



Surveillance of Foodborne and Waterborne Disease Outbreaks in Kerman Province from 2015 to 2019

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Abstract

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Background: Foodborne and waterborne diseases are currently considered significant causes of death and related outbreaks throughout the world. Accordingly, this study investigated foodborne and waterborne disease outbreaks in Kerman Province.

Methods: The foodborne and waterborne disease outbreaks data in this descriptive-analytical study were collected from 2015 to 2019 in 9 cities that were registered in the Health Department of Kerman University of Medical Sciences. The outbreaks were examined and compared in terms of time (year, season, and month), county, etiological factors, type of food, and the place of the outbreak.

Results: A total of 160 waterborne and foodborne disease outbreaks occurred in 9 cities in Kerman province from 2015 to 2019, which led to 3111 diseases, 824 hospitalizations, and 3 deaths. Most outbreaks were reported in Kerman in the spring and were mainly caused by food containing meat. Moreover, the most important known factor was *E. coli*. Residential houses were also the most common site of the reported outbreaks.

Conclusion: Given the high incidence of outbreaks in Kerman province, further education is necessary to improve the food health system and food safety.

Keywords: Outbreak, Foodborne and waterborne diseases, Epidemiology, Kerman, Iran

Background

Foodborne and waterborne diseases are currently considered a significant cause of death and related outbreaks throughout

the world (1). Food poisoning is the most common and important form of foodborne diseases caused by the consumption of food



contaminated with natural and chemical toxins and is characterized by symptoms such as a short incubation period and clinical signs of acute gastroenteritis (2). According to the World Health Organization (WHO), an outbreak occurs if two or more people share a common food or beverage source and show similar symptoms of the disease (3). Foodborne and waterborne diseases are caused by bacteria, viruses, parasites, and prions (4). These diseases are a constant threat to public health and a significant obstacle to economic and social development worldwide (5). In total, there are more than 250 infectious and non-infectious agents that may be sources of food contamination (6). Foodborne diseases cover a wide range of illnesses, from diarrhea to cancer. Although most of them are present in the form of gastrointestinal symptoms, they may also be manifested in the form of neurological symptoms, genetic complications, and immunity dysfunctions (7).

Every year, about one in 10 people in the world become ill after eating contaminated food. Food poisoning also kills more than 420,000 people a year. Children are most affected by these diseases and 125,000 deaths occur annually in people under 5 due to food poisoning (7). Most of these deaths are caused by diarrhea. In addition to diarrhea, other serious consequences of food poisoning include kidney and liver failure, brain and neurological disorders, reactive arthritis, cancer, and death. Furthermore, previous studies have shown that the microbial quality of water has an effect on the incidence of bloody diarrhea and typhoid fever, and this association has been more evident in rural areas than urban areas. For instance, it has been shown that 23% of rural water resources in Iran have microbial contamination (8, 9). Foodborne diseases are directly related to poverty in low- and middle-income countries, with about 80% of all illnesses and 33% of deaths occurring due to contaminated water and food consumption in third world countries (10, 11).

According to studies conducted in Iran, foodborne disease outbreaks have a higher percentage than waterborne disease outbreaks (12, 13). Increasing international trade and complex and lengthy food chains increase the risk of food contamination. Furthermore, urban growth, climate change, migration, and international travel, as well as lifestyle changes that have led to increased consumption of fast

food, large-scale food preparation, and long-term refrigeration have resulted in an increase in foodborne diseases and related outbreaks (14, 15). Given the importance and spread of foodborne and waterborne diseases, the present study aimed to examine foodborne and waterborne disease outbreaks in different counties of Kerman Province from 2015 to 2019.

Methods

This descriptive-analytical study examined foodborne and waterborne disease outbreaks reported from 2015 to 2019 in 9 counties of Kerman Province including Kerman, Zarand, Bardsir, Shahr-e Babak, Orzueyeh, Ravar, Rabor, Baft, and Kuhbanan. According to the regulations, any outbreak is reported via telephone calls from rural and urban health centers or private medical centers to comprehensive health service centers and from these centers to the health center of the relevant county. Immediately after receiving the initial report, the outbreak investigation team (including the comprehensive health service center physician, a specialist, an environmental health expert, or an epidemiologist) will attend the scene to confirm the outbreak and conduct an initial investigation, and if the outbreak is confirmed, necessary actions will be taken to investigate the causes of the outbreak and control it. Outbreak data are collected in collaboration with the Reporting Center by the Outbreak Investigation Team at the urban headquarters. Then, the collected data are recorded in the portals of the Infectious Disease Management Center, Food and Waterborne Disease Management and Nosocomial Infections and are approved by the provincial headquarters. The outbreak data form includes the name of the province, the county, the affected city or village, the date of outbreak occurrence and end, the date of the outbreak report, the population at risk (number of people present at the outbreak site), number of affected patients, hospitalizations and deaths from the outbreak, the predominant age and sex group, the main outbreak site, common signs and symptoms, route of transmission, number of samples taken from contaminated water and food, and microbial agents involved in the outbreak. The incidence rate of the disease in the outbreak was estimated by dividing the number of cases by the population at risk.

