

Quality and Food Safety in school feeding and nutrition units from public schools from São Luís, State of Maranhão

Qualidade e Segurança Alimentar em unidades de alimentação e nutrição escolares da rede municipal de educação de São Luís, Maranhão

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ABSTRACT

Introduction: School feeding and water offered to schoolchildren should be safe from the hygienic-sanitary point of view. **Objective:** To evaluate the hygienic-sanitary conditions of the School Food and Nutrition Units (UANE) of the municipal education network of São Luís, Maranhão, Brazil, and to analyze the microbiological quality of the food served and the drinking water of the schools. **Method:** The hygienic-sanitary conditions of 40 schools were evaluated using the Checklist of Good Practices in School Feeding (LVBPAE), proposed and validated by Stedefeldt et al.¹³. Quantification of coliforms at 35 °C and 45 °C, enumeration of *Escherichia coli*, enumeration of *Staphylococcus aureus* coagulase positive, and *Salmonella* spp. of 57 school feeding samples. Also, 64 water samples from the drinking fountains were analyzed. **Results:** All UANE presented a regular health risk. The average compliance in Good Practices (BP) was 69.7% (\pm 3.83). No food was considered unfit for consumption. There was a high water contamination rate in drinking fountains, with 48.4% of samples positive for total coliforms and 12.5% for *Escherichia coli*. **Conclusions:** Corrective measures should be taken for BP items considered critical and that guarantee the microbiological quality of the water served to schoolchildren.

KEYWORDS: School Feeding; Good Manufacturing Practices; Food Hygiene; Food and Nutrition Security; Water

RESUMO

Introdução: A alimentação escolar e a água ofertadas aos escolares devem ser inócuas do ponto de vista higiênico-sanitário. **Objetivo:** Avaliar as condições higiênico-sanitárias das Unidades de Alimentação e Nutrição Escolares (UANE) da rede municipal de educação de São Luís, Maranhão, Brasil e analisar a qualidade microbiológica da alimentação servida e da água dos bebedouros das escolas. **Método:** Avaliou-se as condições higiênico-sanitárias de 40 escolas, utilizando-se a Lista de Verificação de Boas Práticas na Alimentação Escolar (LVBPAE) proposta e validada por Stedefeldt et al.¹³. Realizou-se a quantificação de coliformes a 35 °C e a 45 °C, enumeração de *Escherichia coli*, enumeração de *Staphylococcus aureus* coagulase positiva e a pesquisa de *Salmonella* spp. de 57 amostras da alimentação escolar. Foram analisadas, ainda, 64 amostras de água dos bebedouros. **Resultados:** Todas as UANE apresentaram risco sanitário regular. A média de conformidades em Boas Práticas (BP) foi de 69,7% (\pm 3,83). Nenhum alimento foi considerado impróprio para o consumo. Verificou-se alto índice de contaminação da água dos bebedouros, com 48,4% das amostras positivas para coliformes totais e 12,5% para *Escherichia coli*. **Conclusões:** Devem ser tomadas medidas corretivas para os itens de BP considerados críticos e que garantam a qualidade microbiológica da água servida aos escolares.

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INTRODUCTION

The National School Meals Program (PNAE), popularly known as school meals, is considered one of the largest school nutrition programs in the world. Through the provision of a healthy and adequate diet, PNAE aims to contribute to the growth and development of schoolchildren enrolled in public basic education schools, including those in indigenous lands and remaining *quilombola* settlements¹.

The program has a solid legal framework that guarantees the integral quality of the food served in the schools. Resolution of the Collegiate Board of Directors (RDC) n. 216, of September 15, 2004, of the National Health Surveillance Agency (Anvisa), provides for the technical regulation of Good Practices (GP) for food services, which should also be adopted by School Meals and Nutrition Units (UANEs)². In this sense, the meals produced in the UANEs must meet the nutritional needs of the students with products that have adequate sensory and nutritional aspects. Moreover, these products must be safe as to their hygienic-sanitary conditions³.

