there may be other factors that influence the adoption of appropriate food safety practices. A study by Rebouças et al. (2017) has demonstrated a positive association between satisfaction at work and the implementation of appropriate hygiene practices, thus suggesting that adequate working conditions positively influence food safety practices. Furthermore, according to the data evaluated, there has been no association between food safety training and self-reported food safety practices ($p = .7144$), showing that, in isolation, food safety training does not seem to be sufficient to guarantee food safety. The research by Cunha et al. (2014b) support these findings, as they have observed that food safety training based on theoretical aspects had no relation with food handlers' attitudes and practices.

Some studies have demonstrated the relevance of the “OB” factor – the optimistic bias, which is a positive perspective individuals attribute to events, considering that negative reactions are less likely to occur to oneself than to others (Gouveia & Clarke, 2001). The OB factor allows for an exploration of food handlers' feelings and perceptions, which can influence their behavior and can be associated with adequate food safety practices (Cunha et al., 2014b; Rossi et al., 2017). According to these authors, this optimistic bias seems to influence food handlers' practices, causing many to neglect important tasks based on the belief that other employees make more mistakes than themselves. Rossi et al. (2017) have noted that an overly optimistic food handler can neglect operations and contaminate food. However, despite observing an optimistic bias among study participants, the

authors found that the “OB” factor was not related to the food handlers' level of food safety knowledge. Cunha, Braga, Passos, Stedefeldt, and Rosso (2015) also failed to identify an association between the “OB” factor and food handlers' food safety knowledge, attitudes, and practices.

Understanding the factors that influence the adoption of adequate food safety practices during food handling is extremely important for the adoption of strategies that can minimize possible hindrances, thus facilitating the execution of appropriate food handling and reducing the risks to the health of the consumers.

4 | CONCLUSION

This study has observed that food handlers of Popular Restaurants of RN have satisfactory levels of food safety “knowledge”, “self-reported practices”, and “observed practices”. Additionally, we identified a positive correlation between the food safety “knowledge” and “self-reported practices” variables among food handlers, revealing that the greater the knowledge on food safety, the more positive self-reported food safety practices. The observed food safety practices have presented satisfactory results. However, hygienic-sanitary conditions of Popular Restaurants are inadequate, having higher percentages of inadequacy in those items that are independent of the food handler's actions, which directly imply that food safety and, consequently, meeting the objectives proposed by the legislation, serve as a basis for the state program operation to meet. The research data show the need to adapt the physical facilities of the units, utensils, and equipment, improving the working conditions of the manipulators and enabling the implementation of Good Practices. Motivational factors and specific formations are also relevant in this process and may influence the adoption of appropriate food handling practices.

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