The data collected in this study showed the diseases were transmitted during the outbreaks through water, food, water and food, and unspecified sources. Besides, foods in outbreaks were divided into 14 categories including kebabs and broth and other meat-containing foods; drinking water; fruits and juice; chicken and poultry meat; salads, vegetables and poisonous mushrooms; fish and seafood; compotes and canned food; milk and dairy products; cakes and pastries; sausages and other fast foods; soups and stews; chicken eggs and other poultry eggs; unspecified sources and other items. Moreover, a total of 11 outbreak sites were identified in this epidemiological study including home celebrations and wedding and religious ceremonies, daycare centers and boarding houses, restaurants and motels, cafeterias and fast-food restaurants, school/university dormitories, kindergartens, schools, and universities, garrisons and barracks, hotels, inns, and unspecified locations.

The data collected from the forms were sorted and codified in Excel software and then analyzed with SPSS software (version 22). The

frequency of the outbreaks was assessed using descriptive statistics including frequency, percentage, tables, and graphs. Moreover, the incidence of diseases in different population groups was compared using the chi-square or Fisher tests. All statistical procedures were performed at the significance level of $p < 0.05$. The protocol for this study was approved with the code of ethics IR.KMU.REC.1399.328 by the Ethics Committee of Kerman University of Medical Sciences.

Results

The results of the study indicated that a total of 160 waterborne and foodborne disease outbreaks occurred in 9 counties in Kerman Province from 2015 to 2019, which resulted in 3111 diseases, 824 hospitalizations, and 3 deaths. The incidence of outbreaks in the studied years varied from 1.11 to 2.27 cases per 100 persons per year. The number of infected cases and hospitalizations in the studied years were significantly different, while the number of deaths in different years did not show a significant difference (Table 1).

Table 1. The descriptive statistics for outbreaks, people at risk, patients, hospitalizations, and deaths by year

Year	Outbreaks		People at risk		Incidence per 100 persons at risk*	Infected cases		Hospitalizations		Deaths	
	Frequency	%	Frequency	%		Frequency	%	Frequency	%	Frequency	%
2015	26	16.3	38574	22.7	2.27	878	28.2	311	37.7	2	66.6
2016	26	16.3	9583	5.6	2.09	201	6.4	58	7.03	0	0.0
2017	25	15.6	81478	48.04	1.88	1533	49.2	378	45.8	0	0.0
2018	34	21.3	23965	14.1	1.11	267	8.5	15	1.8	1	33.3
2019	49	30.6	15981	9.4	1.45	232	7.4	62	7.5	0	0.0
Total	160	100	169581	100	1.83	3111	100	824	100	3	100
P-value						0.001		0.001		0.17	

* Number of people present at the outbreak site

Most cases of outbreaks and hospitalizations occurred in the spring. Furthermore, the number of patients and hospitalizations in different seasons were significantly different (Table 2). The highest and lowest number of outbreaks were reported in April and March,

respectively (Figure 1). The highest number of outbreaks was found in Kerman County and the highest number of patients and hospitalizations were reported in Ravar County. But all deaths occurred in Kerman County (Table 3).

Table 2. The descriptive statistics for outbreaks, people at risk, patients, hospitalizations, and deaths by season

Season	Outbreaks		Infected cases		Hospitalizations		Deaths		
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	
Spring	55	34.4	2149	69.07	494	59.9	1	33.3	
Summer	51	31.9	338	10.8	85	10.3	1	33.3	
Autumn	39	24.4	521	16.7	191	23.1	1	33.3	
Winter	15	9.4	103	3.3	54	6.5	0	0	
Total	160	100	3111	100	824	100	3	100	
P-value					0.001			0.001	

