

Vital Surveillances

Characteristics of Settings and Etiologic Agents of Foodborne Disease Outbreaks — China, 2020

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ABSTRACT

Introduction: Foodborne diseases are a growing public health problem and have caused a large burden of disease in China. This study analyzed epidemiological characteristics of foodborne diseases in China in 2020 to provide a scientific basis for prevention and control measures.

Methods: Data were collected from 30 of 31 provincial-level administrative divisions (PLADs) in the mainland of China, excluding Xizang (Tibet) Autonomous Region, via the National Foodborne Disease Outbreaks Surveillance System. The number and proportion of outbreaks, illnesses, hospitalizations, deaths by setting, pathogen-food category pairs and etiology were calculated.

Results: In 2020, 7,073 foodborne disease outbreaks were reported, resulting in 37,454 illnesses and 143 deaths. Among the identified pathogens, microbial pathogens were the most common confirmed etiology, accounting for 41.7% of illnesses. Poisonous mushrooms caused the largest proportion of outbreaks (58.0%) and deaths (57.6%). For venues where foodborne disease outbreaks occur, household had the highest number of outbreaks (4,140) and deaths (128), and catering service locations caused the largest proportion of illnesses (59.9%). Outbreaks occurring between June and September accounted for 62.8% of total outbreaks.

Conclusions: Foodborne disease outbreaks mainly occurred in households. Microbial pathogens remained the top cause of outbreak-associated illnesses. Poisonous mushrooms were ranked the top cause of deaths in private homes in China. The supervision and management of food safety and health education should be strengthened to reduce the burden of foodborne diseases. Publicity should be increased to reduce the incidence of mushroom poisonings in families, and supervision and management of food should be strengthened to reduce microbial contamination.

INTRODUCTION

An outbreak of foodborne disease is defined as the occurrence of two or more cases of a similar illness resulting from ingestion of a common food (*1*). It is a global health problem that is harmful to humans. Foodborne diseases encompass a wide spectrum of illnesses, including infectious diseases caused by microorganisms and toxic diseases mainly caused by chemical and toxic agents. The World Health Organization estimated that 600 million foodborne diseases occurred globally in 2010, causing 420,000 deaths (*2*). The US CDC estimated that 48 million foodborne diseases (1 in 6 Americans) occur each year in the USA, resulting in 12,800 hospitalizations and 3,000 deaths (*3*). In the Western Pacific Region, including China, 125 million people get sick and more than 50,000 die every year due to foodborne diseases (*4*). Foodborne diseases bring huge economic burdens to human beings. According to the requirements of Food Safety Law of the People's Republic of China, the National Foodborne Disease Outbreaks Surveillance System was established to continuously and systematically collect data on foodborne disease outbreaks in 2010.

Therefore, the objectives of this study were to characterize the epidemiological status of foodborne diseases in China and to analyze the distribution of high-risk foods and pathogenic factors to provide technical support for food safety risk assessment, formulation and revision of standards, and risk management.

METHODS

The study obtained data on foodborne disease cases reported through the National Foodborne Disease Outbreaks Surveillance System from January 1, 2020 to December 31, 2020. Data were collected from 30 of 31 provincial-level administrative divisions (PLADs) in the mainland of China, excluding Xizang (Tibet) Autonomous Region. Data requested for each outbreak

report included the individual CDC reporting the outbreak, date of occurrence, number of illnesses, hospitalizations, and deaths, etiology, implicated food(s) and setting. All variable values were reported as counts or proportions (%). The number and proportion of outbreaks, illnesses, and deaths by etiology, setting, and food categories were calculated. The statistical analysis was performed using SPSS (version 21.0, IBM Corp, Chicago, USA).

RESULTS

Most outbreaks (97.5%), illnesses (98.0%), and deaths (99.1%) were linked to households and catering service locations. Households and catering service locations were the most common settings of reported outbreaks. In 2020, the highest number of outbreaks occurred in households (4,140), followed by catering service locations (2,719), and school campuses (27). Most illnesses (59.9%) were reported in catering service locations, followed by households (37.6%), and 0.5% in campuses. Within catering service locations, street stalls accounted for the largest proportion (26.2%) of outbreaks, and school canteens accounted for the largest proportion (13.6%) of illnesses. However, households had the most deaths, accounting for 89.5% of all deaths (Table 1); poisonous mushrooms (79 deaths), aconite (10 deaths), bongkreik acid (11 deaths), and methanol (8 deaths) were the most common causes of deaths, accounting for 84.4%

of total deaths in private home settings.

