

Original Article

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An epidemiological investigation of foodborne and waterborne disease outbreaks in Fars Province in Iran from 2020 to 2023

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ABSTRACT

Objective: To examine the incidence of foodborne and waterborne diseases as well as the relationship between the sources of outbreaks and the method of drinking water supply with the initial symptoms of the disease in Fars province of Iran from 2020 to 2023.

Methods: This cross-sectional study analyzed 630 confirmed outbreaks reported to health centers within the jurisdiction of Shiraz University of Medical Sciences from March 2020 to March 2023. Data analysis was performed using SPSS software, version 22.

Results: Totally 630 outbreaks were reported, affecting 2363 primary cases with 190 hospitalizations from 2020 to 2023. The highest incidence of the outbreaks by year and month was reported in 2022 (n=266, 42.2%) and in April (n=77, 12.2%). The main source of infection in the outbreak was food with 426 (67.6%) cases, with food poisoning syndrome being the most common symptom observed (n=435, 69.0%). Besides, the causative agent of 461 (73.1%) outbreaks was unknown and 56 (8.9%) was salmonellosis. Additionally, relationship between source of outbreak and the method of drinking water supply with primary symptoms of the disease was statistically significant (P<0.001).

Conclusions: This study found that the cause of most outbreaks is unknown, with transmission occurring through food, which leads to the hospitalization of many individuals. The findings can help officials and the public increase awareness, implement stricter monitoring of water and food safety, and ultimately reduce the burden of disease.

KEYWORDS: Outbreak; Foodborne diseases; Waterborne disease; Iran

1. Introduction

Contaminated food and water are significant contributors to the transmission of diseases and the onset of outbreaks, leading to millions of child deaths from acute diarrhea each year[1]. An estimated 4% of deaths worldwide are related to water hygiene and quality[2]. Understanding the dangers posed by foodborne

Significance

Outbreaks of water- and foodborne diseases are one of the most important public health issues in the world and Iran, which, if neglected, can cause significant mortality. This study examines the epidemiological aspects of these outbreaks. The results showed the most important source of food outbreaks and the most primary symptoms were in the form of food poisoning syndrome. Moreover, relationship between source of outbreak and the method of drinking water supply with primary symptoms of the disease was statistically significant.

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pathogens to public health—along with the delayed onset of symptoms, which can range from days to years, and the variability in their clinical manifestations and diagnostic features—reveals why these agents constitute a major public health issue[3]. More than 250 infectious and non-infectious agents are implicated in food contamination[4]. Common waterborne infectious agents include diseases caused by salmonellosis, campylobacteriosis, shigellosis, and giardiasis[5]. Common signs of various foodborne diseases include nausea and vomiting, cramps and abdominal discomfort, diarrhea, and occasionally fever and headaches, along with other indicators that typically appear within hours and may last for several days[6,7]. Also, the main causes of deaths related to these factors are the presence of viruses and human intestinal monocytes, which are mainly transmitted through the fecal-oral route, resulting in significant contamination of water and food sources[8]. In Iran, the identification of the causes of foodborne and waterborne illnesses through laboratory tests has only been successful in 40% of instances, with *Escherichia coli* and *Shigella* identified as the most commonly detected pathogens for these illnesses, respectively[1]. The increased likelihood of outbreaks associated with food and water, especially waterborne diseases, presents a risk not only to the health and safety of individuals and animals but also affects government expenditures for education, public health, and the upkeep of crucial infrastructure[5]. Generally, an outbreak of waterborn or foodborne diseases is characterized by at least two people from a group becoming ill after consuming contaminated food[1]. Therefore, prevention and control of factors that contribute to disease outbreaks are essential to prevent possible harm. Carrying out comprehensive investigations of outbreaks at suitable time, according to existing literature, improves the identification of pathogens transmitted *via* water and food, which is now integrated as national guidelines within the Iranian healthcare system. In Fars Province of Iran, diseases resulting from contaminated water and food constitute a significant part of public health issues; however, the overall patterns and circumstances of these outbreaks have not been examined in recent years. Thus, this study aimed to investigate the epidemiology of foodborne and waterborne outbreaks in Fars Province of Iran, aiding policymakers and healthcare professionals in strengthening prevention and control strategies for these outbreaks.