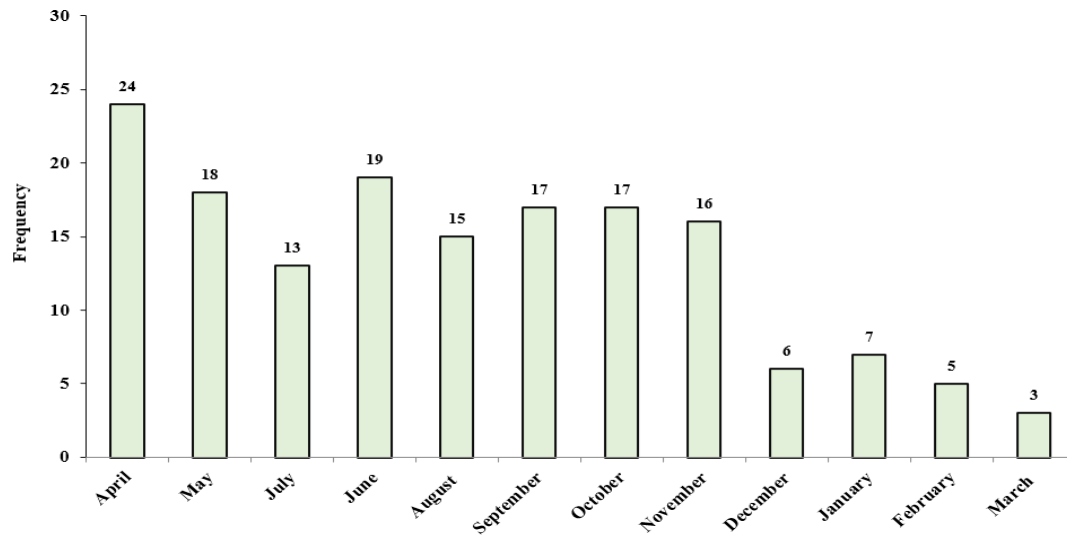


Figure 1. The frequency of outbreaks by month

Table 3. The descriptive statistics for outbreaks, people at risk, patients, hospitalizations, and deaths by county

County	Population	Outbreaks		Incidence per 100000 population	Infected cases		Hospitalizations		Deaths	
		Frequency	%		Frequency	%	Frequency	%	Frequency	%
Kerman	738724	61	38.1	118.71	877	28.1	299	36.2	3	100
Zarand	138133	32	20	216.45	299	9.6	68	8.2	0	0.0
Bardsir	81983	17	10.6	208.57	171	5.4	68	8.2	0	0.0
Shahr-e Babak	103975	13	8.1	45.20	47	1.5	9	1.09	0	0.0
Orzueeyeh	38510	10	6.3	277.84	107	3.4	19	2.3	0	0.0
Ravar	43198	8	5.0	3245.52	1402	45.0	346	41.9	0	0.0
Rabor	35362	7	4.4	378.42	137	4.4	5	0.6	0	0.0
Baft	84103	6	3.6	53.50	45	1.4	4	0.4	0	0.0
Kuhbanan	21205	6	3.6	122.61	26	0.8	6	0.7	0	0.0
Total	1285193	160	100	242.06	3111	100	824	100	3	100

The data also showed that foodborne and waterborne disease outbreaks were more frequently reported in urban areas (47.5%) and the number of patients and hospitalizations were significantly different in terms of place of residence (Table 4). Foodborne and waterborne disease outbreaks were not detected in laboratory studies in 90.6% of cases. Besides, *Escherichia coli* (*E. coli*) was the most common risk factor for the disease outbreaks compared to other factors (Table 5).

Food was the most important factor in transmitting the outbreaks in most cases (45.6%) (Figure 2). Moreover, the type of food was the most commonly reported factor in 66.9% of outbreaks. Among the identified factors, the highest outbreaks were reported for kebabs, broth, and other meat-containing foods

