Hygiene and good practices in school meal services: Organic matter on surfaces, microorganisms and health risks

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ABSTRACT

The aim of this study was to evaluate and classify the sanitation and hygiene conditions in Porto Alegre/Rio Grande do Sul (RS) public schools using an analysis of surfaces that come in contact with food and a food safety checklist validated for the school environment. The following mesophilic heterotrophic bacteria count medians were observed on each piece of equipment or utensil studied: countertops, 27.3 Colony-Forming Units (CFU)/cm²; cutting boards, 15 CFU/cm²; blenders, 14.5 CFU/cm²; dishes, 2 CFU/cm²; and refrigerators, 1 CFU/cm². The median of the surface measurements analyzed by adenosine triphosphate (ATP) bioluminescence was less than 40 Relative Light Units (RLU)/100 cm² for all equipment and utensils, except for the countertop surface, which had a median of 52.5 RLU/100 cm². The data from 120 schools showed that 33, 64 and 3% were classified as high, regular and low health risk, respectively. The results showed that most schools were exposed to cross-contamination with failures especially with regard to environmental hygiene and procedures. Failures related to both factors potentially raise the risk of outbreaks in this environment. The scores used enabled the classification of school meal services and the identification of the points that need more attention. Intervention strategies that target different aspects of food handling, not only knowledge, may be promising in this scenario, which may address problems that mainly involve the food handler and promote changes in food handling practices.

1. Introduction

The National School Nutrition Program (Programa Nacional de Alimentação Escolar — PNAE) is the largest school meal service program in Brazil. The program budget for 2012 was approximately 1.5 billion US dollars and benefited more than 45 million basic education and young and adult students in public schools (Peixinho, 2013). Providing students with meals that comply with satisfactory hygiene standards is a principle of this program, thus ensuring the essential conditions for the promotion and maintenance of student health, including the implementation of the Good Manufacturing Practices (GMP) for food handling (Brasil, 2006). In Brazil, Resolution no. 216 is the legislation of the National Agency for Health Surveillance (Agência Nacional de Vigilância Sanitária — ANVISA) that establishes procedures for the GMP of food services, including schools (Brasil, 2004).

There are many simple and effective methods for assessing the hygienic conditions of school kitchens, which identifies critical points of microorganism multiplication, survival and contamination. The detection of microorganisms and determination of residual organic matter after sanitizing surfaces that come in contact with food are among the direct methods used to assess the cleanliness of establishments that prepare food (Andrade, 2008, 412p). Bioluminescence provides an estimate of surface cleanliness in real time, including the presence of organic waste and, consequently, the risk of microorganisms. Adenosine triphosphate (ATP) bioluminescence provides quick results and can be used to monitor...
equipment and utensils. By contrast, microbiological analyses require longer periods to obtain results (Aycicek, Oğuz, & Karci, 2006). This assessment becomes additionally important because the cross-contamination between food and equipment/utensils is considered a main causal factor of outbreaks according to the Centers for Disease Control and Prevention (Center for Disease Control and Prevention, 2009). Microorganisms on surfaces that have residues promote microbial growth and biofilm formation. A release of these microorganisms may occur, which then contaminates food (Andrade, 2008, 412p; Forsythe, 2010; Pires et al., 2005).

In this context, there are no reports in Brazilian schools that evaluate surfaces that come in contact with food.

Among the indirect methods, there is currently a checklist of GMP for the school environment that has been proposed and validated as a tool to assess food processing in schools (Stedefeldt, Da Cunha, Silva Junior, Silva, & Oliveira, 2013). Several previous studies have used checklists to assess the safety of food; however, these instruments contained different criteria and items, which did not allow a direct comparison of the results (da Cunha, Stedefeldt, & de Rosso, 2012; Lockis et al., 2011; Santana, Almeida, Ferreira, & Almeida, 2009).

