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Review

Bacterial Foodborne Diseases in Central America and the Caribbean: A Systematic Review

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Abstract: Foodborne diseases (FBD) represent a significant public health concern, particularly in regions like Central America and the Caribbean (CAC), where surveillance gaps due to a lack of resources, knowledge, and technical abilities hinder control over outbreaks. This review investigates the bacterial pathogens responsible for FBD, their prevalence, management challenges, and prevention strategies. A systematic review followed PRISMA guidelines, focusing on bacterial FBD in CAC from 2000 to 2024. PubMed and Google Scholar were used as primary databases, supported by other sources to identify relevant studies. Inclusion criteria encompassed studies focusing on bacterial pathogens, prevalence, risk factors, and surveillance practices. Out of 509 studies initially identified, 35 met the inclusion criteria. The most prevalent pathogens were *Salmonella* spp., *Escherichia coli*, *Campylobacter* spp., and *Aliarcobacter* spp., with contamination often associated with poultry, eggs, and vegetables. Key challenges included inadequate surveillance systems, limited resources, and inconsistent reporting practices. More significant investment in pathogen monitoring, documentation, and education, along with technologies like whole-genome sequencing (WGS), is crucial. Institutional and governmental funding is vital to improve surveillance and strengthen regional risk analysis.

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1. Introduction

Foodborne diseases (FBD) represent a significant public health challenge globally, with implications for food safety, the economy, and social development [1,2]. While the human body naturally harbors a variety of microorganisms, it remains vulnerable to pathogens capable of causing foodborne diseases and intoxication [3,4]. Such diseases can lead to acute symptoms like diarrhea, fever, and abdominal pain but can also include severe complications such as neurological damage, organ failure, and, in extreme cases, death [5,6]. The economic and social repercussions are equally profound, imposing direct and indirect financial costs on individuals and businesses. FBD strains public healthcare systems, impacting labor productivity by triggering an increase in the number of sick days taken by employees while encompassing substantial economic losses due to healthcare costs [5,7]. Regarding businesses and food brands, bacterial infections related to food can also create a negative impact following an outbreak. For instance, the State of Georgia lost almost 14 million dollars in its tomato industry in 2008 due to a Salmonella saintpaul outbreak mistakenly linked to tomatoes [8].

Additionally, these infections can affect vulnerable populations, such as infants, the elderly, and immunocompromised individuals, exacerbating the social impact and underscoring the need for strengthened food safety measures, particularly in regions where regulations may be less rigorous [9,10]. Authors previously reported several cases of infections with Salmonella enterica (SE), where 17% of patients stated having an underlying illness such as sickle cell anemia, septicemia, HIV, and multiple myeloma before the onset of bacterial infection. It was also mentioned that young children are more susceptible to Salmonella infection at lower inoculum than adults. Those under five were also shown to be at greater risk for SE infection from consuming raw or undercooked eggs [11].

Addressing these issues requires understanding the scope of the problem to develop effective public health measures targeting food safety. The burden of these diseases is reflected in the numbers of infections reported annually worldwide, where studies have identified the presence of pathogens such as Escherichia, Arcobacter, Listeria, Staphylococcus, Shigella, Campylobacter, and Pseudomonas in various food products [12–16]. In general, diarrheal diseases comprise approximately 95% of cases of food illnesses in Central America and more than 50% of those reported internationally. At the same time, the World Health Organization (WHO) estimates that unsafe food causes about 600 million illnesses and 420,000 deaths globally each year, with children under five being most affected [17,18]. For instance, *Campylobacter spp*. is responsible for approximately 500 million infections yearly. In contrast, *Salmonella spp*. is estimated to cause over 90 million diarrhea-associated illnesses annually, with 85% of these cases being food-related [19].

In order to prevent illnesses and outbreaks, continuous pathogen monitoring and detection must be supported by education on possible causes of foodborne diseases, sanitation, and good manufacturing practices [20–23]. Despite the developing surveillance system for FBD and guidelines provided by the Pan-American Health Organization (PAHO) in food handling practices for Central America and the Caribbean (CAC), it was evidenced in a survey that a systemic lack of understanding in national regulations was still present among food safety professionals in government, academia, and private sectors in the region [24]. In the same way, several researchers state a lack of resources and ability to collect and analyze outbreak information and detection of pathogens due to a significant technical gap in t low- and middle-income countries regarding data interpretation using bioinformatics [25]. Other studies state a lack of economic support in this region to carry out investigations regarding FBD [8,26]. These results highlight the need for improved documentation of food-related diseases, their epidemiological importance, and risk analysis practices in CAC [7,24].

As stated previously, knowledge of the incidence and strategies of surveillance and detection of bacterial foodborne diseases in the region is crucial for managing and preventing possible outbreaks. With little to no documentation found in FBD in countries belonging to CAC and difficulties in finding summarized research on the subject, the need for literature reviews is highlighted. For this reason, this document aims to address critical knowledge gaps by analyzing FBD in Central America and the Caribbean over the past two decades. By compiling recent documentation, we intend to assess the literature on food-related bacterial illnesses and their prevalence in countries from Central America and The Caribbean, the existing challenges regarding their management and surveillance, and current strategies to prevent and control outbreaks in the region. We will assess the primary bacterial pathogens, their sources, detection methods, and affected populations for this objective. In this manner, we intend to underscore the need for enhanced surveillance, improved documentation, and food safety education to prevent future outbreaks, identifying opportunities for further research.

2. Materials and Methods

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2.1. Study Design

This systematic review was designed according to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines [27]. The purpose of the search was to identify relevant studies on the incidence of bacterial foodborne diseases in Central America and the Caribbean, along with possible seasonal patterns, primary causative agents, risk factors, challenges in surveillance, and strategies for preventing and managing outbreaks.

2.2. Search Strategy

PubMed was used as the primary database to locate relevant investigations. At the same time, Google Scholar was utilized as a secondary tool to find records that could not be found on the previous platform. Search settings prioritized articles published between January 1st, 2000, and September 15th, 2024. Clinical Trials, meta-analyses, Randomized Controlled Trials, Surveys, Reviews, and Systematic Reviews were included to ensure thorough research. To ensure comprehensive coverage, a combination of general and specific keywords and phrases was employed, using Boolean research method.

2.3. Identification of Studies

The literature review was conducted to identify relevant studies on bacterial foodborne diseases in Central America and the Caribbean. To ensure thorough research, clinical trials, meta-analyses, randomized controlled trials, surveys, reviews, and systematic reviews were included.

A combination of general and specific keywords and phrases was employed to ensure comprehensive coverage, using Boolean research method. As shown in Table 1, the terms were divided into blocks, each one related to a specific topic: (1) Foodborne Diseases, (2) Microbiological terms, (3) Prevalence and Epidemiology, (4) Challenges in controlling FBD, (5) Control Systems & Public Health, (6) Strategies to prevent and control FBD, (7) Geographic Scope. Then, to find documentation about the scope of the review, the blocks were combined using the Boolean Operator "AND" in between each block and "OR" in between each term belonging to the same block.

