







Foodborne disease in Brazil from 2015 to 2021: an exploratory study

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Abstract

For food to be considered healthy, among other aspects, it must be free of contamination that could lead to the development of foodborne diseases (FBDs). The hygienic and sanitary aspects of food consumed by the population as well as its incorrect handling procedures can cause FBDs. Many contaminated foods seem to have normal sensory characteristics, without changes in texture, flavor, and odor, so often those who consume it do not have the perception and understanding that food that appears to be perfect visibly brings risk internally when consumed, which can cause an FBD. Given these considerations, this study aimed to characterize, report, and quantify the occurrence of outbreaks of FBD affected in the North, Northeast, Midwest, Southeast, and South regions of Brazil between 2015 and 2021 using as a source of data those notified via the Data Sheet Research in the Notifiable Diseases Information System (SINAN). A total of 60,907 cases of food poisoning were recorded across the country due to FBD outbreaks, resulting in 71 fatalities. While the highest number of cases of foodborne outbreaks occurred in the southeast, the highest number of fatalities from FBD occurred in the north of the country. The highest percentage of FBD outbreaks occurred in homes (probably due to the period of the COVID-19 pandemic), although the causative food and the responsible microorganism remained unknown. In this way, it is possible to perceive that in addition to the underreporting that may exist and has already been reported by other articles on the subject, the numbers reported in the Brazilian health system may also demonstrate a lack of investigation into the cause of FBD.

Keywords: foodborne illnesses; outbreaks; food poisoning; death.

1 INTRODUCTION

For food to be considered safe, it must be free of contamination that could lead to the development of foodborne diseases (FBDs), as any microbiological contamination of food poses a risk to food safety (Sirtoli & Comarella, 2018). Among the symptoms are vomiting, nausea, diarrhea, digestive complications, fever, and anorexia, which can lead to death (Lee & Yoon, 2021).

The hygienic and sanitary aspects of food as well as its incorrect handling procedures can cause FBD. To ensure the quality of food in the hygienic and sanitary aspects, knowledge of various procedures is essential, starting from the purchase of raw materials to the consumption of ready-to-eat food (Vicente et al., 2018). Lack of hygiene when handling food or cross-contamination through contaminated utensils and environments, not only in commercial spaces such as restaurants but also in households, demonstrates great importance in the occurrence of FBD outbreaks (Nunes et al., 2017). The occurrence of FBD is related to several factors such as sanitation of food conditions, water quality unfit for human consumption, and inadequate personal hygiene practices (White et al., 2022).

Many contaminated foods may have acceptable sensory characteristics, without changes in texture, flavor, and odor, and therefore, during consumption, there is no perception or understanding that the food may pose a health risk (Lorenzo et al., 2018).

In Brazil, exogenous intoxications, which include outbreaks of FBDs, are notified via the Data Sheet Research in the Notifiable Diseases Information System (SINAN NET) (Maronezi et al., 2020). SINAN NET collects, transmits, and disseminates data routinely generated by the Epidemiological Surveillance System of the three spheres of Government, through a computerized network, supporting the investigation process and providing subsidies for the analysis of epidemiological surveillance information on compulsory notifiable diseases (de Souza Melo et al., 2018).

When one or more people present a similar clinical picture, after consuming the same food, where it would possibly be contaminated with microorganisms considered pathogenic or toxins released by microorganisms, it is considered an outbreak of FBD (Bintsis, 2017).

Some cases can be considered outbreaks even with a single case such as those caused by highly virulent microorganisms

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like *Clostridium* and enteropathogenic *Escherichia coli* (Sirtoli & Comarella, 2018).

Soragni et al. (2019) explained that although FBD is very important for public health and causes fatalities, many points make studies related to these diseases difficult, such as underreporting and subsequent lack of analysis of the place of occurrence (home or not) and the food involved, generating unrealistic numbers of notifications. Another fact is that most of these foodborne illnesses end up not being diagnosed by physicians and outbreaks are not always recognized due to the rapid recovery that occurs within 24–48 h, which ends up making identification, notification, and investigation difficult (Todd, 2014).

Outbreaks that are reported usually end up being restricted to those involving a larger number of people (two or more) or when the symptoms last for a long time, requiring medical intervention. Likewise, in these cases, a correct investigation is difficult, due to the lack of signs and symptoms in the individual involved when, in fact, it occurs, since, in most cases, this individual has already started medical treatment, impairing the collection of samples (Santos et al., 2017).

