

Surveillance for Foodborne Disease Outbreaks — United States, 1998–2008



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Surveillance for Foodborne Disease Outbreaks — United States, 1998–2008

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Abstract

Problem/Condition: Foodborne diseases cause an estimated 48 million illnesses each year in the United States, including 9.4 million caused by known pathogens. Foodborne disease outbreak surveillance provides valuable insights into the agents and foods that cause illness and the settings in which transmission occurs. CDC maintains a surveillance program for collection and periodic reporting of data on the occurrence and causes of foodborne disease outbreaks in the United States. This surveillance system is the primary source of national data describing the numbers of illnesses, hospitalizations, and deaths; etiologic agents; implicated foods; contributing factors; and settings of food preparation and consumption associated with recognized foodborne disease outbreaks in the United States.

Reporting Period: 1998–2008.

Description of the System: The Foodborne Disease Outbreak Surveillance System collects data on foodborne disease outbreaks, defined as the occurrence of two or more cases of a similar illness resulting from the ingestion of a common food. Public health agencies in all 50 states, the District of Columbia, U.S. territories, and Freely Associated States have primary responsibility for identifying and investigating outbreaks and use a standard form to report outbreaks voluntarily to CDC. During 1998–2008, reporting was made through the electronic Foodborne Outbreak Reporting System (eFORS).

Results: During 1998–2008, CDC received reports of 13,405 foodborne disease outbreaks, which resulted in 273,120 reported cases of illness, 9,109 hospitalizations, and 200 deaths. Of the 7,998 outbreaks with a known etiology, 3,633 (45%) were caused by viruses, 3,613 (45%) were caused by bacteria, 685 (5%) were caused by chemical and toxic agents, and 67 (1%) were caused by parasites. Among the 7,724 (58%) outbreaks with an implicated food or contaminated ingredient reported, 3,264 (42%) could be assigned to one of 17 predefined commodity categories: fish, crustaceans, mollusks, dairy, eggs, beef, game, pork, poultry, grains/beans, oils/sugars, fruits/nuts, fungi, leafy vegetables, root vegetables, sprouts, and vegetables from a vine or stalk. The commodities implicated most commonly were poultry (18.9%; 95% confidence interval [CI] = 17.4–20.3) and fish (18.6%; CI = 17.2–20), followed by beef (11.9%; CI = 10.8–13.1). The pathogen-commodity pairs most commonly responsible for outbreaks were scombroid toxin/histamine and fish (317 outbreaks), ciguatoxin and fish (172 outbreaks), *Salmonella* and poultry (145 outbreaks), and norovirus and leafy vegetables (141 outbreaks). The pathogen-commodity pairs most commonly responsible for outbreak-related illnesses were norovirus and leafy vegetables (4,011 illnesses), *Clostridium perfringens* and poultry (3,452 illnesses), *Salmonella* and vine-stalk vegetables (3,216 illnesses), and *Clostridium perfringens* and beef (2,963 illnesses). Compared with the first 2 years of the study (1998–1999), the percentage of outbreaks associated with leafy vegetables and dairy increased substantially during 2006–2008, while the percentage of outbreaks associated with eggs decreased.

Interpretation: Outbreak reporting rates and implicated foods varied by state and year, respectively; analysis of surveillance data for this 11-year period provides important information regarding changes in sources of illness over time. A substantial percentage of foodborne disease outbreaks were associated with poultry, fish, and beef, whereas many outbreak-related illnesses were associated with poultry, leafy vegetables, beef, and fruits/nuts. The percentage of outbreaks associated with leafy vegetables and dairy increased during the surveillance period, while the percentage associated with eggs decreased.

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Public Health Actions: Outbreak surveillance data highlight the etiologic agents, foods, and settings involved most often in foodborne disease outbreaks and can help to identify food

commodities and preparation settings in which interventions might be most effective. Analysis of data collected over several years of surveillance provides a means to assess changes in the food commodities associated most frequently with outbreaks that might occur following improvements in food safety or changes in consumption patterns or food preparation practices. Prevention of foodborne disease depends on targeted interventions at appropriate points from food production to food preparation. Efforts to reduce foodborne illness should focus on the pathogens and food commodities causing the most outbreaks and outbreak-associated illnesses, including beef, poultry, fish, and produce.