Three searches were conducted for PubMed: blocks 1, 2, 3, and 7 were combined to find documentation about the prevalence and epidemiology of FBD in CAC. To find out the main challenges regarding the control of this burden in the region, a combination of blocks 1, 2, 4, 5, and 7 was used. A search using blocks 1, 5, 6, and 7 was conducted to look for strategies for its prevention and management.

On the other hand, a combination of the search entries belonging to blocks 1, 2, 3, and 7 was used on Google Scholar to find any possible record that was not retrieved from the primary database used in this review.

Table 1. Keywords and phrases used as search entries for research on PubMed and Google Scholar, and the blocks in which each one belongs.

Search blocks	Keyword and phrases
Foodborne Diseases	"Foodborne disease" OR "Foodborne illness" OR "Foodborne infections" OR "Food Contamination" OR "Food Poisoning"
Microbiological Terms	Microbiological OR Bacteria* OR Pathogen* OR *Salmonella* OR *E. coli* OR *Campylobacter* OR *Vibrio* OR *Staphylococcus* OR *Shigella* OR *Helicobacter* OR *Listeria*
Prevalence/Epidemiology	Prevalence OR Incidence OR Epidemiology OR Outbreak* OR "Temperature related" OR "Geographical distribution" OR "Seasonal patterns" OR Statistics OR Report*
Challenges in Controlling FBD	Barriers OR Challenges OR Limitations OR Obstacles OR Deficiencies OR "Knowledge gaps" OR "Lack of knowledge" OR

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	"Research gaps" OR "Inadequate practices" OR "Unhygienic practices" OR "Socioeconomic factors"
Control Systems & Public Health	"Food safety" OR "Food inspection" OR "Public health" OR Regulation* OR Infrastructure OR "Control systems" OR Intervention OR Policy OR Surveillance OR "Food handling" OR "Food preparation" OR Sanitation OR Hygiene OR Awareness OR Education OR "Disease control" OR Monitoring
Strategies to Prevent and Control FBD	Strategies OR Techniques OR Practices OR Solutions OR Innovation OR Advances OR Technologies OR Enhancing OR Improvement OR Strengthening OR Prevention OR "Education programs" OR "Detection methods" OR "Control measures" OR "Multisectoral approach" OR Regulation OR Infrastructure OR "Control systems" OR Policies OR Surveillance OR "Food handling" OR "Food preparation" OR Sanitation OR Hygiene OR Awareness OR Education OR "Disease control" OR Monitoring OR Interventions OR "Risk management" OR "Public awareness" OR Research
Geographic Scope	"Central America" OR "Caribbean" OR "The Antilles" OR "Tropical countries" OR "Tropical climates" OR "Hispanic countries" OR Panama OR "Costa Rica" OR Nicaragua OR Honduras OR "El Salvador" OR Guatemala OR Belize OR "Antigua and Barbuda" OR "The Bahamas" OR Barbados OR Dominica OR "Dominican Republic" OR Grenada OR Guyana OR Haiti OR Jamaica OR "Saint Lucia" OR "St. Kitts and Nevis" OR "St. Vincent and the Grenadines" OR Suriname OR "Trinidad and Tobago"

2.4. Selection Process and Quality Assessment

In the screening process, we first reviewed the titles to determine whether the selected articles were appropriate. Then, all abstracts were screened, and if relevant, the full-text article was evaluated.

Studies regarding the incidence of bacterial foodborne diseases, with seasonal patterns, primary causative agents, risk factors, challenges in surveillance, and strategies for preventing and managing outbreaks in Central America and the Caribbean were included. Reference lists in included studies and reviews were also contemplated, ensuring that the review captured current and foundational topics insights (Figure 1).

On the other hand, literature regarding parasitic, viral, fungal, animal, or plant-related FBD was discarded, as the scope of the review was FBD caused by bacteria. In the same manner, studies reporting on the incidence of food-related illnesses in countries outside the region were also excluded. We excluded duplicate publications and articles without available abstracts or full texts.

The articles were categorized into good, medium, and poor quality. Good-quality articles had an unbiased selection of subjects, scientifically valid methods, and appropriate data analysis, with complete and accurate results. Medium-quality articles recognized and addressed selection bias, which had some limitations in data analysis, used precise methods, and produced valid results. Poor-quality articles did not acknowledge selection bias and had flawed or incomplete methods, inappropriate data analysis, and incomplete results. They were excluded from the study, and no data was extracted.

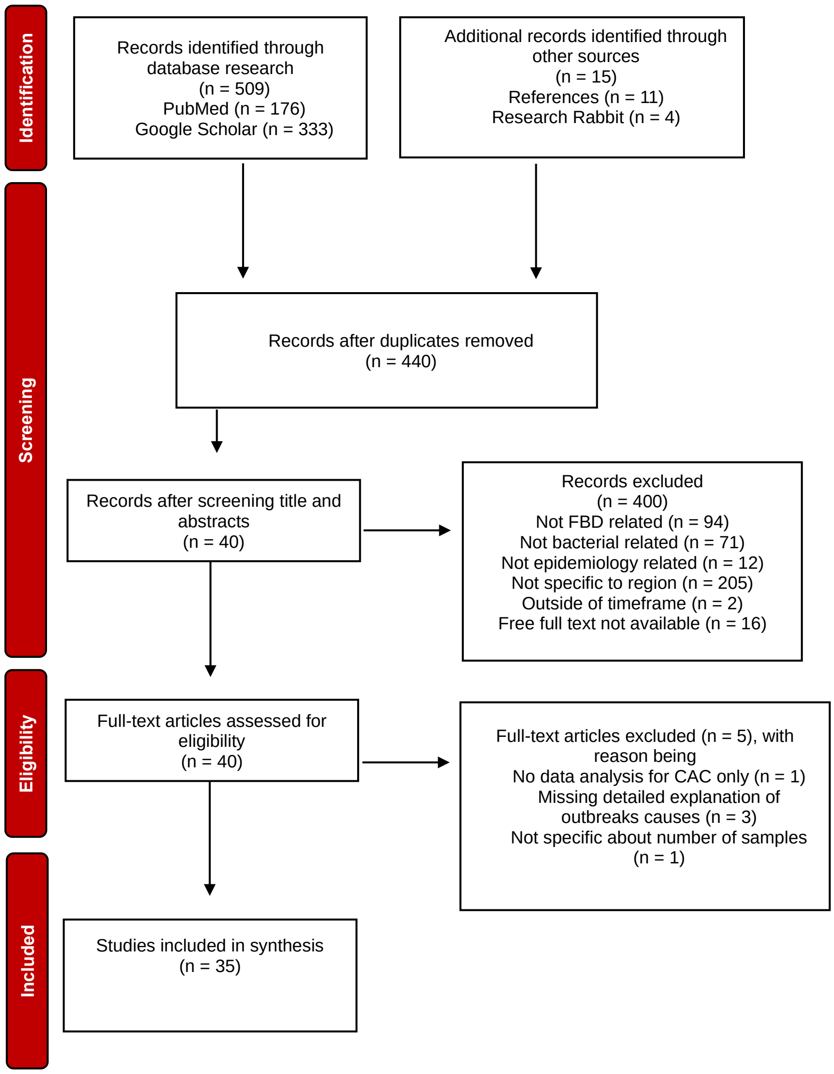

Figure 1. Flow diagram showing the process of identification, screening, assessment for eligibility and inclusion of articles.