Outbreaks in schools have been reported in the scientific literature (Lee & Greig, 2010; Richards et al., 1993; Yang et al., 2010), which concluded that cross-contamination was a major factor that contributed to the occurrence of outbreaks (Chan & Chan, 2008); therefore, detailed studies on the methods and techniques for microbial cleaning and identification are necessary. In Brazil, 8451 outbreaks were reported between 2000 and 2011, of which 657 occurred in schools (Brasil, 2011). However, the magnitude of the problem is even greater because of underreporting and the absence of a complete health monitoring system, even in developed countries (Seaman & Eves, 2006). Therefore, the aim of this study was to evaluate the health conditions of the food service units in Porto Alegre public schools using 3 methods: a mesophilic heterotrophic bacteria count, bioluminescence for the evaluation of surfaces and a health risk analysis through the application of a GMP checklist for the school environment.

2. Materials and methods

2.1. Sample

A cross-sectional study was conducted in Porto Alegre, the capital of the state of Rio Grande do Sul (RS), Brazil, from October 2008 to June 2009. In this city with approximately 1.4 million inhabitants (IBGE, 2011) and a Human Development Index (HDI) of 0.865 (UNDP, 2000), there were 345 schools managed by state and municipal governments, which served 245,350 students in primary education and high school when the data were collected.

Porto Alegre/RS public schools assisted by PNAE with at least 100 enrolled students participated in the study. For the schools that fulfilled this criterion (n = 282), the number of schools to be assessed was calculated (n = 120) using the following criteria: the expected prevalence of 50% of surface samples with mesophilic heterotrophic bacteria above 50 Colony-Forming Units (CFU/cm²); a 95% confidence interval and a maximum error of 7% (Centers of Disease Control and Prevention, 2010)). The evaluated units were drawn from the records of public schools available in the State Department of Education and Municipal Department of Education. All schools were visited, unannounced, after authorization from the Department of Education. The study was submitted to and approved by the Ethics Committee of the Federal University of Rio Grande do Sul (project no. 17265).

None of the schools had implemented the Hazard Analysis and Critical Control Points (HACCP).

2.2. Surface swab collection

Samples were collected from the surfaces of 5 pieces of equipment or utensils available in the environment where food for the students was prepared: inside the blender, inside the refrigerator, countertops where food was handled, cutting boards and dishes where meals were served to the students. These pieces of equipment and utensils were chosen because they were basic items of school food service and were highly used. Prior to collection, we determined whether the equipment was ready for use. If not, the handlers were asked to sanitize the surface according to the routine procedure. Two samples were collected from each surface: one for the mesophilic heterotrophic bacteria count and one for the quantitative measurement of organic matter by ATP bioluminescence.

For the mesophilic heterotrophic bacteria count, samples were collected from each surface using swabs that were previously moistened in 0.1% peptone water and then rubbed on an area of 100 cm² (10 cm × 10 cm) delineated by a template. After collecting the samples, the swabs were placed into test tubes containing 10 mL of 0.1% peptone water (adapted from Silva et al., 2007). For the ATP bioluminescence test, a similar area was sampled using an appropriate swab for each equipment or utensil evaluated (ATP Luminometer, Hygiena, System SURE II®, Camarillo, US).

2.3. Mesophilic heterotrophic bacteria count

After collection, the tubes were transported to the laboratory, and 10⁻¹, 10⁻² and 10⁻³ dilutions were prepared. The samples were plated on Plate Count Agar (PCA, Merck, Darmstadt, Germany) and incubated at 37 °C for 24–48 h. After this period, the colonies were counted. To calculate the number of CFU/cm², the number of colonies observed in the corresponding dilution factor were multiplied and divided by 100 (Silva et al., 2007).

The results obtained in the mesophilic heterotrophic bacteria count were classified according to criteria proposed by Silva Junior (2008) which considers that equipment surfaces and utensils with ≤50 CFU/cm² of mesophilic heterotrophic bacteria after cleaning have a satisfactory hygiene level and those with >50 CFU/cm² have an unsatisfactory hygiene level.

2.4. Quantification of ATP bioluminescence

Surface organic matter was quantified using an ATP Luminometer. After collection, the swab was inserted into a cuvette containing the luciferin-luciferase enzyme complex. In the cuvette, there was a reaction between ATP and the released light from the enzyme complex, whose amount was measured by the equipment. The results were expressed as Relative Light Units (RLU). Surfaces with <30 RLU/100 cm² were considered acceptable (Bartz, Ritter, & Tondo, 2010).