2. Material and methods

2.1. Study setting

This cross-sectional study examined a total of 630 outbreaks reported to health centers in the cities under the jurisdiction of Shiraz University of Medical Sciences from March 2020 to March 2023. Sampling was done through census sampling, and all outbreaks during this period were included in the study.

2.2. Inclusion criteria and exclusion criteria

A total of 641 outbreaks were reported, 11 of which were excluded from the study due to no final confirmation. In this study, a total of 630 outbreaks appeared in the final analysis.

2.3. Data collection

Data were collected from 32 health centers in the city and reported outbreaks to these centers after their appearance. After reviewing the outbreak team (chlorination, food samples, drinking water microbial sampling, stool sampling), a list of patients was prepared, followed by field surveys and analysis by epidemiologists or environmental health prevention and control. The checklist was developed to collect information on demographic characteristics (age group, sex), outbreak location, outbreak date, number of initial cases, syndrome type, potential sources of outbreaks (*e.g.*, water, food), hospitalization status, causative agent, and symptoms associated with the outbreak. In this study, unimproved water is water that has not undergone a purification process to remove contaminants, suspended particles, pathogenic microbes such as bacteria or parasites, and other disease-causing agents. The report was sent to the university's health office within 24 hours and entered into the relevant outbreak portal after final approval and review. Additionally, all documents were stored in the city's health centers.

2.4. Statistical analysis

All documents and outbreak registration portal were sorted and encoded in Excel software and analyzed in SPSS software (version 22). Prevalence was assessed based on descriptive statistics such as frequency and percentage. The relationship between the outbreak and the method of supplying drinking water with the initial symptoms of the disease was also examined using the *Chi*-square test. Due to the nature of the descriptive study, there were no variables that played the role of interaction or confounder in this study. Also, due to the census method for entering outbreak cases, there were no missing data. All analysis was done at a significance level of $P<0.05$.

2.5. Ethical approval

This study was approved by the Ethics Committee of Shiraz University of Medical Sciences with approval No. of IR.SUMS.REC.1402.047.

3. Results

3.1. Demographic characteristics

In this study, 630 outbreaks of diseases related to contaminated water and food were reported, affecting a total of 2 363 primary cases. A total of 594 samples were gathered, with 190 individuals in needs of hospitalization. Shiraz, the capital of Fars Province, experienced the highest number of outbreaks, totaling 283 (44.9%) outbreaks, along with 1 035 (43.8%) primary cases. Following that, Marvdasht County reported 50 (7.9%) outbreaks with 162 (6.9%) primary cases while Ghirokarzin County recorded 27 (4.3%) outbreaks with 68 (2.9%) primary patients.

Of total cases, 1 563 (66.1%) were residing in urban areas, and more men (1 222, 51.7%) were infected than women. Also, more men (102, 53.7%) were hospitalized than women (88, 46.3%). Detailed demographic information can be found in Table 1.

Table 1. Demographic characteristics of population under study (n=2 363).

Variables	Subgroup	Number (%)
Sex	Men	1 222 (51.7)
	Women	1 141 (48.3)
Age group (years)	<5	207 (8.8)
	5-18	558 (23.6)
	18-60	1 466 (62.0)
	>60	132 (5.6)
Living location	City	1 563 (66.1)
	Village	800 (33.9)
Total hospitalization		190 (8.0)
Hospitalization by sex	Men	102 (4.3)
	Women	88 (3.7)
Hospitalization by age group	< 5 years	36 (1.5)
	5-18 years	84 (3.6)
	18-60 years	64 (2.7)
	>60 years	6 (0.3)

3.2. Settings of outbreaks

The occurrences of outbreaks were more in the city (422 cases, 67.0%) compared to the village (208 cases, 33.0%). In terms of outbreak locations, the largest number was found at home (220 cases, 34.9%). This was followed by food supply and distribution centers with 211 (33.5%) cases. Other locations accounted for 190 (30.2%) cases. Lastly, kindergartens, schools, and student dormitories reported 9 (1.4%) cases. In terms of symptoms, the majority were identified as food poisoning syndrome, accounting for 435 (69.0%) individuals. Then, acute watery diarrhea syndrome was reported by 107 (17.0%). The main drinking water source was piped water with 534 (84.8%) cases. Next, improved water sources contributed to 33 (5.0%) cases. Furthermore, the main source of infection in the outbreak was food with 426 (67.6%) cases, then water and food combined accounted for 85 (13.5%) cases and unknown source with 74 (11.7%) cases.