2.5. Data Collection and Analysis

Data on bacterial-related foodborne diseases were collected based on the available information in current literature, including the outbreak year, pathogen, food incriminated, reason for infection, number of cases, number of hospitalizations, deaths, and location. The variables were descriptively compared using mainly figures and tables.

3. Results

3.1. Study Selection

During the manual research through PubMed and Google Scholar, 176 and 333 records were identified, respectively. Research Rabbit was used as an artificial intelligence to discover more articles we could have missed in the manual search, adding four more records with full text available. Additionally, 11 papers were discovered by referencing articles in which the full text was screened. After duplicates were removed using Mendeley Reference Manager, the total of articles available for screening was 440. The latest were evaluated based on their titles and abstracts, following the above selection criteria, resulting in 400 excluded articles and 40 full-text papers ready for eligibility assessment. After the revision of the complete texts, five were excluded based on the quality

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assessment created regarding the scope of the review. After the eligibility assessment and exclusion of full-text articles, we were left with 35 included papers that fulfilled the inclusion criteria and could be used for data extraction and synthesis (Figure 2).

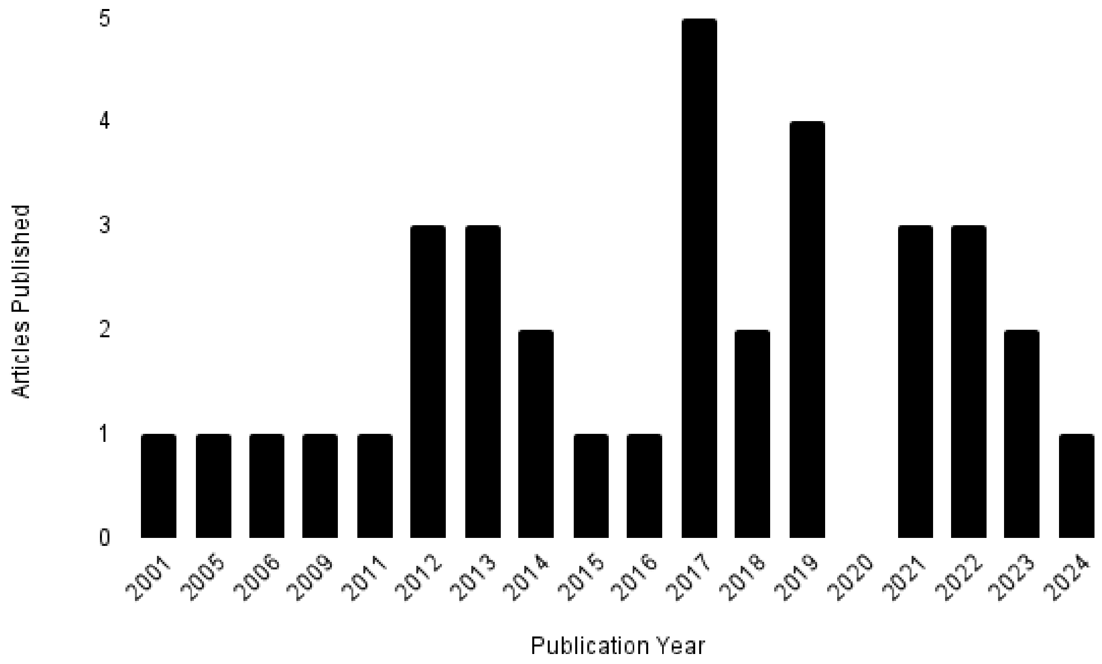

Figure 2. Bar chart showing the number of papers published annually from 2001 to 2024. It highlights a peak in 2016 and noticeable increases in 2020, 2022, and 2023.

3.2. Data Extraction

Data on bacterial-related foodborne disease included, if available in each study, the responsible pathogens, source of food incriminated, reason for infection, number of cases, number of hospitalizations, deaths, and location. Information regarding the current methods for detecting and isolating serovars was also included. Furthermore, the implemented surveillance systems, existing limitations, and knowledge gaps in the previous topics were also retrieved from the included literature and discussed in this review.

Table 2. Primary strategies for prevention and control of FBD in CAC.

Diseases	Symptoms	Causal agent	Countries	Sources of pollution	References
Salmonellosis	Diarrhea, fever, abdominal pain, nausea, vomiting	*Salmonella spp.* (gram-negative bacilli)	Guatemala, Trinidad and Tobago	Egg, meat, poultry, milk.	[28,29,30]
Enteric infections: urinary, cerebrospinal fluid (CSF), lung tissue or bloodstream, hemolytic	Abdominal cramps, diarrhea (hemorrhagic colitis), fever and vomiting.	*Escherichia coli.*	Salvador	Contaminated foods, such as raw or undercooked ground meat products, raw milk, contaminate	[31, 32]

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uremic syndrome, bacteremia, septicemia, meningitis, peritonitis, mastitis				d raw vegetables and sprouts.	
Inflammatory bowel diseases, Barrett's esophagus and colorectal cancer. Gastroenteritis and bacteremia. Thrombophlebitis, endocarditis, abscesses, mycotic aneurysm, peritonitis, arthritis, meningitis	Acute watery or bloody diarrhea, fever, weight loss, and cramps	*Campylobacter spp.*	Guatemala, Costa Rica	Consumption of undercooked or contaminated food, through contact with animals. Tap, well and pond water. Person-to-person transmission may occur (fecal-oral or through fomites).	[33, 34]
Shigellosis (bacillary dysentery)	Watery or bloody diarrhea, fever, nausea and sometimes toxemia, vomiting, colic and tenesmus	*Shigella spp.*	Cuba	By fecal-oral route or by direct person-to-person contact, contaminated food or water	[35, 36, 37]
Disease caused by: bacteremia (infectious endocarditis, etc.), direct invasion of organs (cellulitis, mastitis, nosocomial pneumonia, among others), exotoxins (gastroenteritis, etc.)	Chills, persistent fever, gastrointestinal pain	*Staphylococcus spp.*	Cuba	Raw milk, the processing environment and handlers, contaminated foods	[38,39]
Listeriosis	Septicemia, meningitis,	*Listeria spp*	Costa Rica	Contaminated foods	[40,41]

	pregnancy complications (miscarriage), neurological symptoms in vulnerable populations. Note: Invasive listeriosis (septicemia/meningitis) mainly affects vulnerable populations, while the gastrointestinal form is less severe and self-limiting.			(fresh and home-produced products, such as unpasteurized cheese and milk, as well as ice cream and fish), meat and poultry products.	
Septicemia, endocarditis, peritonitis, gastroenteritis	Diarrhea	*Aliarcobacter spp.*	Costa Rica	Water, animals (chicken, pork, beef), human clinical samples, food (fresh and pre-cut vegetables, milk, mollusks) and food facilities	[42]
Enterocolitis	Abdominal pain, diarrhea, fever	*Clostridium difficile*	Honduras, Costa Rica	Health institutions, in the environment and food	[43,44,45]

Countries	**Disease**	**Strategies**
Guatemala, Trinidad and Tobago	Salmonellosis	Establish an integrated surveillance system in collaboration with agricultural and health authorities to identify and assess the risk and implement control practices to reduce the burden of salmonellosis [30]. Regulate access to and use of antimicrobial agents by establishing a surveillance system [35].
El Salvador	Enteric infections: urinary, cerebrospinal fluid	The Central American Technical Regulation (RTCA) 67.04.50:80 is used for the surveillance and inspection of various food groups, with distinct microbiological criteria. Additionally, the Mandatory Salvadoran Standard NSO 67.02.13:98 sets limits for the microbiological characteristics that meat products must meet [81].
Guatemala, Costa Rica, países de América	Inflammatory bowel diseases, Barrett's esophagus, and colorectal cancer	**diseases, Barrett's esophagus, and colorectal cancer** Establish effective surveillance and control strategies to prevent the spread of *Campylobacter* throughout the production chain [15].