In the United States, a large proportion of FBD is transmitted by inadequately prepared food in households, resulting in an annual economic burden of approximately 36 billion dollars per year. Therefore, the US Department of Agriculture promotes a national campaign on food safety, and several practices, such as washing hands, avoiding cross-contamination, cooking, and refrigerating food properly, that limit or prevent the transmission of diseases (Evans et al., 2020). In Brazil, where it is believed that there is underreporting, most outbreaks are identified in commercial establishments such as restaurants, bars, snack bars, and bakeries (Finger et al., 2019).

The high rate of FBD, regardless of the place of contamination, raises the need for greater inspection and control of food marketing, basic sanitation, and the adoption of public policies to inform the population about good practices in food handling and the risks of consuming incorrectly processed foods, which is key to reducing foodborne illnesses (Finger et al., 2019; Wang et al., 2021). In general, this information needs to be constantly revised as it changes depending on the cultural condition and economy, mainly with the COVID-19 pandemic, among other factors. Given these considerations, this study aimed to report, quantify, and characterize the occurrence of outbreaks of FBD affected in the North, Northeast, Midwest, Southeast, and South regions of Brazil between 2015 and 2021.

2 MATERIALS AND METHODS

This is an exploratory, descriptive, and retrospective study with a quantitative approach to secondary data. To carry out the research, data registered through the TABNET program from SINAN (Data Sheet Research in the Notifiable Diseases Information System — Sistema de Informação de Agravos de Notificação) were used, which are available at the Department of Informatics of the Unified Health System (Departamento de Informática do Sistema Único de Saúde — DATASUS) and Sinan Net (Brazil).

In methods with a quantitative approach to data, quantitative or numerical data are collected through measurements of magnitude, and numbers with their respective units are obtained through metrology. This method generates data that can be studied through mathematical techniques such as percentages, probabilities, statistics, and analytical methods (Pereira et al., 2018).

The study was carried out based on the analysis of data from outbreaks of FBDs notified in the 26 Brazilian states and the Federal District from 2015 to 2021. The data addressed the following variables: exogenous intoxication, number of notifications, toxic agent, circumstance of intoxication, etiological agent, and disease evolution. Data were organized and tabulated using Microsoft Excel 2010 for Windows. The data were arranged in tables and graphs performing a descriptive analysis. As it is a public domain database, made available by the Sistema Único de Saúde (SUS), it eliminates the need to submit the work to the Ethics and Research Committee.

3 RESULTS AND DISCUSSION

According to the data from the Brazilian Ministry of Health between 2015 and 2021, a total of 60,907 cases of food poisoning were recorded across the country due to outbreaks of FBDs, resulting in 71 fatalities. The region with the highest representation in terms of the percentage of cases was the Southeast region with 37.2% ($n = 22,698$) of the total (Figure 1). This region comprises the states of Espírito Santo (ES), Minas Gerais (MG), Rio de Janeiro (RJ), and São Paulo (SP). Of the total cases that were confirmed as foodborne poisoning, 28.8% were confirmed through epidemiological surveys, 26.6% through clinical analysis, and 19.9% through clinical-bromatological laboratory, while 24.4% were considered inconclusive or unconfirmed (Table 1).

A study carried out by Finger et al. (2019) evaluated foodborne disease outbreaks in Brazil from 2000 to 2018, presenting similar results to what was obtained in this work. The highest incidences were registered in the Southeast and South regions of the country with 70.4% of the notifications, and confirmations of FBD were carried out by epidemiological surveys (22.7%), clinical analyses (13.2%), chemical analyses (10.1%), and epidemiological-clinical-bromatological analyses (8.8%).