In 2020, there were 4,662 outbreaks with confirmed etiology. Poisonous mushrooms were the most common cause of outbreaks and deaths, accounting for 58.0% of outbreaks and 57.6% of deaths; bacterial pathogens were the most common cause of illnesses (41.7%); in poisonous animals and plants and their toxins, undercooked *Phaseolus* was the most common cause leading to the largest proportion of outbreaks (31.2%) and illnesses (33.3%); aconite had the most deaths, accounting for 57.1%. Within microbial pathogens, *Salmonella* (286 outbreaks and 3,446 illnesses) was the most common bacterial pathogen associated with outbreaks and illnesses, followed by *Vibrio parahaemolyticus* (128 outbreaks and 1,848 illnesses), and *Staphylococcus aureus* (75 outbreaks and 954 illnesses). Bongkreik acid accounted for the largest proportions (75.0%) of deaths and the largest fatality rate (52.2%). Among the chemical agents, nitrite was the most common pathogenic factor associated with outbreaks (49.1%) and illnesses (49.6%), followed by pesticide (32.5% outbreaks and 27.7% illnesses); methanol had the highest death and fatality rates at 63.6% and 25.0%, respectively, followed by nitrite at 22.7% and 1.1%, respectively (Table 2).

In 2020, outbreaks that occurred at households (7,073) had surpassed those of catering service units (5,652), and outbreaks (485) and outbreak-associated illnesses (6,661) caused by *Salmonella* surpassed those

TABLE 1. Number and proportion of foodborne disease outbreaks, illnesses, and deaths by setting in China, 2020.

Setting	Outbreaks		Illnesses		Deaths		Fatality rate* (%)
	Number	Proportion (%)	Number	Proportion (%)	Number	Proportion (%)	
Household	4,140	58.5	14,066	37.6	128	89.5	0.9
Catering Service Places	2,719	38.4	22,432	59.9	15	10.5	0.1
Street stall	712	10.1	2,659	7.1	3	2.1	0.1
Hotel restaurant	508	7.2	4,184	11.2	5	3.5	0.1
Staff canteen	371	5.3	3,607	9.6	1	0.7	0.0
School canteen	310	4.4	5,081	13.6	0	0.0	0.0
Bistro	291	4.1	1,473	3.9	3	2.1	0.2
Fast food restaurant	240	3.4	1,171	3.1	0	0.0	0.0
Rural banquet	130	1.8	2,165	5.8	3	2.1	0.1
Home delivery of meal	110	1.6	1,807	4.8	0	0.0	0.0
Other	47	0.7	285	0.8	0	0.0	0.0
Campus	27	0.4	196	0.5	0	0.0	0.0
Other location	187	2.6	760	2.0	0	0.0	0.0
Total	7,073	100.0	37,454	100.0	143	100.0	0.4

* Fatality rate=number of deaths / number of illnesses.

TABLE 2. Number and proportion of foodborne disease outbreaks, illnesses, and deaths by etiology in China, 2020.