3.3. Number of foodborne disease outbreaks

In 2022, the total number of outbreaks hit a maximum of 266 (42.2%) cases, while the year 2020 experienced the lowest number with 143 (22.7%) cases. From 2020 to 2023, April was noted for the highest outbreak, totaling 82 (13.0%) cases, whereas June documented 77 (12.2%) cases followed by 67 (10.6%) cases in July (Figure 1).

3.4. Etiology

The most common known causative agent of foodborne and waterborne illnesses were salmonellosis (8.9%) and shigellosis (4.9%). While among the agents that led to outbreaks, most hospitalizations were related to hepatitis A (2.5%). The frequency of agents leading to foodborn and waterborne outbreaks are detailed in Table 2. The age group with the highest outbreak was 18 to 60 years with 1 466 (62.0%) cases (Figure 2).

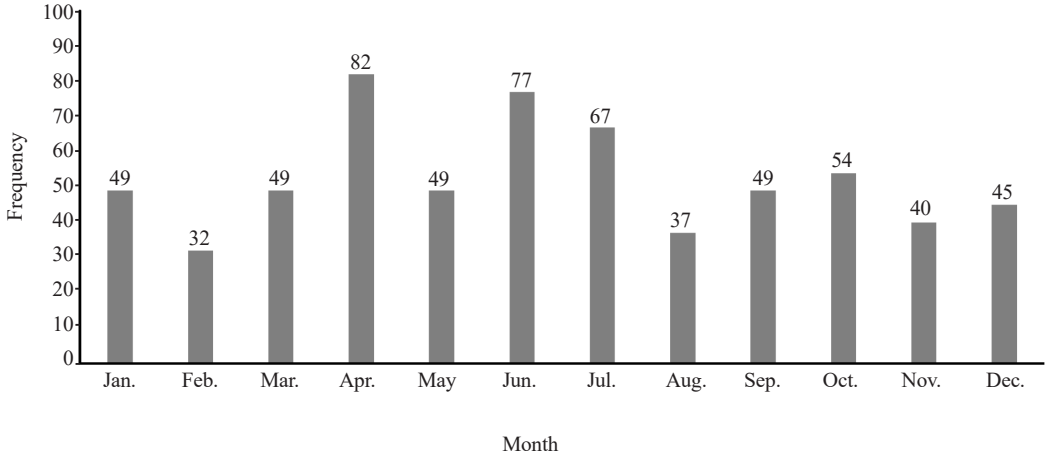


Figure 1. Frequency distribution of waterborne and foodborne outbreaks per month from 2020 to 2023.

Table 2. Number and percentage of hospitalization by agents of waterborne and foodborne outbreaks (n=630).

Agents of outbreak	Number (%)	Hospitalization (%)
Salmonellosis	56 (8.9)	1 (0.2)
Shigellosis	31 (4.9)	11 (1.8)
Hepatitis A	30 (4.8)	16 (2.5)
Toxins	22 (3.5)	6 (1.0)
Giardiasis	12 (1.9)	1 (0.2)
Other	18 (2.9)	6 (0.9)
Unknown	461 (73.2)	149 (23.7)

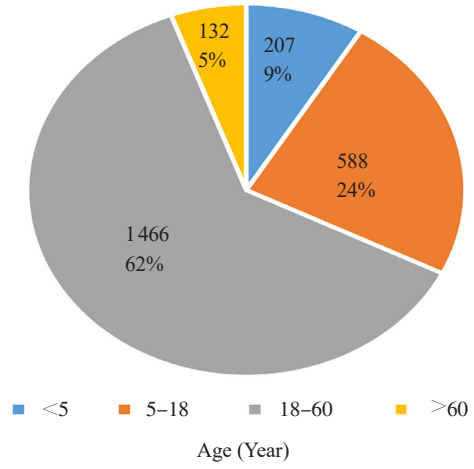


Figure 2. Distribution of occurrence of waterborne and foodborne outbreaks by age group.

3.5. relationship between source of outbreaks with primary symptoms

The relationship between source of outbreaks and the method of drinking water supply with primary symptoms of the disease was statistically significant. For example, 47 (11.0%) of those who reported the source of the contamination as food showed symptoms of acute watery diarrhea syndrome, or 7 (15.6%) of those who consumed water had symptoms of the disease in the form of jaundice syndrome (P<0.001). Also, 23 (4.3%) of those who had plumbing water as their source of water supply had acute bloody diarrhea syndrome, and 30 (90.9%) of those who had been using improved water sources reported food poisoning syndrome (P<0.001). Other sources of outbreak and water supply information are visible in Table 3.