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		Early diagnosis for adequate treatment, especially in immunosuppressed individuals [82].
Cuba, Guatemala	Shigellosis	Strengthen active surveillance with increased support for laboratory work [83][84].
Cuba	Diseases caused by bacteremia, direct invasion of organs, exotoxins	The Cuban government created mandatory standards to control the quality of milk and dairy products. Implement Good Manufacturing Practices that contribute to the greater safety of fresh artisanal cheeses [85].
Costa Rica	Listeriosis.	Improve existing surveillance systems to ensure an appropriate flow of information to facilitate the confirmation of an outbreak of foodborne diseases, as well as identification of its cause. Consider expanding the list of notifiable diseases according to the country's needs. In 2015, the Ministry of Health published the Protocol for the Surveillance of Food and Waterborne Diseases for the detection and intervention of outbreaks. Conduct a risk assessment from the production stage to food consumption [81].
Costa Rica	Septicemia, endocarditis, peritonitis, gastroenteritis	Conduct future research to design control strategies for bacteria at both industrial and domestic levels [86].
Honduras, Costa Rica	Enterocolitis	Increased surveillance

3.3. Foodborne Disease Caused by Bacteria in CAC

Table 2 summarizes the distribution of major bacterial pathogens associated with foodborne diseases (FBD) in Central America and the Caribbean (CAC) based on the reviewed studies (figure 3). *Salmonella spp., s*tands out as the most prevalent agent (38% of reported cases), primarily linked to the consumption of undercooked poultry and raw eggs [30,50,52], followed by enteropathogenic *Escherichia coli* (25%), frequently detected in vegetables irrigated with contaminated water and unpasteurized dairy products [31,32]. *Campylobacter spp.* (18%) and *Aliarcobacter spp.* (12%) have emerged as underestimated pathogens, with outbreaks associated with seafood and raw milk [33,42], whereas *Listeria monocytogenes* (7%) exhibits lower incidence but higher lethality in vulnerable populations [40,41]. Moreover, the data suggest a geographical correlation: *Vibrio spp*., it predominates in coastal areas, particularly the Caribbean islands, while *Shigella spp*. has a higher incidence in urban areas with poor sanitation [35,36,37].

Figure 3. Countries from Central America and the Caribbean reporting bacterial foodborne diseases [48].

These pathogens have been mainly associated with animal-derived products, such as poultry meat, eggs, milk, and dairy products, as well as fresh vegetables and contaminated water [30,31,40]. Notably, *Salmonella spp*. has been widely detected in various food products in Guatemala, Trinidad and Tobago, and the Dominican Republic [50,51,52]. In contrast, *Campylobacter spp*. and *Aliarcobacter spp*. have shown significant prevalence in Costa Rica [33,42,63], highlighting their impact on regional food safety. Although 60% of the studies report underreporting of cases [7,24], a 22% increase in fluoroquinolone-resistant Salmonella detections has been observed between 2015 and 2024, associated with the unregulated use of antimicrobials in poultry farms [25,26]. This issue, along with the variability in surveillance and food safety control systems across countries in the region [8,86], underscores the need to strengthen oversight in food production and distribution to reduce outbreak incidence.

3.3.1. *Salmonella* spp.

A series of studies conducted across the Caribbean region investigated the prevalence and serotypes of *Salmonella spp.*, highlighting significant findings related to animal reservoirs and food products. In Suriname, 9% of pig farms tested positive, with serovars such as *S. Ohio* and *S. Brandenburg*, though no contamination was found in pork samples [28]. In Grenada, 17% of blueland crabs carried *Salmonella*, with *S. Saintpaul*, *S. Montevideo*, and *S. Newport* identified, indicating that crustaceans could act as reservoirs [29]. *Salmonella* was found in 34.3% of retail chicken carcasses in Guatemala, with *S. Paratyphi B* and *S. Heidelberg* being prevalent serovars, and higher contamination rates were linked to ambient storage in municipal markets [30]. *Salmonella enterica* was a prominent pathogen in the Dominican Republic reported in travel-related cases. The most common serotype was *S. Enteritidis*, with 16% of cases leading to hospitalization [31–33]. Similarly, in Jamaica, Bahamas and, Costa Rica, Guatemala, El Salvador, *S. Enteritidis* was the predominant serotype, and for each country, 12%, 19%, and 14% of travelers were hospitalized, respectively [32,33].

In Trinidad and Tobago (T&T), contamination was reported in 14.2% of dressed chicken, with *S. Javiana* prevalent in cottage processors and *S. Kentucky* in supermarkets [34]. Chilled broiler carcasses had a 60% contamination rate, with serovars such as *S. Enteritidis*, *S. Javiana*, and *S. Infantis* [35]. Another poultry research reported a 6.1% contamination rate in cecal samples, with *S. molade* as the most identified serovar [36]. Additionally, 3.5% of samples tested positive in broiler farms and hatcheries, with *S. Westhampton* and *S. Kentucky* detected in hatcheries [37]. Likewise, 13% of table eggs tested positive, with *S. Enteritidis* accounting for 58.3% of positive samples, indicating transovarian infection in farm-sourced eggs [38,39]. Cross-contamination during poultry processing was also significant, with contamination rates of 60% during bleeding and 40% during evisceration [40,41].

3.3.2. *Escherichia coli*

One study in T&T investigating the prevalence of Escherichia coli in table eggs demonstrated that out of 184 samples collected from various sources, including retail outlets and farms, 68 samples (37.0%) tested positive for the bacterium. The highest prevalence was observed in composite egg samples from farms, where 71.7% were positive, followed by samples from malls (41.9%) and other retail outlets (20.6%) [38]. Furthermore, a study evaluating the occurrence of selected foodborne pathogens in poultry and poultry giblets from small retail processing operations in the same country found that E. coli was present in 100% of the six fresh chicken carcasses sampled from 16 pluck shops over six weeks [41].

3.3.3. *Campylobacter* spp.

The same investigation evaluating bacterial contamination in table eggs in T&T found that out of the 184 samples collected, only two (1.1%) tested positive for *Campylobacter coli* [38]. In contrast, a separate investigation about foodborne pathogens in poultry from small retail processing operations reported a high prevalence of *Campylobacter* in chicken carcasses, with 89.6% (86/96) of the whole carcasses testing positive [41].

3.3.4. *Shigella* spp.