Introduction

Surveillance for Foodborne Disease Outbreaks

Foodborne diseases cause an estimated 48 million illnesses each year in the United States, including 9.4 million caused by known pathogens (1,2). Only a minority of foodborne illnesses, hospitalizations, and deaths occur as part of recognized outbreaks (3). The contaminated food that caused an individual illness rarely is determined. Therefore, foodborne disease outbreak surveillance provides valuable insights into the agents that cause foodborne illness, types of implicated foods and ingredients, and settings in which transmission occurs.

CDC conducts surveillance for foodborne disease outbreaks in the United States through the Foodborne Disease Outbreak Surveillance System. State, local, and territorial public health departments have primary responsibility for identifying and investigating foodborne disease outbreaks caused by enteric bacterial, viral, parasitic, and chemical/toxic agents. At the current system's inception in 1973, paper reports were sent to CDC; in 1998, a revised reporting form was implemented, and the system became web-based. The revised form expanded the range of food information, settings, and contributing factors that could be reported. By 2001, all state, local, and territorial health departments were submitting reports through the web-based version of this form, the electronic Foodborne Outbreak Reporting System (eFORS). Data were collected through eFORS until 2008, when the system transitioned to an enhanced form and reporting platform, the National Outbreak Reporting System (NORS). NORS also collects information on enteric disease outbreaks with modes of transmission other than food, including: person-to-person contact, animal contact, water, and environmental contamination. Information about NORS is available at <http://www.cdc.gov/nors>. Foodborne disease outbreaks have been a nationally notifiable condition since 2010.

Foodborne disease outbreak surveillance serves multiple purposes:

- **Identification of foods.** Foodborne disease outbreak investigations have identified common and rare foods associated with foodborne disease outbreaks. Data from outbreaks can help researchers identify changes over time in commonly reported food vehicles, providing insight

into the effectiveness of regulations and control measures. These data also help to identify specific pathogen-food pairs repeatedly linked to outbreaks and illnesses.

- **Identification of etiologic agents.** Outbreak investigations are a key means of identifying new and emerging pathogens and tracking ongoing problems. Prompt and thorough investigations of outbreaks aid in the timely identification of etiologic agents and can lead to appropriate prevention and control measures. Summaries of the results of these investigations provide information on the relative public health importance and impact of specific pathogens.
- **Identification of settings.** Data from outbreaks provide information regarding the food preparation and consumption settings where outbreaks occur. These data help to identify food preparation and handling practices that can be targeted by interventions to reduce foodborne diseases.
- **Identification of points of contamination.** The investigation of outbreaks informs prevention and control measures in the food industry by identifying points of contamination where action can be taken to reduce contamination by pathogens. Improvements at multiple points of food production (e.g., farm, slaughterhouse, and production plant) can contribute to reducing contamination in the food supply.
- **Describing trends in foodborne disease outbreaks.** Summarizing the findings of these investigations illustrates how outbreaks have changed over time and provides information about the efforts needed to prevent them. Data from outbreaks are used to measure progress toward food safety goals to reduce the incidence of illness caused by selected pathogens.

Summaries of data reported to the Foodborne Disease Outbreak Surveillance System have been published previously for 1983–1987 (4), 1988–1992 (5), 1993–1997 (6), 1998–2002 (7), 2006 (8), 2007 (9), and 2008 (10). This report summarizes epidemiologic data on foodborne disease outbreaks reported to CDC during 1998–2008, the eFORS reporting period, including assessments of changes in reporting over time and trends in source attribution. These findings are intended to be used by health departments and regulatory agencies to identify foods and settings for intervention likely to yield the greatest public health benefit.

Methods

Definitions and Sources of Data

A foodborne disease outbreak is defined as the occurrence of two or more cases of a similar illness resulting from the ingestion of a common food. This report includes outbreaks in which the first illness occurred during 1998–2008 that were reported by April 24, 2011. State, local, territorial, and tribal health departments use a standard form (CDC form 52.13, Investigation of a Foodborne Outbreak available at http://www.cdc.gov/nors/pdf/NORS_CDC_5213.pdf) to report foodborne disease outbreaks to CDC. Data requested for each outbreak include reporting state; date of first illness onset; the number of illnesses, hospitalizations, and deaths; the etiology; the implicated food vehicle; the setting of food preparation and consumption; and contributing factors. Multistate outbreaks (i.e., those in which exposure to the implicated food occurred in more than one state) typically are reported to the system by CDC.

