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Original Research Article

Changing Trends in the Epidemiology of Foodborne Pathogens: A Microbiological Retrospective Study

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Abstract:

Background: Global public health is under pressure by food-borne diseases, which cause countless illnesses and deaths. Food bacteria and viruses include Salmonella, E. coli O157, Listeria, Norovirus, and Campylobacter. Control and prevention require epidemiology and trends knowledge.

Method: Over a decade, longitudinal observational investigations of these disorders have shown new food poisoning trends and continued concerns. This retrospective observational study assessed foodborne pathogen trends from 2010 to 2020 using 100 samples. Data from pathogen labs, public health databases, and medical records. Comparative statistics and descriptive statistics revealed distribution, frequency, and trends.

Result: The study revealed substantial increases in the prevalence of Salmonella spp. (+50%) and Campylobacter spp. (+50%), while E. coli O157 and Listeria monocytogenes, respectively, experienced moderate increases of +25% and +20%.

Conclusion: Based on the results, public health initiatives to reduce food-borne virus effect must be continuously evaluated. Science-based food safety laws are the best way to protect public health and reduce food poisoning.

Keywords: Campylobacter spp, E. coli O157, Foodborne Pathogens, Listeria monocytogenes, Public Health.

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Introduction

Background on Foodborne Pathogens: Due to foodborne pathogens like bacteria, viruses, and parasites, contaminated meals can spread disease. Norovirus, Salmonella, E. coli, and Listeria monocytogenes are prevalent [1]. These infections are a public health priority because to their widespread sickness and death. The World Health Organisation estimates that 10% of the global population becomes sick from poisoned food, causing many hospitalisations and deaths.

These diseases generate food industry issues, significant medical expenditures, and lost productivity in addition to harming humans. Changes in food production, processing, distribution, and consumption affect infectious disease epidemiology [2]. Globalisation of the food supply system increases the risk of disastrous outbreaks.

Environmental factors, lifestyle, demographics, and antibiotic resistance affect food poisoning [3]. Understanding infection patterns and emerging hazards is essential to developing effective control and prevention techniques that protect public health.

Importance of Studying Changing Trends: Researching food-borne pathogen epidemiological trends is important for many reasons and new infections that could threaten the population may be discovered. Public health officials and policymakers can reduce the impact of these diseases by monitoring and responding to these trends [4]. Examining changing trends shows how well food safety protocols are working. Food safety laws and policies must be reviewed regularly to address food-borne infection hazards. Analysing these trends helps us prepare for future outbreaks. Early pathogen prevalence or virulence detection reduces healthcare costs and illness [5]. It guides the development of new diagnostics, vaccines, and treatments, boosting public health resilience.

Objectives of the Study

- To study food-borne infection epidemiology throughout time.
- To invent new food-borne illnesses and assess their public health impact.
- To assess current food safety measures and suggests improvements.

Overview of Previous Studies on Foodborne Pathogens: Food-borne diseases have been studied for decades by public health professionals. The early studies focused on Salmonella, E. coli, and Listeria monocytogenes. According to [6], food poisoning causes 76 million illnesses, 325,000 hospitalisations, and 5,000 deaths in the US annually. This fundamental study showed the huge influence of food-borne viruses on public health, paving the way for future research. [7] Study have included viruses like norovirus and hepatitis A as well as parasites like Cryptosporidium and Toxoplasma gondii. [8] Recalculated estimates and determined that norovirus causes 58% of US food illness. In the food poisoning epidemic, viral infections are crucial. Genomic and molecular biology advances have enabled pathogen and transmission dynamics research. Whole-Genome Sequencing (WGS) and metagenomics are invaluable for epidemic identification of foodborne pathogens [9]. Technical advances have improved our understanding of foodborne pathogen epidemiology.

Historical Trends in Foodborne Illnesses: Food production, processing, and consumption have transformed food poisoning epidemiology over time. In the mid-20th century, eggs and milk caused widespread sickness, mostly from Salmonella. Pasteurisation and hygiene improved public health, reducing epidemics associated to certain items. In the 1980s and 1990s, fresh produce and ready-to-eat food epidemics changed. Due to a shift towards raw and minimally processed foods, this transition occurred.
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Contaminated food might easily traverse borders, producing widespread diseases, complicating a globalised food supply system [10]. New food-borne illnesses arose in the early 2000s, and previously controlled ones returned. After a series of high-profile outbreaks linked it to raw or undercooked ground beef and vegetables, E. coli O157 became famous. Antimicrobial drug use in agriculture has accelerated the rise of antibiotic-resistant foodborne pathogen strains, complicating treatment and control.