A healthcare facility-based surveillance system in Guatemala monitored cases of shigellosis from 2007 to 2012. During this period, 5399 stool samples yielded 261 confirmed *Shigella* infections. A significant majority (58%) of these cases involved children five years of age, and 57% were female, with *Shigella flexneri* (59%) and *Shigella sonnei* (36%) being the most frequently isolated serotypes. Environmental factors, such as the warm and rainy seasons, were associated with increased transmission. Social determinants, including overcrowding and low education levels, also compounded the risk of infection [42].

3.3.5. *Staphylococcus* spp.

In a study where poultry and giblets from small retail processing operations were examined over a six week period, Staphylococcus were detected in 100% of the collected samples, indicating widespread contamination in these retail operations [41].

3.3.6. *Listeria* spp.

In Costa Rica, while assessing the prevalence of *L. monocytogenes* in ready-to-eat (RTE) meat products, including bologna, sausages, chorizo, salami, pork cheese, and mortadella, a total of 190 samples were collected from 70 retail stores. *Listeria spp.* was detected in 37.4% of the samples, with a higher prevalence in products cut with a knife (44.2%) than those sliced by machine (30.5%). Among the isolates, *L. innocua* was found in 32.1% of samples, while *L. monocytogenes* was present in only 2.6%. The study highlighted that *L. monocytogenes* can proliferate during refrigerated storage of RTE meats, posing a contamination risk during post-cooking processes like slicing and packaging [43].

3.3.7. *Aliarcobacter* spp.

Three studies in Costa Rica investigated the prevalence of *Aliarcobacter* spp., previously known as *Arcobacter* spp., in chicken and vegetables. In one study, 56% of 50 raw chicken breast samples from retail markets tested positive, with *A. butzleri* (59%) as the dominant species, followed by *A. cryaerophilus* (19%). Multiple strains were detected in the samples, emphasizing the need for standardized protocols, especially for emerging pathogens similar to the latest [44]. Another research

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found that 17.3% of 150 chicken viscera samples tested positive for *Aliarcobacter* spp., with *A. butzleri* (66.7%) and *A. cryaerophilus* (24.2%) prevalent, along with rare detections of *A. skirrowii* (3.1%) [45].

Contamination was also observed in vegetables with *Aliarcobacter* spp., present in 21.1% of fresh samples and 2.2% of pre-cut vegetables. Arugula showed the highest contamination rate (40%), followed by lettuce (16%) and spinach (13%). Among pre-cut samples, lettuce and arugula both had 3% contamination. Pathogenic species identified included *A. skirrowii* and *A. butzleri*. Despite processing efforts, the findings highlight a higher contamination risk in fresh vegetables [46].

3.3.8. *Clostridium difficile*

This study investigated the presence of *C. difficile* in 200 retail meat samples from Costa Rica, including 67 beef, 66 pork, and 67 poultry samples. Four isolates (2%) were identified: one from beef, two from pork, and one from poultry. The identification of the isolates was confirmed through chromatography, biochemical profiling, and detection of the *tpi* gene. The study suggests that *C. difficile* in meat may result from contamination with intestinal contents or environmental factors [47].

Table 2. Prevalence of pathogenic bacteria attributed to food and its sources in Central America and the Caribbean.

Bacteria	Species and Serotypes	Sources	Country	References
Shigella spp.	*Shigella flexneri, S. sonnei*	Stool samples	Guatemala	[42]
Salmonella spp.	*S.* Paratyphi B, *S.* Heidelberg, *S.* Derby, *S.* Enteritidis, *S.* Albert, *S.* Budapest, *S.* Dublin, *S.* Essen, *S.* Haifa, *S.* Israel, *S.* Stanley, *S.* Typhimurium, *S.* Saintpaul	Chicken carcasses		[30]
	S. Anatum, *S.* Ohio, monophasic Typhimurium, Brandenburg, Javaniana	Pigs in farms	Suriname	[28]
	S. Saintpaul, S. Montevideo, S. Newport	Blue land crabs	Grenada	[29]
	Salmonella enterica	Poultry chicken	Dominican Republic	[31]
	S. Enteritidis, *S.* Typhimurium, *S.* Newport, *S.* Javiana, *S.* Corvallis, *S.* Paratyphi A, *S.* Concord, *S.* Typhi	ND	Dominican Republic, The Bahamas, Costa Rica and Jamaica	[32]
	S. Enteritidis, *S.* Typhimurium, *S.* Newport, *S.* Paratyphi A, *S.* Paratyphi B, *S.* Paratyphi C	ND	Dominican Republic, The Bahamas, Costa Rica and Jamaica, Guatemala, El Salvador	[33]
	ND	Chicken carcasses at processing lines	Trinidad & Tobago	[40]
	S. Javiana, *S.* Kentucky, *S.* Manhattan, *S.*	Dressed chickens at cottage processors		[34]

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	subspecies enterica I, S. San Diego			
	S. Enteritidis, S. Javiana, S. Infantis, S. Kentucky, S. Anatum, S. Schwarzengrund, S. Albany, S. Hindmarsh, S. Madjorio, S. Mbandaka, S. enterica subspecies Houtenae, Virchow, Weltevrden, Aberdeen, Alachua, Ayinde.	Broiler chickens at processing plants		[35]
	S. Westhampton, S. Group D	Imported fertile hatching eggs		[37]
	S. Enteritidis, S. Javiana, S. Ohio, S. Braenderup, S. Georgia, S. Caracas, S. Mbandaka, S. Group C1	Table eggs		[38,39]
	S. Kiambu, S. Kentucky, S. Mbandaka	Broiler at processing lines		[41]
	S. Molade, S. enterica subsp. enterica I, S. Typhimurium, S. Group B	Poultry (cecal samples)		[36]
Escherichia coli	NA	Table eggs		[38]
	NA	Chicken carcasses, hearts, livers, and gizzards		[41]
Campylobacter spp.	ND	Table eggs		[38]
	ND	Chicken carcasses		[41]
Staphylococcus spp.	ND	Poultry chicken and giblets		[41]
Listeria spp.	*L. innocua, L. welshimeri, L. grayi, L. monocytogenes*	Ready-to-eat meat products (bologna, sausages, chorizo, salami, queso de cerdo, and mortadela)		[43]
Aliarcobacter spp.	*A. butzleri, A. skirrowii*	Fresh vegetables	Costa Rica	[46]
	A. butzleri, A. cryaerophilus	Chicken breast		[44]
	A. butzleri, A. cryaerophilus, A. skirrowii	Chicken viscera		[45]
Clostridium difficile	NA	Beef, pork, poultry		[47]

NA: Data not applicable. **ND**: Data not determined in the referenced study.