2.5. Checklist application and health risk evaluation

Each school was assessed using the GMP checklist specific for assessing the school environment (Stedefeldt et al., 2013). The individuals responsible for handling the food answered questions during each visit.

The checklist consisted of 99 questions divided into 6 thematic blocks: buildings and facilities, controlled-temperature equipments, food handlers, suppliers, procedures and environmental hygiene. Grades ranging from 0 to 8 were assigned for each checklist question based on the degree of risk and importance to food safety. All responses indicating “no” characterized non-compliance to GMP and were scored a 0. Scores were assigned...
according to the characteristics of the problem for the responses indicating "yes": a score of 8 was assigned to items that represented conditions or situations that prevented the multiplication of microorganisms, 4 was assigned to items that prevented the survival of organisms, 2 was assigned to items that avoided cross-contamination by direct contact with food and 1 was assigned to items that avoided cross-contamination without direct contact with food. In addition, a weight was established for each block (k, equal to 10, 15, 25 or 30) according to the importance and risk level for food safety.

The following formula was used to calculate the points obtained in each checklist block:

$$PB_X = \left( \frac{\sum X}{P_X} - \frac{\sum NA_X}{k_X} \right)k_X$$

where:

- $PB_X$: Score achieved in block $X$ (1–6)
- $\sum X$: Sum of the scores obtained in the items of block $X$
- $P_X$: Maximum possible score in block $X$
- $\sum NA_X$: Sum of the scores of non-applicable questions in the block
- $k_X$: Weight assigned to block $X$

After calculating the scores ($PB$) in each block, the results were summed. Thus, each school received a final score, and risk level was rated by block or total score: very high (0–25 points), high (26–50), regular (51–75), low (76–90) and very low (91–100).

2.6. Temperatures measurements of cold chain equipment

During school visits, measurements of the internal temperatures of all freezing and refrigeration equipment were obtained 20 cm from the object. We used an infrared thermometer gun with a Portable Multi-Temp laser sight and temperature range of −60 to +500 °C.

2.7. Data analysis

The results were tabulated in Microsoft Office Excel 2007 spreadsheets for absolute and relative frequencies. To reduce errors in the database, all data were tabulated by two professionals and then cross-check to identify inconsistencies in the database. The median values of each piece of equipment and utensil were also used for a description of the variables. For quantitative variables the Kolmogorov Smirnov Goodness of fit test was performed, evaluating whether the distribution of variables followed theoretical distributions. The existence of homoscedasticity (equal variances) was verified by Levene’s test. Since the variables showed no adherence to normal and/or heteroscedasticity, it was used a non-parametric tests.

An equipment comparison was performed using the Friedman test. To complement this analysis, we used the Wilcoxon test. A Spearman coefficient was used to evaluate the association between the values of the luminometer with the mesophilic heterotrophic count. The Chi-square test was used to compare the scores from each school and the equipment or utensil parameters for the mesophilic heterotrophic bacteria count and luminometer. The analyses were performed in the Statistical Package for the Social Sciences (SPSS) software version 17.0, and the significance level was $P < 0.05$.

3. Results

Samples from 3 schools were damaged during transport to the laboratory and were not processed in the evaluation of the mesophilic heterotrophic bacteria count on surfaces. High variation of the mesophilic heterotrophic bacteria count was observed on all equipment and utensils and ranged from 0 to $>10^9$ CFU/cm². The following medians of microorganisms on each piece of equipment or utensil were observed for 117 schools: countertops, 27.3 CFU/cm²; cutting boards, 15 CFU/cm²; blenders, 13.5 CFU/cm²; dishes, 2 CFU/cm²; and refrigerators, 1 CFU/cm². An analysis of these results demonstrated no between-group difference for countertops, cutting boards and blenders ($p > 0.05$), whereas the refrigerator and dishes differed between-groups and within-groups ($P < 0.05$).