The Southeast and Northeast regions of the country together accounted for 61.9% of registered cases. Our data corroborate

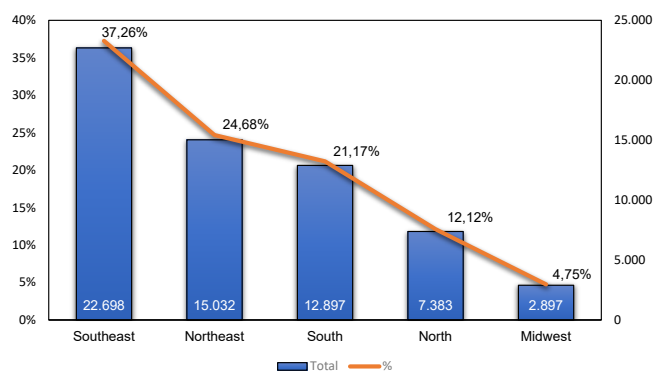


Figure 1. Total number of people affected by the foodborne disease in Brazil from 2015 to 2021.

Table 1. Confirmatory criteria, place of occurrence, causative foods, and etiological agent of death related to foodborne disease in Brazil between 2015 and 2021.

Confirmatory criteria	Total	Percentage (%)
Epidemiological clinic	13	28.8
Clinical laboratory	12	26.6
Inconclusive	11	24.4
Bromatological clinical laboratory	8	17.7
Bromatological Laboratory	1	2.2
Outbreak place of occurrence	Total	Percentage (%)
Residence	17	37.7
Others	10	22.2
Nursing home	5	11.1
Restaurant/bakery	5	11.1
Hospital	4	8.8
Daycare/school	2	4.4
Scattered cases in the neighborhood	1	2.2
Accommodation	1	2.2
Outbreak-causing foods	Total	Percentage (%)
Unknown	24	53.3
Multiple foods	6	13.3
Water	4	8.8
Mixed foods	4	8.8
Fruits, fruit products, and similar	2	4.4
Fresh pork	1	2.2
Sweets and dessert	1	2.2
Inconsistent	1	2.2
Milk and derivatives	1	2.2
Eggs and egg products	1	2.2
Etiological agent	Total	Percentage (%)
Unknown	29	64.4
Inconsistent	3	6.6
<i>Clostridium botulinum</i>	2	4.4
<i>Escherichia coli E</i>	2	4.4
<i>Staphylococcus aureus</i>	2	4.4
Carbamate	1	2.2
<i>Escherichia coli entero-hemorrhagica</i>	1	2.2
<i>Listeria monocytogenes</i>	1	2.2
<i>Salmonella enteritidis</i>	1	2.2
<i>Salmonella</i> ssp.	1	2.2
<i>Trypanosoma cruzi</i>	1	2.2
Hepatitis A virus	1	2.2

those suggested by Draeger et al. (2018), which indicated that these same regions had the highest number of occurrences of notifications referring to the years 2007–2016. In contrast, de Oliveira Ávila et al. (2016) found that FBD outbreaks between 2000 and 2013 were more frequent in the South and Southeast regions. However, the authors report that there seems to be a lack of notifications of cases that occurred as a result of inefficient control by the Health Departments in some regions of the country.

Of the 71 reported fatalities, it was not possible to determine the foods implicated in the occurrence of FBD in most cases (53.3%) (Table 1). In the other cases, where the foods related to the fatalities were identified, 13.3% of the cases occurred due

to the consumption of multiple foods, 8.8% water and mixed foods, and 4.4% fruits, fruit products, and similar. de Oliveira Elias et al. (2018) found that, from 2008 to 2014, most foodborne outbreaks in Brazil did not demonstrate the possibility of identifying the food source related to the outbreak (66.4%).

Regarding the etiological agents, the pathogen was not identified in most of the fatalities, being classified as unknown and inconsistent (71.1%) (Table 1). Among the identified pathogens are *Clostridium botulinum*, *E. coli*, *Staphylococcus aureus*, and *Salmonella* spp. (4.4% each). The value found in this work of unidentified pathogens was greater than that reported by Finger et al. (2019) referring to the years 2000–2018. In addition, these authors reported that among the pathogens identified as causative agents of FBD were *Salmonella* spp. (14.4%), rotavirus (9.9%), and *E. coli* (7.4%).

Salmonella is a Gram-negative bacteria that lives in the gastrointestinal tract of humans and animals but it has also been identified in reptiles and insects and is one of the main bacteria involved in cases of FBD due to its endemic characteristics and because its control depends a lot on human action (Ehuwa et al., 2021). Salmonellosis in humans, characterized by a gastroenteritis syndrome with symptoms such as highlight fever, vomiting, and abdominal diarrhea, is usually caused by contaminated food such as eggs, poultry, pigs, cattle, fruits, and vegetables (Campos et al., 2019; Popa & Papa, 2021).