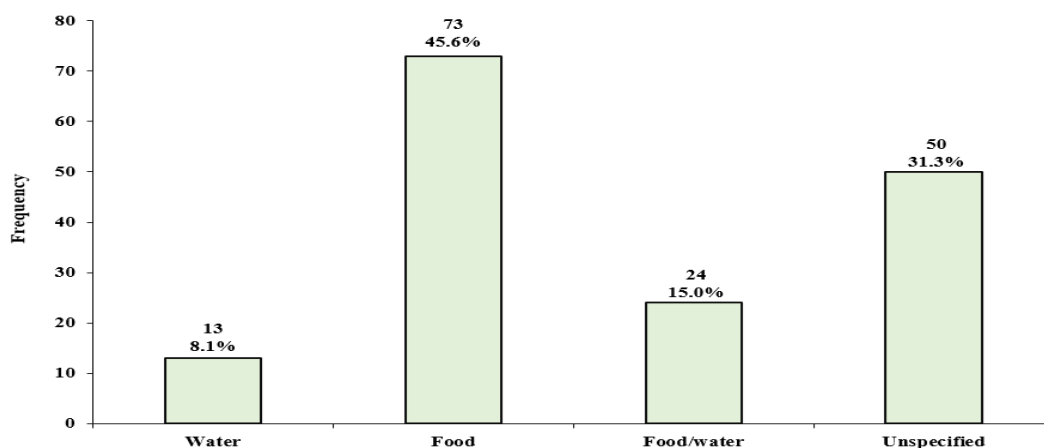
that accounted for 20 cases (12.5%). In contrast, the lowest number of outbreaks were related to chicken eggs and other poultry eggs with 2 cases (1.3%) (Table 6). In 95% of the outbreaks, the location of the outbreak was determined, with the highest number of outbreaks occurring in residential houses (56.9%). Moreover, 1.2% of outbreaks occurred in places such as garrisons, barracks, hotels, and inns. There was also a significant difference between the incidence rate and hospitalization based on the location of the outbreak (Table 7). The most common symptoms in patients due to outbreaks were nausea, vomiting, abdominal pain, and heartburn (26.9%). On the other hand, the least frequently reported symptoms were fever and loss of consciousness, each accounting for 0.6% of cases (Figure 3).

Table 4. The descriptive statistics for outbreaks, people at risk, patients, hospitalizations, and deaths by region

Region	Outbreaks		Infected cases		Hospitalizations		Deaths	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Urban	76	47.5	504	16.2	175	21.2	2	66.6
Rural	71	44.4	2433	78.2	598	72.5	1	33.3
Rural/urban	3	1.9	89	2.8	4	0.4	0	0
Nomadic	1	0.6	7	0.2	0	0.0	0	0
Unspecified	9	5.6	78	2.5	47	5.7	0	0
Total	160	100	3111	100	824	100	3	100
P-value			0.001		0.001			

Table 5. The descriptive statistics for outbreaks, people at risk, patients, hospitalizations, and deaths by the causing agent

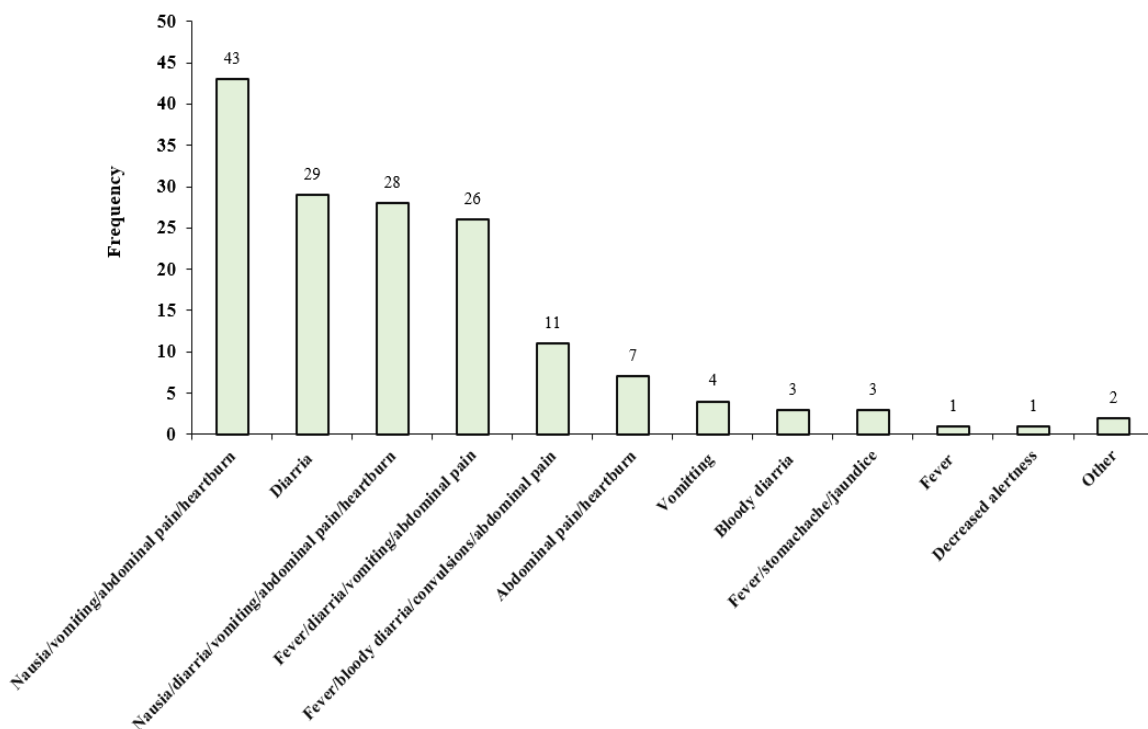
Agent	Outbreaks		Infected cases		Hospitalizations		Deaths	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
E. coli	4	2.5	1497	48.1	383	46.4	0	0.0
Shigella	2	1.3	13	0.4	9	1.09	0	0.0
Vibrio cholerae	2	1.3	2	0.06	2	0.2	0	0.0
Salmonella	1	0.6	31	0.9	0	0.0	0	0.0
Staphylococcus	1	0.6	98	3.1	0	0.0	0	0.0
Entamoeba histolytica	1	0.6	7	0.2	0	0.0	0	0.0
E. coli and Shigella	2	1.3	410	13.1	157	19.05	1	33.3
E. coli and Giardia	1	0.6	14	0.4	1	0.1	0	0.0
Other	1	0.6	9	0.2	9	1.09	0	0.0
Unspecified	145	90.6	1030	33.1	263	31.9	2	66.0
Total	160	100	3111	100	824	100	3	100

