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Epidemiological and microbiological aspects of residential outbreaks of foodborne illness in the Parana State, Brazil

Aspectos epidemiológicos e microbiológicos dos surtos residenciais de doenças transmitidas por alimentos no Estado do Paraná, Brasil

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Abstract

Foodborne illness results in high costs to public health and the food chain production worldwide. The majority of the population is unaware of food safety requirements and consequently, domestic kitchens are sources of contamination and spread of disease. Eating habits and the profile of food handlers in these sites guide the planning of surveillance and public education. This study describes the epidemiological and microbiological aspects of household outbreaks of foodborne illness in the State of Parana, using the Notifiable Diseases Information System database. There were 357 outbreaks between 2008 and 2012 in the State of Parana, and households were the main place of occurrence (43.70%), followed by restaurants and bakeries (21.00%), and kindergartens and schools (11.20 %). Household outbreak records derived from the municipalities for regional health coverage, based in Curitiba, Cascavel, Pato Branco, Foz do Iguaçu and Londrina. These indicated an increased number of reported cases between 2011 and 2012. The increase in reporting reflects a greater awareness among professionals because of training. The results highlight the consumption of contaminated food (36.15%), by strains of coagulase positive *Staphylococcus* (36.23%). They also reflect an intensification and wholeness of public policies on the education of the population regarding hygiene principles in the acquisition, handling, preparation, storage, and consumption of food in the household.

Key words: Home care in health. Foodborne illness. Health education. Microorganisms. Coagulase positive *Staphylococcus*.

Resumo

Doenças transmitidas por alimentos representam mundialmente elevados custos à saúde pública e à cadeia produtiva de alimentos. Boa parte da população desconhece os requisitos à segurança dos alimentos tornando as cozinhas domésticas fontes de contaminação e propagação de doenças. Os hábitos alimentares e o perfil dos manipuladores nestes locais norteiam o planejamento da vigilância e educação da população. O presente trabalho descreve os aspectos epidemiológicos e microbiológicos dos surtos residenciais de doenças transmitidas por alimentos no Estado do Paraná, a partir da base de dados do Sistema de Informação de Agravos de Notificação. No período de 2008 a 2012 foram notificados 357 surtos no Estado do Paraná sendo as residências paranaenses o principal local de ocorrência (43,70%), seguidas pelos restaurantes e padarias (21,00%) e pelas creches e escolas (11,20%). Entretanto, os registros de surtos domiciliares mantiveram-se concentrados nos municípios de abrangência das

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regionais de saúde sediadas em Curitiba, Cascavel, Pato Branco, Foz do Iguaçu e Londrina, com destaque ao aumento de notificação nos anos de 2011 e 2012, que coincide com a sensibilização dos profissionais envolvidos por meio de capacitações. Destacam-se o consumo de alimentos contaminados (36,15%), por cepas de *Staphylococcus* coagulase positiva (36,23%) e normalmente a base de carnes e seus derivados (59,57%), sugerindo a intensificação e integralidade das políticas públicas na educação da população quanto aos princípios de higiene na aquisição, manipulação, preparação, conservação e consumo dos alimentos nos domicílios.
Palavras-chave: Cuidados domiciliares em saúde. Doenças transmitidas por alimentos. Educação em saúde. Micro-organismos. *Staphylococcus* coagulase positiva.

Introduction

Food contaminated by pathogenic microorganisms (bacteria and their toxins, viruses, yeasts and parasites) may compromise the health of many people by triggering inherent implications of over 250 foodborne illnesses (FI). However, consumers are not always aware of the potential hazards of the food they consume, mistakenly associating FI to spoilage of food and, therefore, exposing themselves daily to a significant amount of contaminated food with the potential to cause disease in humans, despite a normal appearance (preserved color, odor and taste) (BRASIL, 2010; NEWELL et al., 2010; FORSYTHE, 2013; VIEGAS, 2014).

Each year more than two million people worldwide die from diarrheal diseases by ingesting contaminated food and water. Annually in the United States, for example, 28% of the population suffers from FI and 0.1% of these individuals are hospitalized. However, in most countries, the FI epidemiological profile is only an estimate, because of the underreporting of cases, as often symptoms are mild, lasting few days, and people generally recover without seeking medical advice. Even when patients do seek medical advice, symptoms are rarely attributed to food consumption because of the diverse etiology of gastrointestinal disorders. This contributes to the limited number of health services notifications (WHO, 2008; SCALLAN et al., 2011; FORSYTHE, 2013; VIEGAS, 2014).