In the United States, the Centers for Disease Control and Prevention (CDC) estimates an average of 1.3 million infections caused by consumption of food contaminated by salmonella and 420 fatalities each year. In the period from 2009 to 2018, the CDC reported 1,410 food-related salmonella outbreaks, of which 5.5% were associated with the consumption of pork (CDC, 2023).

Gomes et al. (2022) analyzed 780 samples of poultry and pork meat from Brazil, where 57 samples (7.3%) were identified as contaminated by salmonella. These contaminated samples were collected in 35 markets, of which 57.1% were classified as neighborhood butchers, 25.7% as supermarkets, 11.4% as municipal markets, and 5.7% as hypermarkets.

Clostridium botulinum is a Gram-positive bacterium formed by spores with distribution in the environment. This microorganism produces a botulinum neurotoxin which is responsible for botulism, a neurological disease in humans and animals (Le Bouquin et al., 2022). Traditional botulinum poisoning occurs with the ingestion of contaminated food, the main foods being homemade canned vegetables, fruits, fish, meat, sausages, seafood, smoked, salted, and canned foods (Chen et al., 2022).

Botulism is a disease caused by neurotoxins that promote the quantum release of acetylcholine from the motor termination at all peripheral cholinergic synapses, producing a deep potent muscular flaccid paralysis that is transient, but, if not treated, can lead to death due to paralysis of the respiratory muscles (Khorasan et al., 2020; Smith, 2009).

Escherichia coli are facultative anaerobic Gram-negative rods that are part of the normal gastrointestinal microbiota in humans and animals (Saeedi et al., 2017). However, the

production of toxins by these microorganisms causes symptoms, such as watery diarrhea, persistent diarrhea, abdominal pain and vomiting, hemolytic uremic syndrome, end-stage renal disease, and hemorrhagic colitis, in human (Munekata et al., 2020). Contamination in humans occurs mainly through water or direct contact with the feces of people already infected (Coelho et al., 2021).

Staphylococcus aureus is a Gram-positive bacterium found on the skin and mucous membranes of humans in the environment, food, water, and soil and can act as a commensal or opportunistic pathogen. In contaminated food, microorganisms can produce thermostable toxins that can cause the development of staphylococcal poisoning (Maestri et al., 2020). *S. aureus* can colonize the skin and nostrils of 50% of healthy adult individuals either persistently or intermittently (Li et al., 2022). The symptoms of the disease are nausea, vomiting, cramps, prostration, low blood pressure, or temperature drop (Fazio et al., 2020).

Camino Feltes et al. (2017) reported FBDs that occurred between 2007 and 2016 and indicated *E. coli*, *Salmonella* spp., and *S. aureus* as pathogenic microorganisms that most cause diarrhea, abdominal pain, vomiting, and/or nausea in individuals. The lack of identification of the pathogens that cause FBD is a global issue. Mun et al. (2020) claimed that 44% of hospitalizations due to FBD in the United States between 2009 and 2016 were caused by unknown pathogens.

According to Draeger et al. (2018), the high percentage of cases of FBD with unknown and inconsistent causes indicates that laboratory tests are not being performed for its detection or that the results are not being properly reported. These authors also point out that the lack of conclusion of FBD outbreaks without any information about the test or etiological agent makes decision-making difficult for the elaboration of public policies that are assertive about the improvement of these issues.

In this study, regarding the place of occurrence of outbreaks of FBD, the home (37.7%) occupies first, followed by other places (22.2%), nursery home and restaurants/bakery (11.1% each), hospital (8.8%), daycare/school (4.4%), and dispersed cases in the neighborhood and accommodation (2.2%). de Oliveira Elias et al. (2018) evaluated FBDs between 2008 and 2014 in Brazil and indicated that company cafeterias, restaurants, and bakeries ranked first, followed by those associated with more than one location in second place, and hospitals and residential health facilities in third place with the greatest rates of FBD contamination.