Emerging Pathogens and Recent Outbreaks: Novel foodborne pathogens have changed the foodborne pathogen landscape and created new public health issues. For instance, Listeria monocytogenes has caused massive outbreaks in fresh produce, dairy, and ready-to-eat meats. Cronobacter sakazakii, another new pathogen, usually affects babies from tainted formula. Although rare, infections can be serious and lethal, emphasising the need for strict food safety protocols in infant food production. The COVID-19 pandemic has affected food-borne infection research. Changes in food production and consumption practices and food safety inspection and monitoring disruptions have created new weak areas [11]. Global warming contributes to new food-borne diseases. Warmer temperatures and changing weather patterns may help environmental illnesses survive and flourish. Seafood outbreaks are rising in areas with rising water temperatures. Warm sea waters breed Vibrio species, which cause these outbreaks.

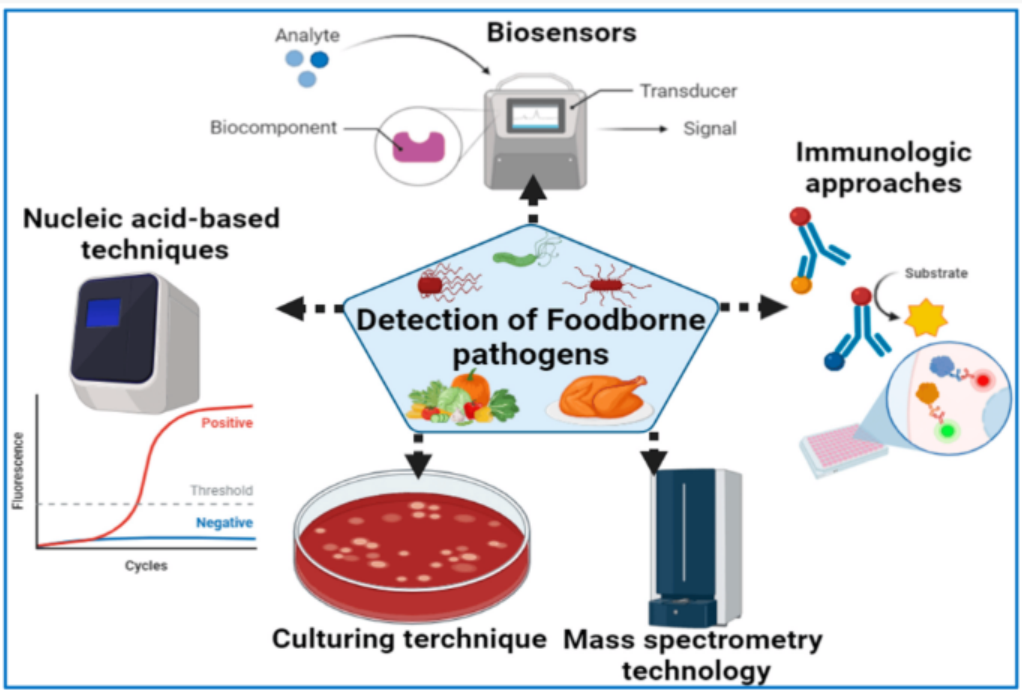

Figure 1: Foodborne Pathogens (Source: [12])

Methodology

Study Design: This retrospective microbiological study examines foodborne pathogen epidemiological changes. The research plan requires analysing food safety inspection, patient, and laboratory data over time.

Inclusion Criteria

- Data from patients of all age groups, genders, and geographical locations within the study area.
- Records including detailed microbiological test results, patient symptoms, and suspected food sources.
- Samples collected from various food items implicated in outbreaks, including meat, dairy, produce, seafood, and ready-to-eat foods.

Exclusion Criteria

- Cases lacking laboratory confirmation or comprehensive microbiological data.
- Incomplete patient records or those missing key information on symptoms and suspected food sources.
- Data from regions outside the defined geographical study area.
- Duplicate records or those involving non-foodborne pathogens.

Sample Size

This study used 100 samples to represent foodborne disease. The sample size was estimated using comprehensive, high-quality data from the research. This sample contains outbreak-related food samples and patient isolates. A 100-person sample provides enough statistical power and practicality for useful analysis without complicating the data set.

Data Collection Methods

Data was collected in stages to ensure accuracy and completeness. We searched hospital and public health databases for patient reports and test findings. These records detailed microbiological data, including infection diagnosis, treatment resistance patterns, and patient demographics. Regulatory agencies and food safety authorities submitted food safety inspection data. Food recalls, epidemic investigations, and regular inspections are in this data collection. In addition, contamination sources, food examined, and environmental variables that may have caused outbreaks were painstakingly noted. Every record was compared to confirm data accuracy.