Despite the requirements of the legislation, hygienic and sanitary conditions in Brazilian schools still fall short of expectations. In Brazil, 11,342 outbreaks of foodborne diseases (FBD) were reported between the years 2000 and 2017^{4,5}. Between 2007 and 2016, 524 outbreaks occurred in daycare centers and schools, which rank fourth among the places with the highest occurrence of FBD^{4,5}. However, it is believed that the problem is even worse because of underreporting and the lack of a fully comprehensive health surveillance system, even in developed countries. The foodstuffs most associated with outbreaks in Brazil were: mixed foods (or preparations), eggs and egg products, sweets and desserts, meat and water. These are also ingredients commonly used in school meals⁴. Among the possible causes of these diseases are inadequate hygiene practices and food prepared by untrained people^{3,6}.

It should be emphasized that food microbiological analysis is supplementary to the application of GP checklists and may be used as a complement to the evaluation of the hygienic-sanitary conditions of school settings⁶.

In addition to food, the water offered in schools must be safe, since water outside drinking standards has a strong impact on health and can transmit gastroenteritis, hepatitis A and E, rotavirus, verminoses, among others diseases⁷.

In this context, the objective of this research was to evaluate the sanitary and hygienic conditions of the UANEs of the municipal education network of São Luís, Maranhão, Brazil, and to analyze the microbiological quality of the food and drinking water of these schools.

METHOD

This is a sectional, descriptive study conducted in the municipality of São Luís, state of Maranhão, Brazil. The municipality of

São Luís has 1,014,837 inhabitants⁸. According to the Municipal Department of Education (Semed), in 2015 the public education network served 89,474 students, distributed in 244 schools (day care centers, preschool and elementary education). Since 2002, the school meals service has been outsourced. Semed segments the local schools in seven nuclei, of which six are in the urban area and one in the rural area.

We chose a non-probabilistic sample of 40 schools, which were randomly chosen via simple draw. We evaluated 30 urban schools (five from each nucleus) and ten from the rural area. Of the schools we evaluated, three were full-time day care centers, ten were part-time day care centers and 27 were elementary schools. Data collection was done between November 2015 and January 2016 by a dietitian.

Analysis of the hygienic-sanitary conditions of the UANEs

After Semed's authorization, the selected schools were initially visited for the application of the School Meals Good Practices Checklist (LVBPAE), an instrument validated and adapted from Anvisa's RDC n. 216/2004. The checklist contains 99 questions divided into six blocks: Facilities, Temperature-control equipment, Handlers, Receipt, Processes and procedures and Environmental sanitation. Each block contains specific weights that were tabulated in formulas and eventually added to the UANE final classification. The results of the total score of each block were compared with the classification criteria of RDC n. 275, of October 21, 2002, Anvisa, which establishes the classification in group A (adequate, > 75% compliance), group B (partially adequate, 51% -75% compliance) and group C (inadequate, < 50% compliance)⁹. Each UANE was classified by total score according to its level of sanitary risk: Very high (0-25 points); High (26-50 points); Regular (51-75 points); Low (76-90 points) and Very Low (91-100 points) according to the LVBPAE classification^{10,11}.

Food microbiological analysis

Subsequently, we returned to the schools to collect samples of food/food preparations from the cafeteria and water from the drinking fountain. The samples were collected in the morning (between 9:00 and 9:30) or in the afternoon (between 3:00 and 3:30), just before the food was served to the students, from November 2015 to January 2016. Microbiological analyses were performed at the Microbiology Laboratory of the Water and Food Quality Control Program of the Federal University of Maranhão.

A total of 57 food items/food preparations were analyzed (Table 1), and a random menu was analyzed per school.

Procedures for collection and transportation of samples, preparation, dilution and microbiological analyses were performed according to the recommendations of the American Public Health Association (APHA)¹². We did the determination of coliforms at



35° C (total coliforms) and at 45° C (thermotolerant coliforms), enumeration of *Escherichia coli*, enumeration of coagulase-positive *Staphylococcus aureus* and the search for *Salmonella* spp. The microbiological parameters were compared with those established in Anvisa RDC n. 12, of January 2, 2001¹³.