Furthermore, relationship between method of drinking water supply and the source of the outbreak was also found to be statistically significant. Therefore, 33 (representing 6.2% of this group) of those who consumed plumbing water, sources of contamination were water, while 25 (representing 75.8% of this group) of those whose water supply was improved sources reported contamination in food (P<0.001) (Table 4).

4. Discussion

The results of this study suggest that foodborne and waterborne disease outbreaks constitute a significant public health problem in Iran. In Pakistan, a country neighboring Iran, nearly 40% of deaths were attributed to waterborne diseases[9]. In this study, the outbreaks increased in Fars Province from March 2020 to March 2023. The highest number of outbreaks (42.2%) was reported in 2022, which was due to the increase in food preparation and distribution centers, the increase in group catering centers and facilities, and most importantly, the improvement of the surveillance system and sensitivity in reporting and recording outbreaks. Also, in this study, the highest number of outbreaks occurred in April, followed by June and July. Possible reasons for increased outbreaks during hot seasons include a rise in food spoilage and eating out. In addition, a hot and humid environment combined with high temperatures promotes the growth of pathogens.

Table 3. Relationship between source of outbreak and method of drinking water supply with primary symptoms of the disease.

Source of outbreak	Acute watery diarrhea syndrome	Acute bloody diarrhea syndrome	Jaundice syndrome	Food poisoning syndrome	Unknown	Total	P
Food	47 (11.0)	8 (1.9)	2 (0.5)	350 (82.2)	19 (4.5)	426 (100)	
Water	20 (44.4)	9 (20.0)	7 (15.6)	8 (17.8)	1 (2.2)	45 (100)	
Water and food	16 (18.8)	7 (8.2)	8 (9.4)	44 (51.8)	10 (11.8)	85 (100)	
Unclear	24 (32.4)	5 (6.8)	3 (4.1)	33 (44.6)	9 (12.2)	74 (100)	
Total	107 (17.0)	29 (4.6)	20 (3.2)	435 (69.0)	39 (6.2)	630 (100)	<0.001
Method of drinking water supply							
Water plumbing	87 (16.3)	23 (4.3)	17 (3.2)	371 (69.5)	36 (6.7)	534 (100)	
Via the tanker	12 (46.2)	2 (7.7)	1 (3.8)	11 (42.3)	0 (0.0)	26 (100)	
Unimproved water sources	7 (50.0)	1 (7.1)	2 (14.3)	3 (21.5)	1 (7.1)	14 (100)	
Improved water sources	0 (0.0)	2 (6.1)	0 (0.0)	30 (90.9)	1 (3.0)	33 (100)	
Unclear	1 (4.3)	1 (4.3)	0 (0.0)	20 (87.0)	1 (4.3)	23 (100)	
Total	107 (17.0)	29 (4.6)	20 (3.2)	435 (69.0)	39 (6.2)	630 (100)	<0.001

Data were expressed by n (%). The percentages in each row are calculated based on the total number of cases in that row.

Table 4. Relationship between method of drinking water supply and the source of the waterborne and foodborne outbreaks.

Method of drinking water supply	Source of outbreak				Total	*P*
	Water	Water and food	Food	Unclear		
Water plumbing	33 (6.2)	66 (12.4)	374 (70.0)	61 (11.4)	534 (100)	
Via the tanker	7 (26.9)	6 (23.1)	7 (26.9)	6 (23.1)	26 (100)	
Sources not improved	5 (35.7)	7 (50.0)	2 (14.3)	0 (0.0)	14 (100)	
Improved sources	0 (0.0)	4 (12.1)	25 (75.8)	4 (12.1)	33 (100)	
Unclear	0 (0.0)	2 (8.7)	18 (78.3)	3 (13.0)	23 (100)	
Total	45 (7.1)	85 (13.5)	426 (67.6)	74 (11.7)	630 (100)	<0.001

Data were expressed by *n* (%). The percentages in each row are calculated based on the total number of cases in that row.