Considering the cutoff point ($< 50$ CFU/cm²), the surfaces of refrigerators (84.6%) and dishes (77.7%) were cleaner, whereas the surfaces of blenders, cutting boards and countertops had similar, but lower level of cleanliness (58.1–60.7%) (Table 1).

The results of 5 surface evaluations by ATP bioluminescence (4 blenders and 1 cutting board) were discarded because of failed readings.

The median of 595 samples was less than 40 RLU/100 cm² for all equipment and utensils except for the surface countertops, whose median was 52.5 RLU/100 cm² (Table 2). The statistical analysis showed that only the dishes differed from the other evaluated utensils.

The surface evaluations using ATP bioluminescence were compared with the surface evaluations for mesophilic heterotrophic bacteria: there was a significant, weak correlation between the values observed with the luminometer and the bacterial counts for countertops ($r = 0.241$; $P = 0.010$) and cutting boards ($r = 0.253$; $P = 0.008$). Most schools had up to 2 inadequate surfaces according to mesophilic heterotrophic bacteria parameters and up to 3 surfaces according to ATP bioluminescence (Table 3).

In schools where only 1 surface was non-standard according to ATP bioluminescence, countertop had the highest frequency of inadequacy, whereas cutting boards prevailed in the evaluation of mesophilic heterotrophic bacteria. In schools that had up to 2 surfaces that exceeded the parameters for mesophilic heterotrophic bacteria, the most frequent association was between countertops and blenders. When analyzed using ATP bioluminescence, the most frequent association included countertops, blenders and cutting boards. However, there was no significant agreement ($P = 0.44$) between schools that had surfaces above the standard for mesophilic heterotrophic bacteria and ATP bioluminescence.

Among the 120 schools evaluated by the GMP checklist prepared for school kitchens, no school was ranked very high risk, 41 schools (34.2%) were classified as high health risk (36 and 50 points), 79 (65.8%) had regular health risk (51–75 points) and no school was classified as low risk or very low risk. The distribution of the thematic block classifications is displayed in Table 4.

Table 1

<table>
<thead>
<tr>
<th>Equipment/utensils</th>
<th>$&lt;50$ CFU/cm²</th>
<th>$&gt;50$ CFU/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countertops</td>
<td>68</td>
<td>49</td>
</tr>
<tr>
<td>Cutting boards</td>
<td>72</td>
<td>45</td>
</tr>
<tr>
<td>Blenders</td>
<td>74</td>
<td>43</td>
</tr>
<tr>
<td>Dishes</td>
<td>92</td>
<td>27</td>
</tr>
<tr>
<td>Refrigerators</td>
<td>99</td>
<td>19</td>
</tr>
</tbody>
</table>

Fig. 1 shows the distribution of schools according to health risk and thematic block.

The blocks labeled buildings and facilities and temperature-controlled equipment had the largest inconsistencies with the frequency of schools classified as very high and high health risk. For items related to buildings and facilities, 84% of schools were
classified at the highest risk levels, in which the main problems were related to the absence of kitchen fixture protection, such as no screens on the windows, inadequate conditions or the absence of toilets only for food handlers. In the block of questions related to temperature-controlled equipment, 47% of schools were classified as high and very high risk. The main problems identified in this block were related to the absence of a thermometer to measure the temperature of food, refrigerators with inadequate temperatures and ice buildup in freezers.

In the food handlers, procedures and environmental hygiene blocks, 22.3, 89 and 91% of schools, respectively, were classified at the highest risk levels. The following major non-conformities were observed: the absence of periodic medical examinations, the use of adornments by food handlers during food preparation, food storage at risky temperatures and the absence of identification of food kept in the refrigerators. There was a high rate of problems related to hand hygiene in these blocks because the staff did not follow proper procedures or use the recommended products for cleaning and disinfection in 99% of schools. For environmental hygiene, 86% of schools inadequately cleaned the floors of processing and handling areas and 98% did not correctly disinfect utensils or equipment.

However, in the block concerning suppliers, nearly all the schools (94%) were classified as very low health risk.