Drinking water microbiological analysis

Sixty-four water samples were analyzed from all drinking fountains in the 40 evaluated schools. For the analysis of total coliforms and *E. coli*, the *Colilert*® chromogenic substrate technique was used qualitatively for the presence or absence of these bacteria¹².

The quality parameters used for analysis were based on Ordinance n. 2.914, of December 12, 2011, by the Ministry of Health¹⁴, which defines that water for human consumption should be free of total coliforms and *E. coli* in 100 mL of the sample.

Statistical analysis

For GP analysis, first we did a descriptive statistical analysis of the results obtained using the quantitative percentage values. Afterward, we conducted the Pearson correlation test (r) ($p < 0.05$), in which the forces of the correlations were

Table 1. Food and/or food preparations served at schools of the municipal education network analyzed according to their microbiological quality (São Luís, Maranhão, Brazil, 2018).

Food/Food preparations served	Quantitative of analyzed samples
Porridge	15
Cookie	9
Ground beef risotto	7
Chicken risotto	6
Fruit smoothie	4
Pasta	4
Beans	4
Rice	3
Chicken stew	2
Juice	1
Chocolate milk	1
Yogurt	1
Total samples	57

classified as negligible (0.01 to 0.09), low (0.10 to 0.29), moderate (0.30 to 0.49), substantial (0.5 to 0.69) and very strong (≥ 0.70), as suggested by Davis¹⁵. The compliance scores of the Facilities, Temperature-control equipment, Handlers, Processes and procedures and Environmental sanitation obtained by LVBPAE were correlated.

Statistical analyses were performed on Statistica® version 7.

Ethical aspects

The research was approved by the Ethics Committee of the Federal University of Maranhão (UFMA), report n. 1.284.438/2015.

RESULTS AND DISCUSSION

All UANEs were classified as having regular health risk. The mean compliance we found was 69.7% (± 3.83). The items with the most critical compliance percentage were processes and procedures, temperature-control equipment and facilities in the food preparation area (Table 2).

The hygienic-sanitary conditions of Brazilian UANEs differ significantly, with a predominance of UANEs with high to moderate sanitary risk, as already demonstrated by several authors^{16,17,18,19,20,21,22,23,24,25,26,27}.

The main non-compliant items observed in Brazilian UANEs are related to inadequacy in the facilities, absence of fine protection nets against insects and rodents, absence of toilets for the exclusive use of food handlers, poor training and inadequate habits on the part of the food handlers, lack of documentation and registration, inadequate thawing, accumulation of obsolete objects in the premises and inadequate ventilation, among others^{16,17,18,19,20,21,22,23,24,25,26,27}. Except for the block on food handlers, all these situations were found in São Luís, according to the compliance percentages listed in Table 3.

The item on facilities is one of the most critical in Brazilian UANEs^{3,16,20,23}. One of the reasons that contributes to this is the fact that Brazilian school kitchens look much more like domestic kitchens than industrial kitchens^{21,27}. Sewage, garbage, accumulation of dust, presence of animals such as cats, dogs and pigeons, stagnant water, depleted material accumulations in the vicinity of the UANEs, inadequate drains and/or gutters, poorly maintained walls, safety system against

Table 2. Average percentage of compliance in good practices (GP) of 40 schools in the municipal education network, according to items analyzed by the School Meals Good Practices Checklist (LVBPAE) (São Luís, Maranhão, Brazil, 2018).

Block	Compliance Percentage	Classification
Buildings and facilities in the food preparation area	48%	Inadequate
Temperature-control equipment	45%	Inadequate
Handlers	92%	Adequate
Receipt	100%	Adequate
Processes and procedures	41%	Inadequate
Environmental sanitation	84%	Adequate



Table 3. Percentage of compliance in good practices (BP) broken down by block of evaluation in the School Meals Good Practices Checklist (LVBP AE) (São Luís, Maranhão, Brazil 2018).