Increasingly, households include elderly and immunocompromised people, and this can enhance the risk of occurrence and severity of foodborne diseases. In this context, housewives play a key role in the surveillance of foodborne illness in Brazil. The evaluation of their knowledge on food safety and good food manufacturing practices becomes strategic in preventing environmental micro-organisms (including, plant surfaces, animals, insects, equipment and utensils, in man and in its own food) and micro-organisms present in the household, from becoming a health hazard by making food unsuitable for human consumption (VIEGAS, 2014).

In Brazil, while few states possess efficient surveillance services for the collation of epidemiological data on these diseases, FI research on outbreaks has evolved considerably, providing historical series of information on notifications that can be used to establish prevention strategies (COSTALUNGA; TONDO, 2002; BRASIL, 2010). In view of the social and economic impact of FI, this study aimed to describe the epidemiological and microbiological profile of household outbreaks of foodborne diseases in the State of Parana, notified to the State Secretariat of Health (SESA) of 399 state municipalities between 01 January 2008 and 31 December 2012.

Material and Methods

A descriptive cross-sectional study of household outbreaks of foodborne diseases in the State of Parana was performed between January 1st, 2008 and December 31st, 2012, based of date in the Notifiable Diseases Information System database

(SINAN Net), linked to the Epidemiological Surveillance Center of the Parana State Secretaria of Health, Brazil.

Epidemiological data

Epidemiological data of reported outbreaks were compiled from investigation records of FI outbreaks, categorized in detail in Microsoft Office Excel® software spreadsheets and including the reporting dates, place of outbreak occurrence, involvement of municipality and regional health centers, and the number of clinical and bromatological specimens collected for laboratory analysis.

Microbiological data

Microbiological data from specimens of suspected foods, collected during FI outbreak investigations, were obtained through reports issued by the Central State Laboratory (LACEN) after analyses and measures recommended by Resolution RDC N°12 of January 2nd 2001, of the National Health Surveillance Agency (ANVISA) (BRASIL, 2001). These reports adopted the *Compendium of analytical methods for the microbiological examination of foods, of the American Public Health Association* (APHA, 2001) for research of *Salmonella* species and coagulase positive *Staphylococcus*, *Escherichia coli*, *Bacillus cereus*, sulphite reducing clostridia at 46° C, and coliforms at 45ºC and 35ºC.

Tabulation and data analysis

From the data tabulation, we performed a descriptive statistical analysis of absolute and relative frequencies of the variables. The analysis identified the following: incidence of household outbreaks reported over the index period, geographical distribution of notifications in 22 regional State health centers and their respective municipalities (399), frequency of collection of clinical and bromatological specimens during the investigation of outbreaks, number of suspected food specimens collected by category, occurrence rate of contamination, and etiologic agents isolated from food specimens analyzed during the index period.

Results and Discussion

Geographical distribution of reported outbreaks

During the index period, 357 FI outbreaks were reported in the State of Parana, occurring in households (43.70%), restaurants and bakeries (21.00%), and kindergartens and schools (11.20 %). Comparable results were obtained during the analysis of earlier outbreaks in Parana, between 1978 to 2002 (AMSON et al., 2006); in São Paulo, between 1995 and 2008 (MAYER; SILVA, 2009); in Rio Grande do Sul, between 2006 and 2007 (WELKER et al., 2010); and in the course of the compilation of epidemiological data from twenty reports of FI outbreaks occurring in Brazil between 1998 and 2011, indexed in major scientific databases (GARCIA; DUARTE, 2014). Data between 2000 and 2011, published by the Secretariat of Health Surveillance, Ministry of Health, confirmed that nationally, households represent the sites with the higher incidence of FI outbreaks (37.99%). A similar trend was reported in 2012 by the countries of the European Union, with 39.7% of outbreak notifications being traced back to household origin (BRASIL, 2013; EFSA, 2014).