When evaluating the temperature of the equipment, 20.8% of refrigerators had a temperature less than or equal to 5 °C, 10.4% had a temperature from 5.1 to 7 °C and 60.4% had a temperature above 7 °C. Considering the 128 freezers evaluated, 31.7% showed temperatures below –18 °C, 54.7% presented temperatures from –12 to –18 °C and 14.1% presented temperatures above –12 °C.

4. Discussion

In the evaluation of surfaces by the presence of mesophilic heterotrophic bacteria, refrigerators had the lowest median (1 CFU/cm²), among the analyzed equipment and 84.6% of schools had lower values than the suggested ≤ 50 CFU/cm² parameter.

However, ATP bioluminescence showed that 50% of refrigerators had unsatisfactory parameters (RLU ≥ 30 RLU/100 cm²). This result demonstrated that the refrigerators were not contaminated but contained organic matter, most likely because of the absence of cleaning and thawing observed in 59% of schools.

In most schools, the ATP bioluminescence values demonstrated that the surfaces of countertops and cutting boards were inadequately cleaned, one-half of schools had satisfactory values for blenders and refrigerators, and most schools had adequate indices for dishes. In relation to mesophilic heterotrophic bacteria, countertops, cutting boards and blenders showed non-significant medians and higher frequencies of schools above the parameter established by Silva (2008).

These results suggested that countertops and cutting boards require greater attention in schools because they showed the highest number of mesophilic heterotrophic bacteria and highest levels of RLU/100 cm². Alone or in combination, these 2 surfaces were also most frequently outside the established parameter. High mesophilic heterotrophic bacteria counts on cutting boards were observed in other studies of school food services (Rodriguez-Caturla et al., 2012; Yoon et al., 2008). Considering the high risk of cross-contamination causing outbreaks (Todd, Greig, Bartleson, & Michaels, 2007), schools should follow the recommendations of the Brazilian health legislation and use cleaning products daily that are registered for surfaces that come in contact with food (Brasil, 2004).

Table 2

<table>
<thead>
<tr>
<th>Equipment and utensils</th>
<th>N</th>
<th>Minimum and maximum values</th>
<th>Median (P25 – P75)</th>
<th>&gt;30 RLU/100 cm² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countertops</td>
<td>120</td>
<td>1 – 2895</td>
<td>52.5 (20 – 150) c</td>
<td>84 (70)</td>
</tr>
<tr>
<td>Cutting boards</td>
<td>119</td>
<td>0 – 2683</td>
<td>37 (11 – 146) b</td>
<td>70 (59)</td>
</tr>
<tr>
<td>Refrigerators</td>
<td>120</td>
<td>0 – 4810</td>
<td>30.5 (9.3 – 89.3) b</td>
<td>60 (50)</td>
</tr>
<tr>
<td>Blenders</td>
<td>116</td>
<td>0 – 9078</td>
<td>30.5 (9 – 141.5) b</td>
<td>58 (50)</td>
</tr>
<tr>
<td>Dishes</td>
<td>120</td>
<td>0 – 7816</td>
<td>14 (7 – 39.5) a</td>
<td>35 (29)</td>
</tr>
</tbody>
</table>

a, b, c: identical letters do not differ by the Wilcoxon test at 5% significance.

Table 3

<table>
<thead>
<tr>
<th>Number of inadequate surfaces</th>
<th>Mesophilic heterotrophic bacteria (N – 114)</th>
<th>ATP bioluminescence (N – 116)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>27</td>
<td>23.7</td>
</tr>
<tr>
<td>1</td>
<td>38</td>
<td>33.3</td>
</tr>
<tr>
<td>2</td>
<td>29</td>
<td>25.4</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>8.8</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>6.1</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Table 4