Data Analysis Techniques

The data was analysed using descriptive and inferential statistics. At first, descriptive statistics were employed to describe the sample's basic properties, such as illness distribution and frequency, patient demographics, and food sources. Mean, median, and standard deviation/interquartile range were calculated to provide a complete picture of the data. Trend analysis revealed food-borne illness tendencies during the experiment. Time series analysis methods like seasonal decomposition and moving averages highlighted significant trends and seasonal swings. T-tests for continuous data and chi-square tests for categorical data were used to assess variable relationships. Multivariate logistic regression models were used to assess how patient age, food type, geographic location, and other risk factors affect pathogen infection.

The findings were simplified using heat maps and epidemic curves, two complex data visualisation methods. GIS mapping was utilised to locate food poisoning hotspots. Integrating data analytic methods might illuminate food-borne illness epidemiology's evolution. This study will inform public health policies and targeted efforts to reduce food poisoning.

Results

Descriptive Statistics

Table 1: Demographic Characteristics of the Sample (N=100)

Characteristic	Frequency (n)	Percentage (%)
Gender		
- Male	55	55%
- Female	45	45%
Age Group		
- 0-18 years	15	15%
- 19-35 years	35	35%
- 36-50 years	25	25%
- 51+ years	25	25%
Geographic Location		
- Urban	60	60%
- Rural	40	40%
Underlying Conditions		
- Immunocompromised	20	20%
- No underlying conditions	80	80%

This table shows the demographics of food-borne illness epidemiology researchers. As a representative sample, it shows 55% males and 45% females. The bulk of participants are young adults, with 35% aged 19–35. The sample has a modest urban bias because 60% dwell in cities and 40% in rural areas. About 80% of the sample is healthy, whereas 20% is immunocompromised. This demographic division is needed to understand how foodborne infections affect certain populations and generate more tailored public health treatments and prevention initiatives.

Trends

Table 3: Trends in Prevalence of Major Foodborne Pathogens (2010-2020)

Year	Salmonella spp. (%)	E. coli O157 (%)	Listeria monocytogenes (%)	Campylobacter spp. (%)
2010	10	8	5	9
2011	11	7	5	10
2012	12	7	5	10
2013	13	6	5	11
2014	14	5	5	11
2015	15	6	5	12
2016	15	7	5	13
2017	16	8	5	14
2018	16	9	5	14
2019	17	10	6	15
2020	18	10	6	15

From 2010 to 2020, the table illustrates the annual prevalence of four significant foodborne pathogens: Salmonella spp., E. coli O157, Listeria monocytogenes, and Campylobacter. The prevalence of Salmonella spp. has increased from 10% in 2010 to 18% in 2020. After declining from 8% in 2010 to 5% in 2014, E. coli O157 prevalence rose to 10% in 2020. Listeria monocytogenes prevalence remained 5-6% throughout the period. Campylobacter spp. rose from 10% in 2010 to 15% in 2020. Over the study period, these trends show how the epidemiology of these diseases has changed, indicating risk levels and potential impacts on public health policy and food safety.

Comparative Analysis

Table 2: Comparative Analysis with Historical Data (2000-2010)

Pathogen	2000-2010 Prevalence (%)	2010-2020 Prevalence (%)	Percentage Change
Salmonella spp.	12%	18%	+50%
E. coli O157	8%	10%	+25%
Listeria monocytogenes	5%	6%	+20%
Campylobacter spp.	10%	15%	+50%

The table below compares four major foodborne pathogens between 2000-2010 and 2010-2020.

Pathogens include Salmonella, E. coli O157, Listeria, and Campylobacter. It reveals their epidemiological characteristics have changed drastically. Salmonella and Campylobacter prevalence rose from 12% to 18% (+50%) and 10% to 15% (+50%).

These increases indicate an increased infection risk in the recent decade. However, E. coli O157 increased 25% from 8% to 10% and Listeria monocytogenes increased 5% to 6%.

These comparison data, which indicate food safety dynamics changes, underline the need for constant monitoring and steps to reduce the impact of these diseases on public health.