Etiology	Outbreaks		Illnesses		Deaths		Fatality rate* (%)
	Number	Proportion (%)	Number	Proportion(%)	Number	Proportion(%)	
Poisonous mushrooms	2,705	38.2	9,111	24.3	80	55.9	0.9
Plant and animal toxicants	1,020	14.4	4,584	12.2	21	14.7	0.5
Undercooked Phaseolus [*]	318	4.5	1,526	4.1	0	0.0	0.0
<i>Coriaria sinica</i>	111	1.6	354	1.0	0	0.0	0.0
Potherb	93	1.3	355	1.0	1	0.7	0.3
Aconite	84	1.2	337	1.0	12	8.4	3.6
Bitter bottle gourd	48	0.7	381	1.0	0	0.0	0.0
Tungoil or seed	46	0.7	238	0.6	0	0.0	0.0
Hyoscyamine	33	0.5	183	0.5	1	0.7	0.6
Herb-medicine	27	0.4	110	0.3	0	0.0	0.0
Elephant's-ear	24	0.3	86	0.2	0	0.0	0.0
Sproutedpotato/solanine	17	0.2	97	0.3	2	1.4	2.1
Colchicin	12	0.2	78	0.2	0	0.0	0.0
Gelsemine	11	0.2	64	0.2	3	2.1	4.7
Castor bean	10	0.1	58	0.2	0	0.0	0.0
Pokeberry root	10	0.1	42	0.1	1	0.7	2.4
Sago seed	10	0.1	36	0.1	0	0.0	0.0
Barbados nut	9	0.1	41	0.1	0	0.0	0.0
Undercooked soymilk/Trypsin inhibitor [†]	3	0.0	18	0.1	0	0.0	0.0
Other plants toxicants [§]	83	1.2	285	0.8	0	0.0	0.0
Fish roe	19	0.3	51	0.1	0	0.0	0.0
Tetrodotoxin	15	0.2	53	0.1	1	0.7	1.9
Pupae	13	0.2	60	0.2	0	0.0	0.0
langoustine	10	0.1	25	0.1	0	0.0	0.0
Other animal toxicants ^{**}	14	0.2	106	0.3	0	0.0	0.0
Bacterial	766	10.8	10,483	28.0	16	11.2	0.2
<i>Salmonella</i>	286	4.0	3,446	9.2	4	2.8	0.1
<i>Vibrio parahaemolyticus</i>	128	1.8	1,848	4.9	0	0.0	0.0
<i>Staphylococcus aureus</i>	75	1.1	954	2.6	0	0.0	0.0
<i>Escherichia coli</i>	54	0.8	1,520	4.1	0	0.0	0.0
<i>Bacillus cereus</i>	50	0.7	620	1.7	0	0.0	0.0
<i>Bacillus proteus</i>	10	0.1	149	0.4	0	0.0	0.0
<i>Clostridium perfringens</i>	5	0.1	287	0.8	0	0.0	0.0
Bongkrek acid ^{††}	5	0.1	23	0.1	12	8.4	52.2
<i>Campylobacter jejuni</i>	3	0.0	133	0.4	0	0.0	0.0
<i>Clostridium botulinum</i>	3	0.0	10	0.0	0	0.0	0.0
<i>Listeria monocytogenes</i>	1	0.0	28	0.1	0	0.0	0.0
Others	108	1.5	807	2.2	0	0.0	0.0
2 or more pathogens	12	0.2	224	0.6	0	0.0	0.0
Norovirus	26	0.4	434	1.2	0	0.0	0.0
Chemical agents	163	2.3	922	2.5	22	15.4	2.4
Nitrite	80	1.1	457	1.2	5	3.5	1.1

TABLE 2. (Continued)

Etiology	Outbreaks		Illnesses		Deaths		Fatality rate* (%)
	Number	Proportion (%)	Number	Proportion(%)	Number	Proportion(%)	
Pesticide ^{§§}	53	0.8	255	0.7	2	1.4	0.8
Prohibited drugs	10	0.1	115	0.3	1	0.7	0.9
Methanol	9	0.1	56	0.2	14	9.8	25.0
Other chemical pollutants ^{***}	11	0.2	39	0.1	0	0.0	0.0
Fungi	7	0.1	27	0.1	0	0.0	0.0
Parasitic	1	0.0	4	0.0	0	0.0	0.0
Unknown etiology	2,411	34.1	12,323	32.9	4	2.8	0.0
Total	7,073	100.0	37,454	100.0	143	100.0	0.4

* Refers to uncooked *Phaseolus* beans.

† Contained in uncooked soy milk.

§ Including wild flowers, hellebore, wild ginseng, pollen, daffodils, and wild fruits, etc. Including bee pupae and silkworm pupae.

** Including dog liver, insects, fish gall, toads and ants, etc.

†† Including *Shigella*, *Aeromonas*, *Enterobacter cloacae*, *Citrobacter flaudus*, *Schneider*, and *Enterococcus*, etc.

§§ Including Carbamates, organophosphates, pyrethroids, paraquat, bromfamethamine and bromadiolone, etc. Including clenbuterol hydrochloride, xylazine, and tetramine.

*** Including lead, engine oil, desiccant, chlorine dioxide, and detergent, etc.

of *Vibrio parahaemolyticus*. Foodborne disease illnesses occurred in school canteens (5,081).