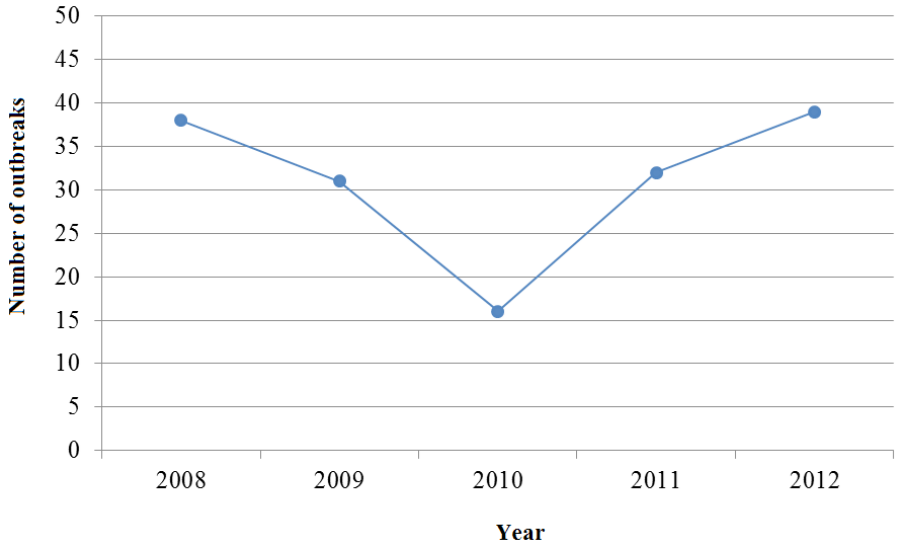
However, household outbreaks records remained concentrated in the municipalities covered by the 2nd (26.11%), 10th (16.56%), 7th (8.28%), 9th (8.28%) and 17th (8.28%) regional health centers, based respectively in Curitiba, Cascavel, Pato Branco, Foz do Iguaçu and Londrina. Moreover, it was observed that the municipalities of five regional health centers (12th, 13th, 15th, 16th, and 19th, with headquarters in Umuarama, Cianorte, Maringa, Apucarana, and Jacarezinho, respectively) recorded no notification

of household outbreak during this period. The analysis of the geographical distribution of the reports revealed that only 56 (14.04%) municipal districts of Parana were responsible for the records of household outbreaks within the index period. Furthermore, majority (57.89%) of the districts only notified the occurrence of one outbreak in the course of this study. In the municipal context, the reporting rates of the municipalities of Curitiba (16.67%), Cambé (7.69%), Cascavel (7.69%), Araucaria (5.77%), and Paranaguá (5.77%) were significant.

Data published by Welker et al. (2010) reported that over 60% of the 186 outbreaks registered in Rio Grande do Sul State municipalities between 2006 and 2007, focused on just three Regional Health Coordinating Bodies (Porto Alegre, Caxias do Sul and Passo Fundo). In Minas Gerais, another study found that only 33 municipalities were involved in the notification of 39 FI in the State in 2010 and, therefore, over 95% of the municipalities of the State of Minas Gerais did not even report one outbreak case due to the consumption of contaminated food (DIAS et al., 2011).

Therefore, the rates of foodborne disease outbreak notification do not reproduce the actual risks to which the population is constantly exposed by consumption of contaminated food. The VE-DTA system is not fully functional throughout the territory, because few municipalities were responsible for the records and many outbreaks were concentrated in the range of only five regional health centers. However, an increasing numbe of notifications occurred, starting in 2011 (Figure 1). This can be attributed to the training in investigation and reporting of FI outbreaks, provided by 425 controllers involved in the health monitoring of municipalities covering ten regional health centers in the State (2nd, 5th, 6th, 7th, 9th, 10th, 12th, 16th, 20th and 21th, respectively based in Curitiba, Guarapuava, União da Vitória, Pato Branco, Foz do Iguaçu, Cascavel, Umuarama, Apucarana, Toledo and Telemaco Borba).

Figure 1. Number of FI household outbreaks reported in the State of Parana between 2008 and 2012, by year of occurrence.



Contextualization of household outbreaks

Epidemiological studies and data indicate that most people have little or no information regarding the appropriate way to acquire, maintain and handle

food, and few consumers consider their homes capable of transforming food into potential sources of disease (VEIGA, 2009; VIEGAS, 2014). Leite et al. (2009) reported that in the neighborhood of Lapa, in Rio de Janeiro, 77.5% of food handlers believed that the risk of contracting a FI in their homes was low or non-existent, while 70% said that the risk is greater when food consumption occurs outside of the household. The results of Praxedes (2003), however, showed in the San Remo community, in São Paulo, 41.3% of respondents had FI symptoms at home while 40.4% sought medical help after considering that they had improved (23.1%) or self-medicated themselves (69.2%).