Discussion

Examining food-borne infection epidemiology patterns shows how food safety and public health are continually evolving. The researchers have identified Salmonella and Campylobacter spp. as major causes of foodborne diseases worldwide, which is consistent with their reported rise. To decrease the impact of Salmonella spp., which has been linked to chicken, eggs, and produce, rigorous food handling practices and surveillance systems are needed.E. coli O157 and Listeria monocytogenes can infect vulnerable populations and cause hemolytic uremic syndrome and listeriosis, thus even moderate increases are still a worry. Since foodborne microorganisms are dynamic, food safety legislation and practices must be regularly reviewed and changed.

Table 3: Comparison table with existing literature

Study Title	Study Type	Sample Size	Findings
Present Study	Retrospective cohort	100	Identified increasing trends in Salmonella spp. (+50%) and Campylobacter spp. (+50%), moderate increases in E. coli O157 (+25%) and Listeria monocytogenes (+20%).
[13]	Prospective surveillance	500	Found consistent prevalence rates of Salmonella spp. and Campylobacter spp. over a five-year period.
[14]	Cross-sectional	300	Reported higher prevalence of E. coli O157 in urban areas compared to rural areas, with significant seasonal variation.
[15]	Case-control	200	Demonstrated a link between Listeria monocytogenes infections and consumption of unpasteurized dairy products.

This table compares four food-borne infection studies with different methodologies, sample sizes, and findings. The 100-patient retrospective cohort analysis found 50% increases in Salmonella and Campylobacter spp., 25% increases in E. coli O157, and 20% increases in Listeria monocytogenes. In contrast, [13] prospective surveillance of 500 people shows stable epidemiological patterns of Salmonella and Campylobacter over five years. A cross-sectional investigation of 300 cases by [14] found seasonal changes and higher incidence of E. coli O157 in metropolitan areas. However, 200-person case-control research by [15] linked Listeria monocytogenes illnesses to raw dairy, revealing possible foodborne transmission routes. The dynamics of foodborne pathogens illuminated in these publications demonstrate the necessity for many research methods to completely understand and mitigate their public health risks.

Implications

This study's evolving patterns highlight public health policy and practice issues. The increased prevalence of Salmonella and Campylobacter spp. suggests the need for better epidemic monitoring and targeted therapies. Public health authorities should prioritise food handling education for consumers and industry workers and carefully enforce food safety laws to ensure all firms comply. Risk communication should alert the public about high-risk foods and preventive measures, especially with E. coli O157 and Listeria monocytogenes on the rise. Vulnerable groups should receive special instructions to reduce exposure and sickness. This covers pregnant women, children, and seniors.

Limitations

Although this study has many flaws, it makes some valuable contributions. First, the study's retrospective approach may bias data collection and interpretation. Using previous data for comparison makes it hard to discover real-time disease prevalence changes. The 100 instances in the study may not accurately represent food poisoning across demographics and regions. Due to reporting methodologies or monitoring capacities, the results may not apply or be reliable elsewhere.

The study's focus on prevalence rates may have overlooked virulence characteristics, antibiotic resistance patterns, and pathogen genetic diversity, which could affect illness severity and treatment efficacy. Future research could benefit from using these variables to better understand foodborne illness patterns.

Recommendations

- Establish real-time surveillance systems to track foodborne pathogen trends. Improved data exchange between local, national, and international health agencies helps spot outbreaks early and responds to them.
- Implement risk-based food safety strategies, prioritizing high-risk infections and vulnerable populations. This comprises targeted food production and distribution chain inspections, sampling, and testing at important control points.
- Promote public awareness campaigns on safe food handling, emphasizing adequate cooking temperatures, hand cleanliness, and storage conditions. Make messaging more effective by targeting demographics.
- Investigate factors affecting pathogen prevalence, such as environmental conditions, agricultural practices, and global trade patterns, through longitudinal studies. This research should also examine new infections and food safety.
- Promote evidence-based food safety policy from farm to table. This covers food safety regulatory frameworks, food processing technology research and innovation, and multinational cooperation to solve global food safety issues.

Conclusion

This study revealed decade-long foodborne pathogen epidemiological trends. Key findings include a 50% increase in Salmonella and Campylobacter prevalence, indicating their significant public health effect. Food safety management is difficult as E. coli O157 (+25%) and Listeria monocytogenes (+20%) increased moderately. These trends show that foodborne infections are dynamic and require ongoing surveillance and aggressive public health initiatives. This study has major implications for public health strategies. The increased prevalence of Salmonella and Campylobacter spp. highlights the need to improve food safety, including food production and distribution chain monitoring. Effective risk communication techniques are needed to educate the public and healthcare practitioners about preventative measures, especially for vulnerable groups. Policymakers can reduce foodborne infections and enhance public health by addressing these issues.

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