The top 10 pathogen-food category pairs resulting in outbreaks, outbreak-associated illnesses, and deaths were analyzed. *Salmonella* in eggs had the highest occurrence, accounting for 32.8% (75/229) of outbreaks, followed by *Salmonella* in sauce-marinated meat (Table 3). *Salmonella* in sauce-marinated meat had the highest proportion (21.7%) of illnesses and 23.2% of hospitalizations, followed by *Salmonella* in eggs.

CONCLUSION AND COMMENT

Influenced by the coronavirus disease 2019

(COVID-19) pandemic, epidemiological characteristics of foodborne diseases in China had changed greatly in 2020.

For the first time in the past 5 years, outbreaks that occurred in private homes had surpassed that of catering service units in 2020 (5). The local residents in mountainous areas of southwest and central China tended to pick mushrooms and poisonous plants frequently in the wild (6). Continued and targeted health education programs should caution against picking wild mushrooms and toxic wild fruits. Eating habits with regional characteristics should be further emphasized and intervention measures should be taken to reduce the occurrence of poisonings.

The study showed that poisonous mushrooms caused the most deaths, the same as previous studies

TABLE 3. Top 10 number and proportion of most common confirmed pathogen-food category pairs resulting in outbreak in China, 2020.

Etiology	Food category	No. outbreaks	Proportion (%)
<i>Salmonella</i>	Egg	75	32.8
<i>Salmonella</i>	Sauce-marinated meat	44	19.2
<i>Salmonella</i>	Pastry	28	12.2
<i>Bacillus cereus</i>	Rice flour	22	9.6
<i>Vibrio parahaemolyticus</i>	Sauce-marinated meat	17	7.4
<i>Salmonella</i>	Livestock meat	13	5.7
<i>Vibrio parahaemolyticus</i>	Crustaceans	11	4.8
<i>Escherichia coli</i>	Sauce-marinated meat	10	4.4
<i>Staphylococcal aureus enterotoxins</i>	Pastry	9	3.9
<i>Salmonella</i>	Poultry	6	100.0
Total		229	32.8

(5). They were mainly caused by wild mushrooms collected by households (97.5%). This was consistent with the research results of Ren et al. (6). Residents picking and eating mushrooms could not distinguish between poisonous mushrooms from non-toxic mushrooms, and the rate of timely treatment after poisoning was low and increased the risk of death. Health education targeted for specific groups in rural areas is also essential to reduce mushroom poisonings.

Outbreaks and illnesses caused by *Salmonella* surpassed that of *Vibrio parahaemolyticus*, becoming the first pathogenic bacteria of bacterial foodborne diseases. This analysis on pathogen and food pairs in China showed that *Salmonella* outbreaks were most often linked to eggs, sauce-marinated meat products. Data showed that *Salmonella* was responsible for the largest number of outbreaks, hospitalizations, and deaths among meats and eggs; this was consistent with the result from the EU: *Salmonella* accounted for 36.8% of deaths in “eggs and egg products” (7). For *Salmonella* outbreaks, most outbreak-associated cases in the US were associated with seeded vegetables, eggs, poultry, beef, and pork, which differed from China (8). Pathogenic microbial contamination was still the main pathogenic factor of foodborne diseases in China and an important food safety issue that should not be ignored. Hygiene guidance and education should be done to reduce the burden of foodborne diseases caused by microbial factors.

Therefore, continued surveillance for foodborne disease outbreaks is important to understand changes in the foods, settings, and pathogens associated with illness (9). In order to reduce public health risks, more measures were adopted to enhance awareness of reporting, improve trace-back technology to achieve early detection, early warning, and early control of food safety risks.

This study was subject to at least two limitations. First of all, for many reported outbreaks, information on certain aspects of the outbreaks was missing or incomplete, so the conclusions might not be representative of unknown aetiologies or food categories. Second, reported foodborne disease outbreaks can't represent all actual occurred outbreaks, since underreporting existed for various reasons, such as administrative intervention, insufficient ability of outbreak investigation, etc.

Not all the National Foodborne Disease Outbreaks Surveillance System recorded with the epidemiological information in 2020. Like most countries, there are also cases of under-report, and incomplete information.

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