Santos et al. (2010) and Fortunato and Vincenzi (2014) showed that 30% and 95%, respectively, of interviewed housewives routinely perform household chores, such as washing clothes and cleaning the house and, specifically, cleaning the bathroom, at the same time as preparing food. Researchers have also identified serious flaws with regard to the storage and thawing of meat products in the home (BARBOSA, 2009; SANTOS et al., 2010), and the presence of vectors and urban pests in the home environment (FARIAS, 2012; SANTOS et al., 2010). Failures in preventing cross contamination and conservation of food under refrigeration were also highlighted, such as the unsafe storage of eggs in the refrigerator door (74%), the use of the same cutting surface to handle different foods (73%), the presence of waste material on the sink and in proximity of food (57%), the use of sponges in poor condition (46%), the use of the same kitchen towel to dry utensils and hands (46%), the presence of cutting surfaces with signs of wear and in poor condition (43%), the exposure of packaged foods at room temperature (32%), and domestic animals access to food preparation sites (20%) (LEITE et al., 2009).

The consequences of ignorance of the fundamental rules of safe food handling is a reality across a range of food marketing sites, in different regions of Brazil (BRASIL et al., 2013; SILVA et al., 2013.). The lack of training of food handlers can lead to the supply of contaminated food to the population (BECKER; KIEL, 2011; GOTTARDO et al., 2011; ALCÂNTARA et al., 2012; ZONTA et al., 2013), which might influence the increase in household outbreaks of foodborne illnesses. Moreover, although often forgotten or neglected, it is necessary that the promotion of safe eating habits is integrated into the basic regionalized planning of educational activities, surveillance, and prevention and control of FI in domestic kitchens. Many families acquire food at street markets, small grocery stores or supermarkets within their neighborhood. However, because of the lack of safe food handling practices, these sources become latent sources of bacterial growth and contamination, posing a health risk to families.

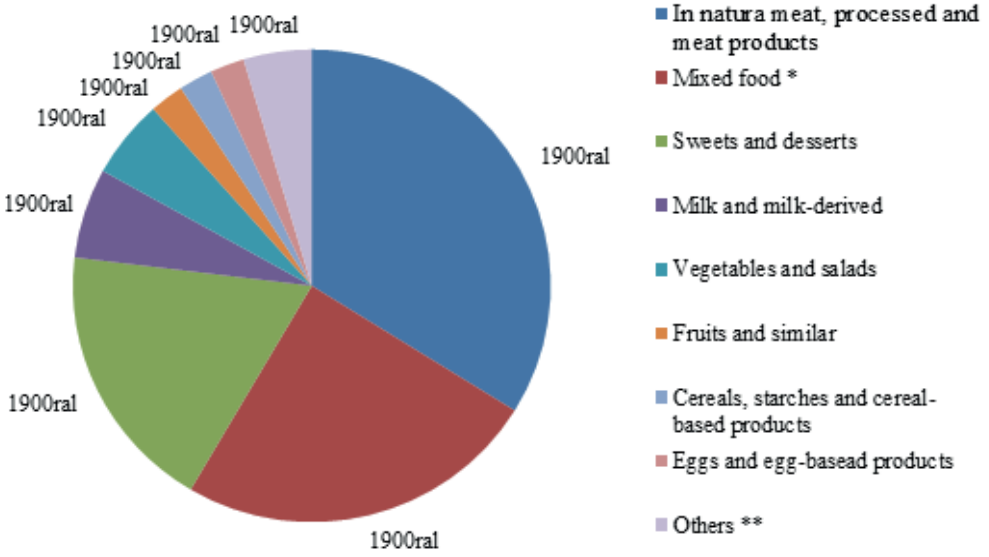
Oliveira and Betiol (2010) highlighted that in the southwestern region of Parana, many consumers are exposed daily to the risk of contracting FI due to the consumption of foods, such as raw milk (17%), rare-cooked meat (28%), meat without inspection (46%), colony eggs (72%), colony cheese (74%) and colony salami (84%), or untreated water (30%), or consumption of potato salads with mayonnaise made with raw eggs (50%). These findings corroborate the results of this study, as eight municipalities in this region accounted for 16 (10.26%) notifications of household outbreaks during the index period.