3.4. Diagnostic and Treatment

Usually, a foodborne diagnostic is based on clinical evaluation and laboratory testing [64] to detect the pathogen or its derivatives through culture methods, immunology, or genomics, following treatment management strategies to address symptoms and prevent further spread. Patients with foodborne illnesses typically present gastrointestinal tract symptoms (e.g., vomiting, diarrhea, abdominal pain), and nonspecific and neurologic symptoms may also occur [65,66]. Patients'

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anamnesis is crucial to determining the etiology of foodborne disease; clinicians focus on the incubation period, duration of the resultant illness, predominant clinical symptoms, the population involved in the outbreak, and the type of food consumed. Meanwhile, culture or biochemical analysis, immunoassay, or acid nucleic detection could achieve pathogen detection or toxin. FDA-cleared platforms currently in use for Syndromic culture-independent molecular diagnostic tests (CIDTs) for acute gastroenteritis to clinical microbiology laboratories vary in the breadth of pathogens that can be detected, they generally share high degrees of sensitivity and specificity and offer some advantages over traditional culture-dependent methodologies [67]. Recently advanced methods have emerged (e.g., hybridization-based, array-based, spectroscopy-based, and biosensor-based processes) [68]. Microbiological and biochemical identification could be time-consuming and laborious. At the same time, immunological or nucleic acid-based techniques may require extensive sample preparation and are not amenable to miniaturization for on-site detection [69]. Although CIDTs offer many advantages, such as simultaneously testing for multiple pathogens from a single specimen, isolates are necessary to conduct whole sequence genome (WGS), identify pathogen subtypes, determine antimicrobial resistance, detect outbreaks, and help link illnesses to likely sources [70]. New perspectives focus on integrating molecular methods, biosensors, microfluidics, and nanomaterials for swift, low-cost detection of foodborne pathogens with high sensitivity and specificity [71]. Most bacterial infections associated with acute gastroenteritis resolve spontaneously with supportive treatment (rehydration) and antibiotics with restrictions because of bacterial resistance and dysbiosis in patients [67].

3.4.1. Economic Impact

Foodborne microorganisms substantially impact food safety and contribute considerably to the public health and economic burden of infectious diseases worldwide [72]. Data regarding the global burden of foodborne illnesses has not recently been found for almost 10 years. The World Health Organization (WHO) estimates the annual Global burden of foodborne disease to be over 600,000,000 cases of illness, with almost 420,000 deaths and 27,000,000 Years of Life Lost (YLL). The sub-regional grouping AMR B (Americas Region B), which includes the Caribbean, experienced 140 Disability Life Years (DALYs) per 100,000 population, much lower than the African countries at an average of about 1200 (DALYs) per 100,000, but almost four times that experience in Europe (41–52 DALYs), North America and Cuba (35 DALYs) [73]. The full extent and cost of unsafe food, and especially the burden arising from chemical and parasitic contaminants in food, is still unknown. Detailed data on the economic costs of foodborne diseases in developing countries are mainly missing [74]. Data on intestinal parasites in Central America placed an estimated 8 million children at risk of helminthiasis annually by 2014 [75]. Food insecurity has severe impacts in the Caribbean, Mesoamerica, and South America, mainly affecting older adults in Indigenous and rural contexts where it intersects with poverty, gender, and ethnicity [76]. Concerning the Caribbean, the regional surveillance data from 2005 to 2014 points to FBD as an increasing public health concern, as reflected by the growing number of cases and outbreaks reported to the official agencies. Salmonella, Shigella, and Campylobacter prevail among bacterial causative agents and contribute to the overall annual economic costs of syndromic acute gastroenteritis (AGE) and FBD, with an estimated burden of $US2.2 M and 40.4 M, respectively [77]. Many of the Caribbean islands rely on the tourism industry as a major contributor to the country's Gross Domestic Product (GDP), both cruise ship and stay-over visitors. Without adequate preventive measures in place, foodborne illnesses could pose a significant threat to tourism and the economic output of the region, directly by the exposure of visitors to foodborne pathogens in contaminated foods and workers who do not report their illnesses or indirectly by causing visitor avoidance out of the fear of being exposed to disease pathogens [73].

3.5. Main Challenges in Controlling FBD in CAC

For a bacterial foodborne illness to occur, the pathogen must be present in a sufficient quantity to cause an infection or produce toxins, the food and temperature must support the growth of the

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pathogen, and the amount of contaminated food ingested must be sufficient to overcome the individual's natural defenses. These conditions, although someway specific, can be met easily without proper handling and comprehension on food safety systems [49,50].

The studies conducted in Central America and the Caribbean (CAC) reveal significant challenges in controlling foodborne diseases (FBD) that are crucial for public health and the tourism-dependent economy of the region (table 3). A comprehensive survey indicated that many food establishments, particularly smaller hotels, struggle with implementing effective food safety systems, notably the Hazard Analysis and Critical Control Points (HACCP) framework. Over one-third of the hotels assessed did not employ a team approach to food safety management and lacked documented HACCP plans. Staff members in these establishments displayed a limited understanding of HACCP principles, underscoring a knowledge gap that hinders proper food safety practices [51]. This situation is exacerbated by a lack of policy and legislation to ensure compliance, especially in smaller properties where adherence to safety measures is often driven more by customer demand than by regulatory requirements [50].

Inadequate foodborne disease surveillance further complicates the control of FBD in the CAC. Studies reveal a critical shortage of data on the morbidity and mortality associated with foodborne illnesses, primarily because diagnostic testing is typically conducted only during outbreaks. This reliance on outbreak data leads to widespread underreporting of sporadic cases, limiting public health authorities' understanding of the prevalence and sources of pathogens in the food supply [8]. For instance, while Salmonella has been identified as the most frequently reported pathogen, the variability in reporting across countries creates a fragmented picture of food safety in the region [29]. Moreover, research on outbreaks and studies regarding identification of bacteria causing FBD in CAC countries are severely lacking, with much of the existing literature being outdated by at least 15 years. This is concerning, as changes in animal genetics, nutrition, and management practices over the years may have affected the exposure potential and susceptibility of different livestock species to pathogens. Studies highlight a significant gap in research regarding pathogens like *Salmonella* and Shiga toxin-producing Escherichia coli (STEC) in animals such as goats and sheep, which are often slaughtered in unsanitary conditions [52]. Researchers have emphasized the existing gaps in data across the region, pointing out that some available information only reflects certain countries rather than the entire area. This discrepancy is particularly evident in the variability of reporting, especially regarding the most commonly identified pathogens [53]. The lack of economic support for conducting FBD research in CAC is further emphasized by [8]. These findings make it clear that institutional and governmental funding is essential to improve the documentation of foodborne diseases, understand their epidemiological significance, and enhance risk analysis practices in the region

Emerging pathogens and antimicrobial resistance present additional challenges in ensuring food safety. The identification of Arcobacter species as potential foodborne pathogens raises concerns about hygiene practices in food preparation and handling. The studies indicate that high levels of Arcobacter may signal poor sanitation, which complicates the overall food safety landscape in the region [44,45].

To prioritize food safety interventions effectively, it is essential to identify the primary sources of human illness, available mitigation options, and their associated costs. Recent methods for attributing foodborne illnesses include microbiological, epidemiological, expert solicitation, and intervention studies. Epidemiological methods analyze outbreak data to estimate the contributions of various foods to disease. However, this approach assumes that outbreak sources are the same as those causing sporadic illnesses. While summarizing outbreak results can help identify common food vehicles linked to illness, it may overlook more complex food sources [54].

Table 3. Main challenges for surveillance of FBD in CAC.