Soragni et al. (2019) evaluated FBD and the participation of inadequate food handling for their occurrence using data from the Epidemiological Surveillance System in Brazil from 1999 to 2008 and reported that the places with the highest occurrence of outbreaks were commercial establishments and residences, except by the state of Rio Grande do Sul where the main location is the residences. Residence/domicile is the main point of occurrence of FBDs also in Portugal (28.8%, 1987–1998) and in the United States, England, Wales, and the Province of Rio Negro in Argentina (27.27%). Previous studies published in the literature, such as Klein et al. (2017), Lentz et al. (2018), and Sousa et al. (2021), do not report the number of fatalities

from foodborne illnesses, perhaps because it is a relatively small number compared with outbreaks.

Marchi et al. (2011) analyzed the occurrence of foodborne disease outbreaks in the municipality of Chapecó (Santa Catarina, Brazil) from 1995 to 2007 and demonstrated that there were 0.04% fatalities. These authors also reported that, in the period 2000–2007, the state of Santa Catarina had 554 cases of people affected by outbreaks of foodborne illnesses, resulting in a ratio of every 8,890 people affected, which resulted in 4 fatalities.

Figure 2 shows the percentage of fatalities caused by FBD that occurred in Brazil from 2015 to 2021 by year (Figure 2A) and by region (Figure 2B). The number of fatalities did not show a trend, nor did it remain stable between 2015 and 2021.

The year 2015 had the highest number of fatalities, of which 17 fatalities were evaluated in this study. Of them, 10 fatalities occurred in the northern region of the country in a housing due to contamination of mixed foods by *E. coli*, followed by the year 2018, which also had 7 fatalities in the northern region, due to contamination of water with the hepatitis A virus, and finally, by the year 2021 with 4 fatalities related to contamination with *Listeria monocytogenes* in a Hospital/Health Unit in the southeast region. However, Sousa et al. (2021) in their epidemiological analysis of foodborne disease outbreaks in the state of Piauí between the years 2015 and 2021 using the same database as this study reported that 91.2% of reported cases did not characterize the etiological agents (receiving denominations of ignored, inconclusive, and inconsistent).

In Brazil, all establishments that prepare, serve, and sell food must follow the legislation RDC no. 216/2004, which demonstrates good practice procedures for food service to guarantee the hygienic-sanitary conditions of prepared foods (Brasil, 2004). Regarding the food industry, legislation RDC no. 275/2002 provides the technical regulation of Standard Operating Procedures applied to food-producing/Industrializing Establishments and the Checklist of Good Manufacturing Practices in Food Producing/Industrializing Establishments (Brasil, 2002).

In recent decades, Brazil has sought to develop tools for the control and prevention of FBD, such as Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP), which are being implemented in several food industries and supervised by the surveillance service of both sanitary and epidemiology (Gallego et al., 2014). Furthermore, the Safe Food Program (PAS) was created in 1998 to disseminate and support the implementation of Good Practices and the Hazard Analysis and Critical Control Points (HACCP) system in large

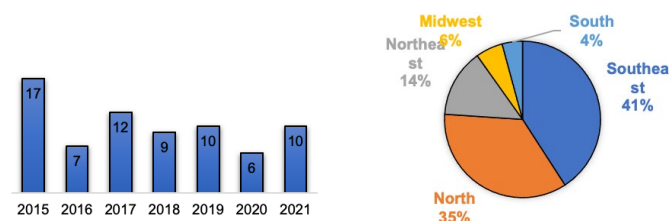


Figure 2. Percentage of fatalities (A) per year and (B) per region from foodborne illnesses in Brazil from 2015 to 2021.

and small companies, with the partnership between the National Industrial Training Service (SENAI), the Brazilian Micro and Small Business Support Service (SEBRAE), and MAPA (Tondo et al., 2015). In this way, all companies (regardless of size) must comply with some of these laws and guarantee the supply of food that is safe to the consumer.

4 CONCLUSION

The FBD is a global public health problem that causes great damage to the economy of several countries and generates fatalities and huge hospital expenses. Even with this great problematization, the existing public policies are still insufficient to guarantee an assertive inspection and documentation of the real numbers of cases, outbreaks, and, mainly, recurrent fatalities from FBD.

Through the analysis that was carried out in this work, it was possible to conclude that between the years 2015 and 2021, the majority of fatalities related to FBD occurred due to outbreaks initiated at home. This makes it clear that Brazil needs to implement continuing education systems on good food handling practices, as well as correct hand hygiene, food and utensils, handling and cooking temperature, cross-contamination, storage, and even transport of lunch boxes to the general population.

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