Evaluation of collection of specimens and food associated with outbreaks

In the present study, we identified the collection of clinical and bromatological specimens, respectively, in 42 (26.92%) and 52 (33.33%) reported outbreaks. Of these specimens, 14 (33.33%) and 25 (48.08%), respectively, showed contamination. It is clear, therefore, that the collection of specimens has not always been performed, and this represents a flaw, which must be corrected, in the process of laboratory confirmation of epidemiological evidence.

Between 2008 and 2012, we collected 130 samples of suspected foods during investigations of notified household outbreaks. These mainly consisted of in natura meats, processed meat products (33.85%), mixed foods (24.62%), and sweets and desserts (18.46%) (Figure 2). Of these samples, only 47 (36.15%) were infected. Few samples contained more than one of the microorganisms researched in this study and covered by the relevant legislation. The majority of contaminated foods were in natura meats, processed meat products (28; 59.57%), mixed food (6; 12.77%), and sweets and desserts (5; 10.64%) (Figure 3). Therefore, while a wide variety of foods is potentially a source of disease, animal products represent the most conducive medium for bacterial growth because generally, they are rich in proteins and nutrients, have high water activity and low acidity, and are natural carriers of some bacteria with pathogenic potential (VEIGA, 2009; FORSYTHE, 2013; MARINS et al., 2014).

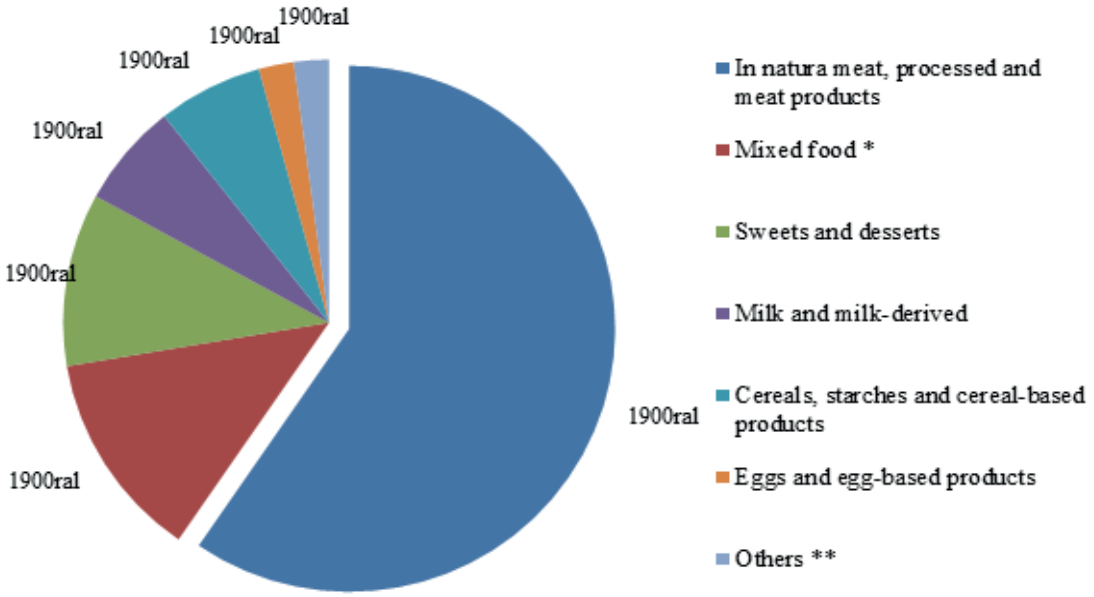
Figure 2. Distribution of the number of suspected food samples collected in FI household outbreaks in the State of Parana between 2008 and 2012, by food category.



Note: * All food containing ingredients from different sources (party snacks, lasagna and pasta); ** Preserves, spices and non-alcohol drinks.

Mayer and Silva (2009) confirmed low identification rates (47%) of food types causing the outbreaks in the State of São Paulo, and increased difficulties isolating the etiologic agents in household outbreaks (72%). Nascimento (2013) found that it was possible to identify the food source or the etiologic agent in only 31% of all FI outbreaks in Porto Alegre (RS), between 2003 and 2011.