Main challenge	Description	References
Inadequate FBD surveillance	Underreporting of foodborne diseases due to limited diagnostic testing during sporadic cases.	[8]

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Lack of updated research	Outdated research on outbreaks and bacteria in food, especially for non-poultry livestock.	[52]
Lack of comprehensive data	Inconsistent and incomplete reporting of FBD data across the region hinders comprehensive disease monitoring.	[52]
Emerging pathogens	Detection of emerging pathogens such as Arcobacter highlights poor hygiene practices in food handling.	[44]
Lack of HACCP implementation	Smaller establishments struggle with adopting and implementing effective HACCP protocols, causing poor food handling practices.	[51]
Knowledge gaps among staff	Insufficient understanding of risk prevention analysis principles among food establishment staff members.	[51]

3.5. Strategies to Prevent and Control FBD in CAC

Examining the strategies to prevent and control foodborne diseases (FBD) in Central America and the Caribbean (CAC), several studies highlight critical gaps in understanding and managing food safety within the region, emphasizing that the epidemiology of microbial and parasitic food pathogens has not been adequately addressed, leading to insufficient focus on the Caribbean food supply chains. There is a pressing need to improve food safety measures while simultaneously enhancing food production to tackle the region's food security challenges [8]. For this purpose, the Centers for Disease Control and Prevention (CDC) has operated in Central America since the 1960s, opening a regional office in Guatemala in 2003 to support Belize, Costa Rica, El Salvador, Honduras, Guatemala, Nicaragua, and Panama, as well as select activities in Colombia, the Dominican Republic, and Peru. CDC is also working closely with health ministries and partners, focusing on public health surveillance, laboratory strengthening, emergency preparedness, border and migrant health, antimicrobial resistance, and climate-health initiatives, including One Health. Since 2018, CDC has strengthened disease and antimicrobial resistance surveillance in Belize, the Dominican Republic, El Salvador, and Guatemala, and, over the past two decades, has supported regional disease surveillance and detection of emerging pathogens through One Health workshops [55,56]. The Pan American Health Organization (PAHO) also works to prevent foodborne diseases (FBD) in the Americas by promoting risk-based food safety frameworks, supporting food safety education, and enhancing surveillance of food contamination. It builds laboratory and inspection capacities, fosters cooperation among health sectors, and strengthens communication on FBD risks. PAHO also coordinates with networks like INFOSAN for emergency responses and supports legal framework development to improve health outcomes related to FBD across the region [49,57].

Efforts to enhance foodborne disease surveillance have been spearheaded by initiatives such as PulseNet Latin America and the Caribbean (PNLAC), established in 2003 to strengthen laboratory-based surveillance and enable the early detection of outbreaks. Through standardized pulsed-field gel electrophoresis (PFGE) protocols, countries within the network can compile a national database of foodborne pathogens and contribute to a regional database maintained by the Pan American Health Organization (PAHO). This collaborative approach allows for the sharing of data among 24 reference laboratories across 16 countries in Latin America and the Caribbean, fostering improved communication and coordination in outbreak investigations and public health responses [58].

Recent technological advancements in next-generation sequencing tools, particularly whole-genome sequencing (WGS), have greatly increased the efficiency of detecting and characterizing infectious pathogens critical to public health. The Global Microbial Identifier (GMI) initiative has been established to create a shared database of genomes, facilitating the identification of microorganisms in various contexts, including food and the environment. By promoting the sharing of sequencing data, GMI supports public health institutions and the One Health concept, enabling early recognition of international outbreaks and providing essential information to clinicians and policymakers. However, challenges persist in building appropriate informatics systems to manage and harmonize data with laboratory operations. Moreover, while WGS is a promising advancement, organizational hurdles remain in adopting this technology, especially in developing countries [59].

Across members of PulseNet International, differences in the maturity and complexity of laboratory surveillance networks, funding, human resources, and the importance of foodborne infections compared to other infectious diseases contribute to variations in WGS implementation strategies. To address the need for real-time surveillance, PulseNet International aims to standardize WGS-based subtyping using extended MLST-based approaches, specifically wgMLST, which offers optimal resolution and epidemiological concordance. Standardized protocols, validation studies, quality control programs, and training materials are essential for implementing and decentralizing new techniques. Recent evaluations indicate that in the United States, PulseNet prevents approximately 270,000 illnesses and saves $500 million annually in medical costs and lost productivity, with an economic return on investment of about $70 for every $1 invested by public health agencies [60].

WGS has offered high-resolution pathogen characterization in several studies in the region. For instance, in Trinidad and Tobago, for 146 *Salmonella* isolates from hatcheries, farms, processing plants, and retail outlets, 23 serovars were identified, with Kentucky (20.5%), Javiana (19.2%), Infantis (13.7%), and Albany (8.9%) being the most prevalent [61]. This level of precision allows for better tracking of contamination sources along the production chain.

Similarly, *Aliarcobacter*, *Listeria monocytogenes*, and *Salmonella* spp. have been identified using PCR-based methods across studies in the region, demonstrating the growing role of molecular techniques in pathogen detection [34,43,46]. Furthermore, whole-genome sequencing of *Shigella sonnei* isolates in Latin America, including isolates from Costa Rica and Guatemala, has revealed new genetic lineages and sublineages, indicating significant public health relevance and the potential for international transmission of foodborne pathogens [62]. The findings highlight the importance of integrating surveillance systems across public health, animal health, and food production sectors to effectively detect and respond to foodborne infections.

Despite these advancements, significant challenges remain. For instance, Adesiyun et al., (2000) noted that the lack of routine investigation and reporting of foodborne outbreaks in the Caribbean hinders effective monitoring and response. Their study on *Salmonella enteritidis* isolates revealed the difficulties in tracing the origins of outbreaks, highlighting the need for systematic surveillance mechanisms [39].

Syndromic surveillance has emerged as a method to enhance food safety monitoring by combining traditional health data with non-traditional sources such as over-the-counter drug sales and environmental data. While this approach allows for quicker outbreak recognition, it also presents challenges, including the need for compatible infrastructure and increased human resources to manage the data effectively [8]. Increased education for local farmers and food producers is essential to develop national and regional food industries and improve food safety practices throughout the supply chain.

It is important to know some strategies that allow preventing and controlling foodborne diseases, such as traceability, which facilitates the history of the product or food, through the registration codes we can know its use and location, as well as through the Hazard Analysis and Critical Control Points (HACCP) we can prevent or avoid risks of foodborne diseases, through the various procedures applied to food. It is essential to establish practical alternatives that make it easier for food producers, processors and distributors to apply easy-to-interpret methods to prevent the infestation of microorganisms that give rise to the presence of foodborne diseases. Therefore, it is important to promote training in these technological areas associated with the production, processing and distribution of food [78-79].

Contaminated raw materials, cross-contamination of food, loss of the cold chain of perishable foods, poor cooking, and insufficient personal hygiene are risk factors that cause foodborne illnesses (ETA). All these risk factors allow the development of scientifically-based prevention and control

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strategies, such as the implementation of biopreservation systems using lactic acid bacteria (LAB) or their metabolites, non-thermal technologies or combinations of these [80].

Table 4. Main strategies for prevention and control of FBD in CAC.