Buildings and facilities in the food preparation area	Compliance percentage	Classification
UANE location	37.5%	Inadequate
Environment	37%	Inadequate
Lighting and ventilation	47%	Inadequate
Water supply	41%	Inadequate
Toilets and locker rooms	74%	Partially adequate
Exclusive washbasins for hand hygiene	29%	Inadequate
Storage areas at room temperature	46%	Inadequate
Consumption area/cafeteria	47.5%	Inadequate
Temperature-control equipment		
Storage area with controlled temperature	45%	Inadequate
Handlers		
Full uniform	58%	Partially adequate
Periodic medical examinations	100%	Adequate
Handlers without clinical disorders	95%	Adequate
Absence of adornments	90%	Adequate
Hair protected by cap	90%	Adequate
Pre-employment medical examinations	100%	Adequate
Participation in Food security training	100%	Adequate
Receipt		
Verification of sensory characteristics	100%	Adequate
Packaging integrity check	100%	Adequate
Expiration date check	100%	Adequate
Processes and procedures		
Hand hygiene	50%	Inadequate
Receipt of raw material	65%	Partially adequate
Storage of raw material	84%	Adequate
Sanitation of vegetables	60%	Partially adequate
Thawing	37.5%	Inadequate
Controls and records	0%	Inadequate
Sample keeping	100%	Adequate
Desalting	67.5%	Partially adequate
Cooking and reheating	100%	Adequate
Distribution	100%	Adequate
Care with eggs	100%	Adequate
Transportation of ready meals	55%	Partially adequate
Environmental sanitation		
Waste/Sanitary sewage	95%	Adequate
Hygiene of the premises	100%	Adequate
Hygiene of utensils/equipment/others	100%	Adequate
Pest and vector control	61%	Partially adequate

accidental fall, inadequate ventilation, absence of toilets and locker rooms for the exclusive use of food handlers, and absence of removable nets on the windows were the main inadequacies found in this block.

Facilities may interfere positively or negatively with the safety of the food handled in the schools³. In this study, Pearson's correlation showed a positive and moderate (0.36) correlation between scores obtained from environmental hygiene and facilities, which



endorses the fact that the inappropriate structure of the UANE environment and its physical area interferes negatively with the safety of products that are handled there³. It is therefore crucial that schools provide better conditions of personal, environmental and food hygiene in more adequate facilities, so as to enable the provision of safer food for the students^{2,10,16}.

Some of the surveyed schools were located in rented buildings that were often not designed or suitable for school operations. In these schools, the kitchen was usually in an improvised location, which may have influenced the noncompliance rates found in this block. The adaptation of UANEs to existing spaces in schools is common in Brazil⁶. In addition to hindering workflow and processing, this contributes to the contamination of food by microorganisms²³.

Only one school had food warming equipment for meal distribution, which was set to maintain food at 60° C. None of the schools had a thermometer for measuring the temperature of food at any stage of the meal preparation process. Temperature monitoring at all stages of the production process is important and recommended by health legislation². Nonetheless, this procedure is rarely followed in Brazilian UANEs^{16,17,22}, most probably because of the peculiar characteristics of these kitchens: food is prepared shortly before consumption times, the kitchens are designed like domestic kitchens and use domestic equipment, the cost of acquiring thermometers and poor training of the food handling staff.

In relation to food handlers, the most frequent noncompliant items were closed shoes and caps for hair protection. We noted the presence of strangers within the context of meal production inside the kitchens. Some of these people had behaviors that can affect food safety, like the use of cell phones, the absence of caps and talking next to prepared meals. RDC n. 216/2004 recommends that visitors comply with the hygiene and health requirements established for handlers².

With the exception of the incomplete use of uniforms, the results found in this block, according to Table 3, depart from the reality verified in Brazil, since UANE food handlers usually have inadequate hygiene habits^{3,17,20}, lack of health control¹⁷ and lack of training²⁵. Admittedly, inadequate food handling is cited as one of the leading causes of food contamination around the world^{6,25}. Despite having high levels of compliance, the data found in this block reinforce the need for ongoing supervision by a dietitian and periodic training of the staff to ensure the hygienic-sanitary quality of the food.

Receipt procedures are standardized for the whole municipal network and were all compliant.