Figure 3. Distribution of the number of food contaminated specimens in FI household outbreaks in the State of Parana between 2008 and 2012, by food category.



Note: * All foods containing ingredients from different sources (party snacks, lasagna and pasta); ** Preserves, spices and non-alcohol drinks.

The lack of laboratorial or epidemiological data challenges and/or prevents the investigative process of FI outbreaks. These difficulties are evident from the analysis of national data between 2000 and 2011, published by the SVS/MS, showing that 3,401 (42.21%) and 4,233 (52.54%) of notifications nationally, did not identify, respectively, the food and etiological agent involved in FI outbreaks (BRASIL, 2013). Failure to identify the etiologic agent is mainly due to the late notification of outbreaks, which interferes with the timely collection of accurate information and specimens. There may be cases where controllers do not collect specimens properly for analysis or where the etiological agent is inactivated due to the poor conditions of storage and/or transport of samples or the use of antibiotics by patients. False negatives can occur due to a non-homogeneous microbial distribution in contaminated food or the absence of specific analytical methodology for research on toxins and/or microorganisms not included in the existing laws and routines of LACEN, such as *Shigella*, *Yersinia,* and *Campylobacter* (BRASIL, 2001).

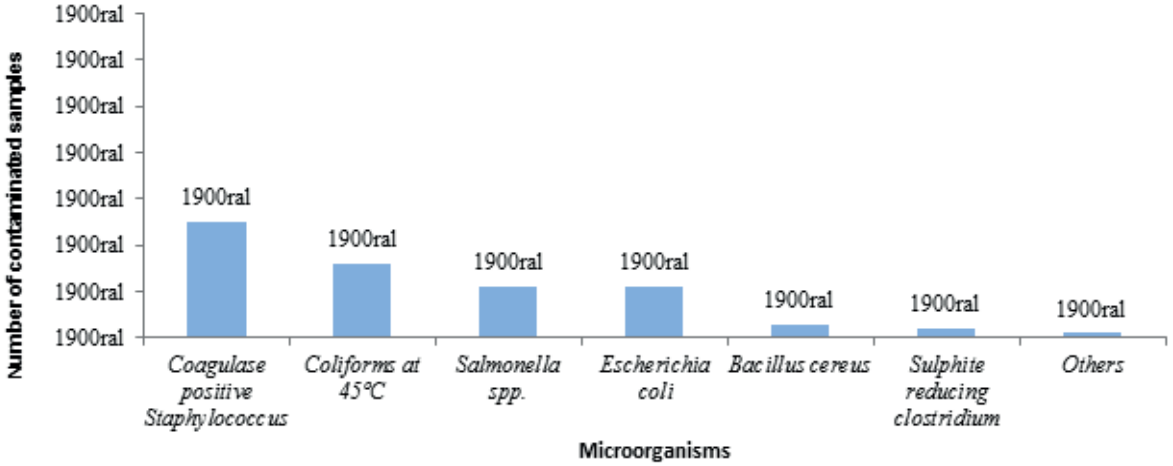
Discussion of laboratory results during the investigation of outbreaks

The main pathogenic microorganisms, or microorganisms with counts above the limits prescribed by Brazilian legislation on food associated with household outbreaks, identified during the index period in this study, were coagulase positive *Staphylococcus* (25; 36.23%), coliforms at 45° C (16; 23.19%), *Salmonella* spp. (11; 15.94%) and *Escherichia coli* (11; 15.94%). Coagulase positive *Staphylococcus* counts ranged from 3.0×10^3 CFU/g to 3.0×10^7 CFU/g with an arithmetic mean $>8.0 \times 10^6$ and a median of 3.0×10^6 CFU/g (Figure 4).

Except for *Salmonella* species, the microorganisms identified in this study, did not confirm the etiology of any foodborne disease. However, laboratory results may indicate the most likely food sources

of contamination in the environment in which they were handled, even if the microorganisms isolated are not epidemiologically associated with the investigated outbreak (FISCHER, 2013).

Figure 4. Distribution of the number of microorganisms isolated in contaminated food samples and involved in FI household outbreaks in the State of Parana between 2008 and 2012.