Our study showed that people aged 18 to 60 years were most susceptible to outbreaks. Reports from a study conducted in the Middle East indicate that the children's age group is the most susceptible[10]. However, in Kurdistan, most of the water-related outbreaks were observed in the age group of 6 to 15 years, which differs from our results. Moreover, there was a higher incidence of foodborne illness in the age group of 16 to 30 years[11]. Young people tend to take part in a wider range of activities, leading to a more diverse intake of food and water in different environments and being in larger crowds, increasing the risk of disease outbreaks.

According to the results, 67.6% of the reported outbreaks were food-related, which is in agreement with the study of Ebrahimi *et al.*, who found that 66.9% of the outbreaks were food-related[12]. Therefore, maintaining food hygiene, preparing food in a hygienic way, and ensuring proper maintenance are important to minimize outbreaks. In our study, 66.1% of foodborne and waterborne outbreaks were identified in urban areas, which was in agreement with the results of Soltan Dallal *et al.*, who found that 78% of the outbreaks occurred in cities[6]. Causes may be related to the gathering of different people in supply and distribution centers, or the increased risk of water contamination due to breaks that may occur at the urban level rather than rural. The results of this study showed that most of the waterborne and foodborne outbreaks occurred in homes, followed by food distribution facilities. Public restaurants were identified as the most common location of these outbreaks by Lee *et al.*[13], and homes were reported as the main location of outbreaks in Kurdistan in Iran[12].

In this study, food poisoning syndrome was the most commonly reported syndrome, followed closely by acute watery diarrhea syndrome. In the Kerman study, patients experienced a range of symptoms, with nausea, vomiting, abdominal pain, and heartburn being the most commonly reported[7]. In a study in Turkey, the most common symptoms of possible cases were abdominal pain, diarrhea, nausea, vomiting, and fever[14]. Differences in environmental conditions, food consumption, and the amount of contaminated food and water consumed may be the main reasons for the differences in symptoms experienced by individuals.

Our findings indicate that the main cause of foodborne and waterborne diseases were salmonellosis and shigellosis, which was consistent with the findings of a study by Kozak *et al.*, which identified *Salmonella*, *Escherichia coli*, and *Shigella* as the most prevalent pathogens[15]. In addition, hepatitis A, a known pathogen in Iran, was an important etiological agent in this study, which was consistent with the findings of Masoumi Asl *et al.*[11]. In a study conducted in the Middle East on foodborne diseases, common infectious agents included: *Salmonella typhi* and other *Salmonella* species, *Shigella*, *Campylobacter jejuni* and *Campylobacter coli*, rotavirus, hepatitis A virus[10]. A study reported that in 2022, as of November, there were a total of 3 063 confirmed cases of cholera and 19 deaths across Iraq due to the constant movement of people across the country for various reasons. Irrigation of vegetables with sewage water was also a reason for the continued spread of the disease[16]. These results indicate that hepatitis A remains a serious threat despite improved access to healthy water and healthy food. A significant portion of the causes of outbreaks remain unexplained, highlighting the need for improved laboratory capacity and staff training to adequately investigate these outbreaks.

This study has certain limitations, including the possibility that some outbreaks may not have been reported through the health care system and that smaller outbreaks may not have been investigated. Furthermore, because this is a cross-sectional study, the underlying causes of the outbreak are not identified. Also, the root cause of a high percentage of outbreaks has not been identified, which results in difficulties in determining the root causes and planning for outbreak control.

5. Conclusions

Iran has seen a significant increase in the number of foodborne and waterborne diseases in recent years. Identifying the causes of outbreaks and their transmission routes can help prevent the spread of these diseases, especially in densely populated areas. This study could serve as a basis for future studies aimed at understanding the causes of outbreaks, identifying environmental risk factors, helping policymakers develop guidelines, monitoring water and food safety more strictly and ultimately improving the healthcare system.

Conflict of interest statement

The authors claim there is no conflict of interest.

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Data availability statement

The data supporting the findings of this study are available from the corresponding author upon request.

Authors' contributions

Karami H provided guidance in conducting the study, conceptualized the study plan, and wrote the manuscript. Jafari F provided guidance in conducting the study, analyzed the data, and wrote the manuscript. Mohammadi Abnavi M analyzed the data and wrote the manuscript. Manoochehri Y compiled and prepared the final data set for analysis, reviewed the analysis, and wrote the manuscript. Ghanbarian M carried out data collection and wrote the manuscript. All authors read and approved the final manuscript for publication.

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