Regarding the hand hygiene procedure, 50% of the food handlers performed it inappropriately. It is noteworthy that in 71% of the UANEs there was no exclusive washbasin for food handlers to wash their hands. Food handlers play a key role in the transmission of foodborne toxoinfections caused by *S. aureus*, often found in septic lesions in the hands²⁸. Inadequacies in

the handwashing technique of UANE handlers - a situation that poses sanitary risk to the meals - were identified by several studies around the country^{16,23,24,29}.

Critical items during food processing, like vegetable washing, proper thawing, desalting, and adequate heat treatment achieved 60%, 37.5%, 67.5% and 100% compliance percentages, respectively. Failure in these items may jeopardize the safety of the food, since it may allow the survival or multiplication of pathogenic microorganisms²⁸.

The time of preparation and distribution of food did not exceed 30 minutes in any of the schools, which minimizes the multiplication of microorganisms.

The item with the worst percentage of inadequacies was "Controls and Records", since no school had a Manual of Good Practices (MGP), Standard Operating Procedures (SOPs), nor a record of temperature and reception, cooking temperature and distribution characteristics. These inadequacies are among the most commonly found in Brazilian UANEs^{16,20,22}. RDC n. 216/2004 states that food producing establishments must have a MGP and SOPs for the application of the standards in their unit, in order to guarantee the safety of the food offered there². The presence of this document in the unit can be a guarantee that the GP are being followed by the institution, since it must contain the activities carried out by UANE to ensure the production of healthy and safe meals.

The MGP and the SOPs should be complied with and not be treated as mere bureaucratic documents present in the UANE. The document should be specific to each establishment. This may be one of the obstacles to the compliance with this item, since at the time of the study the company had 10 dietitians who were responsible for an average 24 schools each, in addition to having to deal with several other assignments, which did not allow them to fully inspect the GP in all schools.

We verified the standardization of environmental sanitation processes like: maintenance of environmental sanitation through adequate and approved cleaning, rinsing and disinfection techniques; use of non-abrasive brushes and sponges; use of cleaning and disinfection products approved by the Ministry of Health; use of cleaning utensils in the food handling and processing area of exclusive use of the UANE; disinfection of utensils and equipment (with chlorinated solution and/or heat); protection of utensils against dust, insects and rodents; and natural drying of utensils without the use of cloths.

The standardization in the processes found in this research can be done in compliance with the operational routines of the service provider. However, items with low compliance ratings need to be fixed. This standardization in the hygiene routines is positive and, according to Danelon et al.³⁰, is one of the advantages of outsourcing PNAE management, considering that private companies are usually more agile in meeting hygiene standards than the public sector.



In 90% of the schools, food handlers said that there was chemical control of vectors and urban pests. However, there were vestiges of insects and/or rodents in 32.5% of them. Documentation of chemical pest and vector control was found in only 60% of the UANEs. A low percentage of adequacy in this item was also identified by studies done in the Brazilian states of Rio Grande do Norte²⁰ and Paraíba²³. The *Codex Alimentarius* and RDC n. 216/2004 establish that the units must follow GP procedures to avoid an environment that can favor the appearance of urban pests and insects. Measures like cleaning, hygiene, evaluation and monitoring of facilities and surroundings can minimize the use of chemicals. This practice is also indicated in current Brazilian legislation^{2,31}. Excessive use of pesticides used in fumigation can lead to health problems for schoolchildren in the short and long terms, and their use should be monitored⁶.

Furthermore, the contract of the City Hall with the outsourced company requires, in addition to the provision of meals within the nutritional and hygienic-sanitary standards of the legislation, the adoption of environmental sanitation measures by the company, such as chemical control and supply of cleaning materials. This requirement reduces problems related to government procurement that may affect the availability of cleaning and disinfection products at the UANEs²⁷ and may have contributed to the high compliance rates observed in this block.

The LVBPAE responses were obtained through direct answers from the cooks, without the follow-up of some activities in Receipt, Processes and procedures (procedures for food preparation, thawing, desalting, storage, cooking) and Environmental sanitation. In this sense, the noncompliance rates in these blocks may be higher than the rates we measured, since the cooks may have reported that they correctly perform the procedures, without, however, doing so²⁷.