<table>
<thead>
<tr>
<th>Block</th>
<th>Health risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings and facilities</td>
<td>Very high 7 (5.8%) 94 (78.3%) 19 (15.8%) 0 0</td>
</tr>
<tr>
<td>Temperature-controlled equipment</td>
<td>High 16 (13.3%) 40 (33.3%) 38 (31.7%) 22 (18.3%) 4 (3.3%)</td>
</tr>
<tr>
<td>Food handlers</td>
<td>Average 4 (3.3%) 23 (19.2%) 63 (52.5%) 27 (22.5%) 3 (2.5%)</td>
</tr>
<tr>
<td>Suppliers</td>
<td>Low 3 (2.5%) 0 4 (3.3%) 0 113 (94.2%)</td>
</tr>
<tr>
<td>Procedures</td>
<td>Very low 1 (0.8%) 106 (88.3%) 12 (10.1%) 0 0</td>
</tr>
<tr>
<td>Environmental hygiene</td>
<td>13 (10.8%) 96 (80%) 11 (9.2%) 0 0</td>
</tr>
</tbody>
</table>

Fig. 1. The distribution of school units by thematic block and health risk.
The present study demonstrated a weak correlation between mesophilic heterotrophic bacteria counts and ATP bioluminescence when countertops and cutting boards were evaluated. This weak correlation between the two techniques has been demonstrated in other studies (Costa, Andrade, Brandão, Passos, & Soares, 2006; Krysinski, Brown, & Marchisello, 1992; Odebrecht, Schmidt, & Franco, 2000). ATP bioluminescence should be used as an indicator of hygiene relative to the amount of organic matter on surfaces, which is important information because the nutrients can facilitate the process of bacterial adhesion and biofilm formation (Andrade, 2008, 412p; Andrade, Silva, & Brabes, 2003; Costa et al., 2006; Pires et al., 2005). However, heterotrophic mesophilic bacteria count is an indicator of microbial contamination (Andrade et al., 2003; Aycicek et al. 2006). Therefore, ATP bioluminescence and heterotrophic mesophilic bacteria counts are complementary tests for the evaluation of environmental hygiene to provide a broader diagnosis of sanitation and hygiene conditions.

Improperly cleaned equipment and utensils (Lee & Greig, 2010) or changes in processed food (Andrade et al., 2003; Dufrenne, Ritmeester, Delfgou-Van Asch, Van Leusden, & De Jonge, 2001; Kusumaningrum, Riboldi, Hazeleger & Beumer, 2003; Todd, Greig, Bartiessen, & Michaels, 2000) have been responsible for outbreaks of foodborne disease in schools. A sanitized surface may be minimally involved in outbreaks, as caused by *Escherichia coli* O157:H7 in Scotland. This outbreak involved 496 individuals and 17 deaths and was associated with a cross-sectional contamination of raw meat cooked with a meat grinder (FAO, 2002).

The results of the surface assessments showed no statistical agreement with the classification of health risk established by the GMP checklist. Schools with low or high health risks presented similar frequencies of surfaces above the parameters for the results of ATP bioluminescence and mesophilic heterotrophic bacteria. The checklist was used to evaluate good practices and compliance with sanitary legislation in food service. The results generated an inspection score that was analogous to the risk of an outbreak from food prepared at the assessed site. The presence of risk factors did not affect the presence of pathogenic microorganisms. Other researchers have noted this distinction and reinforced the use of combined strategies to evaluate food service (Kjeldgaard, Stormly, & Leisner, 2010; Tebbut & Southwell, 1997).

These results are consistent with the GMP checklist item that demonstrated the improper cleaning of equipment and utensils in 98% of schools, thus indicating that all schools did not have standardized cleaning procedures. Another factor that demonstrated the absence of standardization was the absence of a cleaning routine and preventive maintenance of the equipment.

The absence of proper refrigerator temperatures (up to 4 °C in 60% of schools) (Brasil, 2004) and ice buildups (59% of schools) was one of the more frequent observations in school evaluations. Storage temperature was an important parameter that influenced the deterioration of perishable foods and microbial growth; hence, the absence of control offered a greater risk of DTA, particularly if associated with improper food preparation and cross-contamination on surfaces, such as poorly cleaned countertops and cutting boards (CDC, 2006; Tondo & Bartz, 2011; Todd, Michaels, Smith, Greig, & Bartiessen, 2010).