**Figure 2. The frequency of outbreaks by contaminated sources****Table 6. The descriptive statistics for outbreaks, people at risk, patients, hospitalizations, and deaths by the contaminated food**

Food	Outbreaks		Infected cases		Hospitalizations		Deaths	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Kebab/broth, meat-containing foods	20	12.5	192	6.1	23	2.7	0	0
Drinking water	16	10.0	322	10.3	93	11.2	0	0
Fruit/juice	11	6.9	92	2.9	11	1.3	0	0
Chicken/poultry	10	6.3	62	1.9	3	0.3	0	0
Salads/vegetable/poisonous mushrooms	7	4.4	139	4.4	52	6.06	0	0
Fish/seafood	6	3.8	20	0.6	8	0.9	0	0
Canned food	6	3.8	37	1.1	22	2.6	0	0
Milk/dairy products	5	3.1	24	0.7	2	0.2	1	33.3
Cakes/ pastries	4	2.5	20	0.6	13	1.5	0	0
Sausages/fast foods	4	2.5	1382	44.4	332	40.2	0	0
Soups/stews	4	2.5	312	10.02	126	15.2	1	33.3
Eggs	2	1.3	8	0.2	1	0.1	0	0
Other	12	7.5	167	5.3	45	5.4	0	0
Unspecified	53	33.1	334	10.7	95	11.5	1	33.3
Total	160	100	3111	100	824	100	3	100

Table 7. The descriptive statistics for outbreaks, people at risk, patients, hospitalizations, and deaths by the place of occurrence

Food	Outbreaks		Infected cases		Hospitalizations		Deaths	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Houses	91	56.9	584	18.7	152	18.4	1	33.3
Celebrations, wedding and religious ceremonies	21	13.1	0905	61.2	470	57.0	1	33.3
Daycare centers/boarding houses	4	2.5	18	0.5	0	0.0	0	0
Restaurants/motels	6	3.8	32	1.02	10	1.2	0	0
Cafeterias/fast food restaurants	5	3.1	19	0.6	0	0.0	0	0
School/university dormitories	4	2.5	28	0.9	18	2.1	0	0
Kindergartens/schools/universities	3	1.9	125	4.01	37	4.4	0	0
Garrisons/barracks	1	0.6	28	0.9	28	3.3	0	0
Hotels/inns	1	0.6	6	0.1	0	0.0	0	0
Other	16	10	278	8.9	98	11.8	1	33.33
Unspecified	8	5	88	2.8	11	1.3	0	0
Total	160	100	3111	100	824	100	3	100
P-value				0.001		0.001		

**Figure 3. The frequency of outbreaks by symptoms**

Discussion

Currently, with the growing complexity of food production and distribution methods, more attention is paid to food health and safety. However, despite the advanced monitoring system in most countries of the world, foodborne and waterborne diseases continue to be serious problems (16). The results of this study showed an upward trend in outbreaks in most of the years under review, which could be attributed to the improvement of the health system and the screening and

reporting procedures. Mahmoudi Asl et al. examined foodborne disease outbreaks in Iran from 2006 to 2011 and found the frequency of outbreaks has been increasing during the period in question (17). Similarly, a study conducted by Wu et al. in one of the provinces of China also showed that the frequency of outbreaks had been increasing from 2011 to 2016 (18).