Several types of outbreaks are excluded from the Foodborne Disease Outbreak Surveillance System, including those that occur on cruise ships and those in which the food was eaten outside the United States, even if the illness occurred in the United States. Outbreaks with other modes of transmission (e.g., water, person-to-person contact, and animal contact) also are not captured by this system; since 2009, these outbreaks have been reportable through NORS.

Laboratory and clinical guidelines for confirming an etiology are specific to each bacterial, chemical/toxin, parasitic, and viral agent (http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html). Suspected etiologies are those that do not meet the confirmation guidelines. The cause of the outbreak is categorized as multiple etiologies if more than one etiologic agent is reported.

Analysis

Descriptive

The number of outbreaks, illnesses, hospitalizations, and deaths for each year, state, and setting was calculated. For outbreaks caused by a single confirmed or suspected etiology, etiologies were grouped as bacterial, chemical/toxin, parasitic, or viral. Population-based rates of reported outbreaks over the 11-year surveillance period were calculated for each state using U.S. Census estimates for the midpoint of the surveillance period (2003) (11). Changes in the percentage of outbreaks caused by each etiology group were calculated using a Chi-square test.

Reporting Rates

So that changes in outbreak reporting nationwide during 1998–2008 could be assessed, the median number of outbreaks reported by each state annually and interquartile ranges were calculated (12). Changes in the detection, investigation, and reporting of foodborne outbreaks within each state during the surveillance period were evaluated using the annual percentage change in each state's outbreak reporting rate, calculated as follows:

$$\frac{AORR_{prev\ yr} - AORR_{curr\ yr}}{AORR_{prev\ yr}}$$

in which AORR is the annual outbreak reporting rate (i.e., number of outbreaks reported per 1 million population, as estimated using the U.S. Census estimates for the midpoint of the surveillance period (2003) in the previous year (*prev yr*) and the current year (*curr yr*) of analysis, respectively. For each state, the median annual percentage change during the first half of the surveillance period (1998–2003) was compared with the median annual percentage change for the second half (2004–2008). The median annual percentage change was used as a measure of change over time to limit the impact of surveillance artifacts that influence reporting on estimates of change. Multistate outbreaks and states that reported no outbreaks during 2 or more years during the surveillance period were excluded from analysis.

Foods

Reported implicated food vehicles were included in the analysis regardless of the criteria by which they were identified (i.e., statistical evidence, laboratory evidence, compelling supportive information, and other data or experience made food a likely source). If the implicated food contained a single contaminated ingredient, or if all ingredients in the food belonged to a single commodity, the outbreak was assigned to one of 17 commodity groups: fish, crustaceans, mollusks, dairy, eggs, beef, game, pork, poultry, grains/beans, oils/sugars, fruits/nuts, fungi, leafy vegetables, root vegetables, sprouts, and vegetables from a vine or stalk (13). Outbreaks associated with implicated foods that could not be assigned to one of these commodities (e.g., the food contained ingredients from more than one commodity) (14), or for which the report contained insufficient information for commodity assignment, were not attributed to any commodity.

The percentage of outbreaks attributable to each food commodity is dependent upon several factors and is highly variable from year to year and across different states. In addition, the single commodity percentage estimates are mutually dependent, so direct estimation of 95% confidence intervals