High rates of noncompliance were observed in the procedures and food handlers block, which emphasized the absence of standard operating procedures, training and preventive postures for the occurrence of DTA. According to the Codex Alimentarius (2009), training is crucial for any food hygiene system, although several studies show that individual training does not guarantee a change in practice (Cook & Casey, 1979; Ehiri, Morris, & McEwen, 1997; Park, Kwak, & Chang, 2012). The study developed by da Cunha et al. (2013) presented an effective intervention in the context of school meals and involved aspects such as knowledge, attitudes, practices and motivation. Intervention strategies that target different aspects of food handling, not only knowledge, may be promising in this scenario, which may address problems that mainly involve the food handler.

Because food handlers and their inadequate practices are among the main causes of outbreaks (Bryan, 1978; Greig, Todd, Bartielson, & Michaels, 2007), including in Brazil (Costalunga & Tondo, 2002), these thematic blocks of the checklist received the highest weights (procedure − k = 30 and food handlers − k = 25) on the GMP checklist scores. These blocks effectively contributed the most to a health risk classification between average and high.

Incorrect hand cleaning was indicated in most (99%) of the schools in the present study, which was similar to the results observed in other studies conducted on school food services (da Cunha et al., 2012). The hands are a potential vehicle for cross-contamination of food and contact surfaces, and proper hand hygiene could prevent 34% of *E. coli* infections (Todd et al., 2009). The food handler and contact with contaminated surfaces are potential causes of cross contamination and, consequently, outbreaks. Additionally, storage at incorrect temperatures in 67% of schools was the main problem observed in the processes and procedures block, which favored microbial growth and increased DTA risk.

The buildings and facilities block showed a high number of non-conforming items on the GMP checklist. No school was classified as very low or low health risk. Other studies conducted in schools in other Brazilian states also observed similar results (Cardoso et al., 2010; Oliveira, Brasil, & Taddei, 2008; Santana et al., 2009). However, unlike the other blocks on the GMP checklist, the buildings and facilities block was more closely connected to government investments in school improvement and demonstrated an absence of school renovations and maintenance. Small monthly investments might generate significant changes in the adequacy of the school food service through sanitation laws (Lockis et al., 2011).

5. Conclusion

Regarding surfaces, most schools had satisfactory results for the heterotrophic mesophilic bacteria count. However, the surfaces of countertops, cutting boards, refrigerators and blenders required better cleaning, as demonstrated by the ATP bioluminescence evaluation. The health risk assessment using the checklist showed the incorrect practice of environmental hygiene procedures. The countertop and cutting board surfaces were worse in the heterotrophic mesophilic bacteria count and ATP bioluminescence evaluations. The results of both techniques for the dishes differed from all other utensils and equipment. The frequency of and correct environmental cleaning technique should be a permanent topic in intervention strategies to adapt good practices to this environment. Another important point is to use different strategies to teach the importance of a good technique to generate attitudinal changes.

School food services at public schools in Porto Alegre show weaknesses in GMP, especially with regard to environmental hygiene and procedures. Failures related to both factors potentially raise the risk of outbreaks in this environment. The majority of the schools had been categorized as average health risk and no school was classified as low risk or very low risk. This study presents the use of scores to determine the health risk in school meal services. The scores used enabled the classification of school meal services and the identification of the points that need more attention. These aspects can facilitate the adoption of corrective measures and the creation of public policies involving food safety in school meals and also enable the implementation of the prerequisite program and HACCP system in the future.
The health risk classification established by the GMP checklist was not consistent with the results of the surface evaluations of mesophilic heterotrophic bacteria and ATP bioluminescence. Although the purpose of the evaluations was similar, the nature of the results was distinct. The combined results allowed the identification of flaws mainly related to environmental hygiene. Easier-to-understand results are an important step in health risk management and can facilitate the risk communication for students, community, principals and mayors.

Acknowledgments

The authors would like to thank all the participants of this study, the Collaborative Center of School Feeding of Federal University of Rio Grande do Sul (CECANE UFRGS) and São Paulo (CECANE UNIFESP) and to the National Fund of Education Development (FNDE) study sponsor.

References