According to the data in this study, foodborne and waterborne disease outbreaks occurred in all seasons, but their frequency was higher in the warm seasons of the year

including spring (April) and summer, which can be attributed to more holidays, higher temperatures in these seasons, more frequent travels, use of fast foods, and insufficient observance of hygienic and health protocols, as well as insufficient attention to the consumption of drinking water and healthy food. A study conducted in 2012 in different provinces of Iran also showed the occurrence of more outbreaks in summer (14). Furthermore, a study in Korea and Japan showed that the outbreaks of foodborne microbial diseases were more frequent in spring and winter, respectively. The differences in the frequency of outbreaks in different seasons can be due to different weather conditions, school closures and different patterns of infectious agents (19).

This study showed that most of the outbreaks were in Kerman County, which could be due to the larger population of this city. Kerman is the capital of the province with many tourist attractions. This county hosts more travelers and thus the non-compliance with health protocol during the travel can lead to an outbreak. According to the results of this study, most of the outbreaks were reported in urban areas, which may be due to a large number of restaurants, halls, and military barracks in urban areas. Similarly, Dallal et al. showed that most of the outbreaks (78.08%) occurred in urban areas (14), but another study in Kurdistan province reported a higher frequency of outbreaks (52.14%) in rural areas (20).

Limiting the capacity of laboratories to identify pathogens is an important factor that prevents identifying possible causes of outbreaks (21). In this study, the etiological cause of many outbreaks was unclear. However, *E. coli* was reported as the most frequent cause of outbreaks. In the same vein, Bokaie et al. studied foodborne and waterborne disease outbreaks in Iran and showed that among the known etiological factors, *E. coli* had the highest frequency accounting for more than 30% of the outbreaks (22). In contrast, a review study in Barbados, an eastern Caribbean island, found that *Salmonella* was a more common cause of outbreaks than other agents (23). The difference in the causes of the outbreaks may be due to differences in the epidemiological situation of each country or region. Although the identification of

etiological factors has improved in recent years, a high percentage of outbreaks still end without identifying the causative agent (22).

The data in this study indicated the outbreaks were mainly caused by foods containing meat, as evident in studies conducted in Canada and France (24, 25). However, another study in China showed that toxic fungi were the most common causes of outbreaks (26). According to the US Centers for Disease Control and Prevention, the most common foods that cause foodborne disease outbreaks were chicken (17%), beef (16%), and leafy vegetables (14%), respectively (27). Differences in the causes of outbreaks in different countries and regions may be attributed to differences in lifestyle and commonly used foods in each country, as well as the differences in protocols and health monitoring procedures in each country.

According to the results of this study, most outbreaks occurred in residential houses, as reported in studies conducted in Iran (22) and Europe (28). These findings can be a warning for more attention and training to prepare healthy home-cooked food. However, studies in the United States (29), Hong Kong (30), and Australia (31) reported that most of the outbreaks occurred in restaurants. Different climatic conditions, the type of foods, and the cause of the outbreaks can cause different symptoms in affected people. In this study, the patients' symptoms were very different, and nausea, vomiting, abdominal pain, and heartburn were more common than other symptoms. In a study in the French military, the most common symptoms of foodborne disease outbreaks were abdominal pain, diarrhea, nausea, vomiting, and fever, respectively (25).

One of the limitations of this study was that it did not identify the etiological factors underlying the outbreaks. Thus, given the low frequency of known etiological factors, the identified outbreak factors cannot be representative of the pathogens causing outbreaks and have little generalizability.

Conclusion

Water-borne and food-borne diseases are still serious health problems. Neglecting this issue can cause major problems for people. These

types of outbreaks can be prevented by extensive collaboration and training of all staff in this field. Following the findings of this study, continuous monitoring for food preparation in different places as well as attention to the health status of drinking water seems necessary. Given that the highest frequency of outbreaks was related to meat, training to properly cook food used in homes and other places is of great importance.

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Conflict of interest

The authors declared no conflict of interest.

- the Outbreak of Waterborne and Foodborne Diseases in Kurdistan Province. *J Res Environ Health*. 2019; 5(3): 239-48. [In Persian]. doi: 10.22038/jreh.2019.38425.1280.
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