Strategy	Description	Outcomes	Challenges	References
Centers for Disease Control and Prevention (CDC)	Since the 1960s, CDC has operated in Central America, strengthening public health systems. A regional office opened in Guatemala in 2003 to coordinate disease surveillance, lab capacity, emergency response, and One Health initiatives.	Improved disease detection and antimicrobial resistance tracking in the region.	Coordination across multiple countries and health systems.	[55,56]
Pan American Health Organization (PAHO).	PAHO promotes risk-based food safety frameworks, education, and contamination surveillance in the Americas, strengthening lab capacities and emergency response with partners like INFOSAN.	Enhanced FBD risk communication and response capacity in Latin American health systems.	Varying levels of infrastructure and legal frameworks.	[49,57]
PulseNet Latin America and the Caribbean (PNLAC)	Established in 2003 to strengthen laboratory-based surveillance using standardized PFGE protocols. Countries contribute to a regional pathogen database maintained by PAHO, enhancing early outbreak detection and investigation.	Improved coordination in outbreak detection and response across 16 countries.	Variations in laboratory capacity, funding, and priority given to FBD compared to other infectious diseases.	[58]
Next-Generation Sequencing (NGS) Tools	Technologies like Whole Genome Sequencing (WGS) allow more efficient pathogen detection and characterization, facilitating the early recognition of international outbreaks. Supports the One Health concept through shared genome databases.	High-resolution pathogen tracking, including identification of serovars. Increased ability to detect genetic lineages.	Organizational challenges, especially in developing countries. Data management and harmonization challenges due to inadequate informatics systems.	[59,60]
Molecular Detection Methods	Techniques such as PCR-based method, which have been used to identify pathogens like *Aliarcobacter* spp., *Listeria* spp., and *Salmonella* spp. across studies in the region.	Improved detection of pathogens, allowing for quicker responses and more effective control strategies.	Need for expanded access to molecular detection tools and trained personnel across the region.	[46][46]
Global Microbial Identifier (GMI)	A shared database for genome sequencing data, allowing identification of microorganisms in food,	Enhanced sharing of sequencing data. Supports early outbreak recognition and provides critical	Building and managing appropriate data informatics systems,	[59]

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clinical, and environmental samples.	information for public health institutions and policymakers.	particularly for developing countries.

4. Discussion

This systematic review consolidates evidence on bacterial foodborne diseases in Central America and the Caribbean, reflecting both pathogen prevalence and food source attribution. The findings align with earlier studies, although some discrepancies emerge in relation to pathogen frequency, key food sources, and outbreak reporting across the region.

Salmonella spp., *Escherichia coli*, *Campylobacter spp.*, and *Aliarcobacter spp.*, were the most reported bacteria regarding foodborne illnesses in CAC. For example, Pires et al., 2012 reported that *Salmonella spp.* and *E. coli* remained significant across decades, with the addition of *Shigella spp.* and *Vibrio parahaemolyticus* in later years [54]. Similarly, Guerra et al., 2016 noted that non-typhoidal *Salmonella* caused the majority of foodborne outbreaks between 2005-2014, followed by *Campylobacter* and *Shigella* [53]. However, while *Campylobacter* infections were substantial in some areas, Hull-Jackson & Adesiyun, (2019) found no significant *Campylobacter* outbreaks in Barbados. The observed variance may be attributed to differences in surveillance, data collection, and underreporting practices across countries [63].

As observed, a consistent theme across studies is the attribution of bacterial infections to animal-based foods. Eggs, poultry, and dairy products emerged as primary vehicles in both this review and earlier literature. Indar-Harrinauth et al., (2001) highlighted the association between *Salmonella Enteritidis* and raw or undercooked eggs in Trinidad and Tobago, a finding that aligns with the region's reliance on poultry products [11]. Pires et al., (2012) also noted a shift in food source importance over time, with grains and beans gaining prominence by the 2000s, while the contribution of meat and water declined [54]. In this review, poultry and egg-related outbreaks were consistently reported, emphasizing the significance of these sources. Similarly, studies from Trinidad and Tobago found widespread contamination of retail poultry and eggs with *Salmonella*, indicating that food safety practices remain a concern.

Several studies, including this review, underscore the challenge of underreporting and the limited scope of laboratory-confirmed outbreak investigations, with much of the available research being outdated by more than 15 years. This is alarming because advancements in animal genetics, nutrition, and management practices over time may have altered livestock species' vulnerability to pathogens and their exposure risks [25,52]. The prevalence data from CAC countries shows significant variability, with Costa Rica, Trinidad & Tobago, and Guatemala taking the lead in pathogen surveillance. Costa Rica's research on chicken and vegetables, as well as Trinidad & Tobago's extensive monitoring of poultry and eggs, highlight proactive efforts in food safety. However, many other countries in the region show underreporting, likely due to limited resources or infrastructure. For instance, all the reports found regarding Dominican Republic, were made by alien countries and by extensive research of globally available data based on laboratory reported cases. These reports included other countries, such as Jamaica, Costa Rica, The Bahamas and Guatemala, but lacked specificity on the prevalence of each pathogen regarding each region, and some did not identify a source of infection, as they only displayed an overview for bacterial foodborne infections in CAC. In relation to this, Pires et al., (2012) observed that 80% of the reported outbreaks in the 2000s lacked identified food sources, potentially skewing the results [54]. Similarly, Hull-Jackson & Adesiyun, (2019) reported under-detection of outbreaks in Barbados, suggesting deficiencies in outbreak investigations and laboratory testing [63]. These challenges highlight the need for improved surveillance infrastructure to enhance food safety management across the region, as low reporting of prevalence, means a lack of representation of the actual epidemiological status of a country [25].

The findings of this review, when contextualized within prior studies, emphasize the persistent burden of foodborne bacterial pathogens and the importance of monitoring specific foods like

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poultry, eggs, pork, beef and fresh vegetables. Variations across countries, such as the significance of *Campylobacter* in some but not all regions, highlight the need for tailored public health strategies for different regions. Enhanced surveillance, better reporting mechanisms, and stricter food handling practices are essential for mitigating foodborne disease risks [26]. Investments in monitoring and controlling food safety throughout the supply chain, especially in informal markets, could also address some of the risks identified in this review and prior investigations.

5. Conclusions

This investigation highlights the significant burden of bacterial foodborne diseases (FBD) in Central America and the Caribbean (CAC), emphasizing the prevalence of key pathogens in poultry, eggs, and vegetables. The findings reveal a consistent association between animal-based food products and FBD outbreaks, aligning with previous literature, though regional variations in pathogen prevalence and underreporting practices remain evident. The review also underscores the need for improved surveillance and reporting mechanisms to address underreporting and laboratory-confirmed outbreak investigations, as other nations in the region face challenges due to limited resources and infrastructure, making it difficult to assess the true epidemiological landscape. Investments in surveillance infrastructure, food safety measures, and education programs across the food supply chain, particularly in informal markets, are essential for mitigating the risks associated with bacterial foodborne illnesses.

Moreover, the economic impact of FBD on public health systems and tourism-dependent economies in these regions cannot be overlooked. Enhancing food safety by improving hygiene practices will be critical to reducing the transmission of foodborne pathogens. Further research and data collection, particularly through advanced technologies like WGS are necessary to build a comprehensive food safety management framework. This multifaceted approach, involving research, policy development, and public education, will be fundamental in tackling the public health challenge of foodborne diseases in CAC.

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