Laboratory diagnosis of staphylococcal food poisoning requires researching enterotoxins produced by enterotoxigenic *Staphylococcus*, particularly by the species *S. aureus*. Counts above 10^5 CFU/g increase the likelihood of staphylococcal enterotoxins because at this count, the isolated enterotoxigenic pathogens are able to produce sufficient amounts of enterotoxin to trigger the symptoms of an acute intoxication (FORSYTHE, 2013). The presence of *Escherichia coli* counts above the levels recommended by law, does not confirm the etiology of infection with *Escherichia coli* causing diarrhea. Nevertheless, it signals hygiene and health issues, as this microorganism remains the main indicator of fecal contamination, primarily of fresh foods.

Previous surveys in Parana, between 1978 and 2000, have indicated that 41% of foodborne outbreaks reported in the State, without specifically identifying the outbreak locations, were caused by *S. aureus* (AMSON et al., 2006). Coagulase positive *S. aureus* (17.90%) was also among three of the most frequently isolated microorganisms in the outbreaks in Rio Grande do Sul State, between 2004 and 2012 (FISCHER, 2013). National data corroborate this, as the etiological agents most frequently involved in FI outbreaks nationally, between 2000 and 2011, were *Salmonella* species (39.16%), *S. aureus* (19.01%) and *E. coli* (11.35%) (BRASIL, 2013). These results exclude unknown, inconclusive, and inconsistent information (4,233),

Independently of the involved microorganism, the absence of timely investigations and the lack of information available to consumers should be noted as factors enhancing the frequency of FI outbreaks. Thus, it is vital that states and municipalities implement the surveillance of these diseases in the household environment. This surveillance should be proactive and clearly integrated within programs of Surveillance in Health and Primary Health Care. Existing practices should be continuously incorporated into the collective knowledge in a creative way, fostering participation, as well as mobilizing and challenging individuals and health professionals to focus beyond curative care, towards the identification of risk factors and

the development of health promotion and disease prevention strategies (BRANDÃO, 2001; ALVES, 2005; BRASIL, 2010).

In this context, the professionals of the Family Health Strategy are ideal partners, through their repeated home visits to counsel family groups on adopting healthy eating habits and safe food handling practices. If health status is related to the behavior of the individual, intervention promoting education should enable people to learn to perceive the risk of foodborne infection within their reality and lifestyles (PRAXEDES, 2003; THORPE, 2003; LEITE; WAISSMANN, 2007; RODRIGUES; RONCADA, 2008; BERNARDINO; OLIVEIRA, 2012; VIEGAS, 2014).

Hence, it is essential that consumers are aware of the potential risks that contaminated foods pose to their health and of the precautions required for the conservation, handling and consumption of food in order to ensure safe consumption (VEIGA, 2009; WELKER et al., 2010; BERGAMINI et al., 2013; DEON et al., 2014; FORTUNATO; VINCENZI, 2014). Moreover, cultural and traditional issues that guide the consumption of locally produced products, particularly meat products, must be observed by public agencies responsible for the design of good manufacturing practice programs to guide producers (GOTTARDO et al., 2011).

This approach will prevent the handling and storage of contaminated raw products by uninformed housewives, gradually decreasing the colonization and survival of pathogenic microorganisms in foods, food handling environments, household equipment, and appliances. Despite the risk of underreporting in a voluntary national surveillance system, the authors believe that the results obtained in this study contribute to improving the VE-DTA system in the State of Parana, through the combination of programs of health surveillance and basic health care. These, in turn, reduce the occurrence of household outbreaks of foodborne illness.

Conclusions

The FI outbreaks, reported in the five-year period analyzed, followed the same epidemiological and microbiological characteristics described in previous studies undertaken in Parana. Households were the main place of occurrence of outbreaks, with low levels of food samples collected for laboratory analysis. The main types of food collected and analyzed during the outbreaks were raw meats, processed and meat products, mixed foods and sweets or desserts. Some samples were contaminated with more than one microorganism and coagulase positive *Staphylococcus* was the main bacterium isolated in food involved in household outbreaks.

Coordination and integration of Surveillance in Health and Primary Health Care are required so that the information is representative of FI occurrence. Efforts are needed to promote the continuing education of the population and the fundamental rules on acquisition, handling, preparation, storage, and consumption of food in households of Parana.

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