Soares et al.²⁷ surveyed some criticisms of LVBPAE, like the fact that this instrument was based on RDC n. 216/04², which establishes hygienic-sanitary conditions for all services that provide food to the public (snack bars, restaurants, industrial kitchens, buffets, bakeries, pastry shops and others). Nevertheless, the UANEs are more similar to domestic kitchens than to industrial kitchens, and therefore some items are not properly considered in the evaluation. Some items pointed out by LVBPAE as inadequate, such as the presence of exclusive washbasins for the cooks, lamp protection systems, temperature control of the cold and hot chains of meal production processes, collection and storage of samples, presence of MGP and SOPs, labeling of products after handling and discarding of cleaning cloths every two hours, can be considered inadequate, when in fact they do not even fit with the reality of some UANEs.

However, these issues do not override the importance of this research and reinforce the need for better follow-up of the City Hall in relation to the services provided by the company, since all these situations are provided for in the contract and should therefore be fulfilled.

In the Brazilian UANEs, there is evidence of high coliform counts at 45° C in the meals, especially in juices and salads^{6,32}. In spite of this, none of the food/food preparations analyzed were considered unfit for consumption. Adequacy in the use of GP, adequate heat treatment and short time interval between preparation and distribution of food may have favored the microbiological quality of the food studied in this research.

Half of the participating schools presented contamination in drinking water. Of the total water samples we analyzed, 48.4% (n = 31) tested positive for the presence of total coliforms and 12.5% (n = 08) for *E. coli*, which means health risks for students, teachers and school staff.

Of the schools that presented contamination in drinking fountains, only 15% (n = 3) performed water tank sanitation on a semiannual basis. This situation may have favored the presence of these microorganisms, together with the fact that all drinking fountains contaminated by *E. coli* were close to the school toilets, which may have generated cross-contamination in the plumbing, and the very contamination brought by the students after toilet use.

In Brazilian public schools, drinking fountains with water of poor microbiological quality are still common, as found in Salvador-Bahia³³, Picos-Piauí³⁴ and Alfenas-Minas Gerais³⁵. Among the food outbreaks reported in Brazil between 2007 and 2017, about 6.2% were caused by the ingestion of contaminated water, which means contaminated water was the third largest FBD carrier in the period⁴.

A program of intensive monitoring of this water, with periodic microbiological analyses done by the Municipality, as well as measures to control or eliminate environmental risk factors is necessary to avoid possible health problems for this population³². Actions such as the sanitation of the water tank (only 7.5% of the 40 schools performed sanitation actions every six months), cleaning of drinking fountains and periodic filter replacement can improve the quality of the water offered to schoolchildren⁷.

In this research, only one school could present reports attesting to the potability of its water. It is noteworthy that it was a full-time day care center and it was the principal who periodically paid a private company to do the water analysis.

CONCLUSIONS

In São Luís, although microbiological analyses show that food served in schools does not pose health risks for schoolchildren, actions are needed to minimize the sanitary risk in critical GP items like facilities for food preparation, temperature-control equipment and processes and procedures, in order to ensure the safety of the food served in those schools. It should be emphasized that the food supply service is outsourced, and there is a need for greater supervision by the Municipality, in particular by the Health Surveillance body and the civil society, based on the mechanisms of social



control provided for in the rule of law, such as the School Meal Council (CAE) in order to demand the correction of non-compliant items.

Schoolchildren are among the population groups that are most vulnerable to FBD. The PNAE legislation ensures the sanitary quality of school meals offered to these children. Inadequacies in

this context are violations of the human right to adequate food, which includes a diet free of physical, chemical and biological contaminants. Therefore, the authorities should take immediate action, especially in relation to the poor quality of the drinking water in the municipal schools evidenced in this study. This should be done to guarantee the health protection of the citizens served by the program.

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Conflict of Interest

Authors have no potential conflict of interest to declare, related to this study's political or financial peers and institutions.



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