(CIs) from the reported data are not feasible. Consequently, random samples of the original dataset were drawn repeatedly (i.e., bootstrap resampling) and used to create a distribution of values representative of the original dataset from which CIs associated with the percentage of outbreaks associated with each commodity during the study period were estimated (15). This analysis required the assumption that outbreaks reported during the study period represented a random sample of all foodborne outbreaks occurring in the United States. Bootstrap resampling of outbreaks with one or more implicated foods reported and caused by a single suspected or confirmed etiology was performed to estimate the mean percentage of outbreaks in the resampled distribution associated with each pathogen-commodity pair* and CIs. Changes in the percentage of outbreaks attributed to specific commodities over time were estimated by grouping outbreaks into four 2–3-year time periods (1998–1999, 2000–2002, 2003–2005 and 2006–2008) and by performing bootstrap resampling of outbreaks for each time period. For each etiology, a set of 1,000 replications obtained from the original data was used to generate a bootstrap distribution of the mean percentage of outbreaks associated with each food commodity. Outbreaks with implicated food vehicles that could not be assigned to a single commodity were excluded from the replicates after bootstrap resampling. CIs were determined by using the two values that encompassed the central 95% of the bootstrap distribution (the percentile method). Sensitivity analysis was performed to evaluate the impacts on estimated attribution percentages associated with state reporting variability.

The mean percentage of outbreaks in the resampled distribution attributable to each commodity and CIs were determined for norovirus, Shiga toxin–producing *Escherichia coli* (STEC), *Clostridium perfringens*, all *Salmonella* serotypes combined, *Salmonella* serotype Enteritidis, and *Salmonella* serotype Typhimurium. The percentage of outbreaks caused by other etiologies attributed to individual food commodities could not be estimated reliably because of the relatively low number of reported outbreaks caused by these etiologies during the surveillance period.

Results

Foodborne Disease Outbreaks

During 1998–2008, CDC received reports of 13,405 foodborne disease outbreaks, resulting in 273,120 illnesses, 9,109 hospitalizations, and 200 deaths (Table 1). An average of 1,219 (range: 968–1,403) outbreaks, 24,829 (range: 19,951–28,895)

illnesses, 828 (range: 593–1,261) hospitalizations, and 20 (range: 9–48) deaths was reported each year. Overall, the reported annual national rate of foodborne disease outbreaks was 4.2 outbreaks per 1 million population, ranging from a low of 3.3 in 2005 to a high of 4.8 in 2000 (Figure 1). The average annual rate of outbreak-related illnesses was 85.7 per 1 million population, the average annual rate of hospitalizations was 2.8 per 1 million population, and the average annual rate of deaths was 0.1 per 1 million population.

Outbreaks were reported by public health officials from 50 states, the District of Columbia (DC), Guam, Puerto Rico, and the Republic of Palau; 128 multistate outbreaks were reported. The total number of outbreaks reported by each state during 1998–2008 varied (range: 22–2,055; annual median: 116) (Figure 2). The median of the average annual state reporting rate was 3.1 outbreaks (range: 0.68–22.34) per 1 million population.

Etiologic Agents

A single confirmed or suspected etiologic agent was reported for 7,998 (60%) outbreaks; these outbreaks accounted for 204,048 (75%) illnesses (Table 1). Among the 7,998 outbreaks with a reported etiology, the etiology was confirmed in 5,059 (63%) outbreaks. Of the 7,998 outbreaks with a single confirmed or suspected etiology, 3,633 (45%) were caused by viruses, 3,613 (45%) by bacteria, 685 (9%) by chemical and toxic agents, and 67 (1%) by parasites.

Eight pathogens caused 89% of the 5,059 confirmed, single-etiology outbreaks, including norovirus (39%), *Salmonella* (26%), Shiga toxin–producing *E. coli* (STEC) (6%), scombroid toxin/histamine (5%), *Clostridium perfringens* (5%), *Staphylococcus enterotoxin* (3%), ciguatoxin (3%), and *Campylobacter jejuni* (2%). Overall, norovirus was the most common cause of outbreaks and illnesses, causing 3,444 (43%) of the 7,998 outbreaks with a confirmed or suspected single etiology, resulting in 100,652 (37%) illnesses, 1,028 (11%) hospitalizations, and five (3%) deaths (Table 1).

Salmonella was the second most common etiology, causing 1,449 (18%) of the 7,998 outbreaks with a confirmed or suspected single etiology and 39,126 (19%) illnesses (Table 1). Among the 1,291 outbreaks caused by *Salmonella* with a confirmed serotype, Enteritidis was the most common, causing 418 (32%) outbreaks, followed by Typhimurium (170 outbreaks [13%]), Heidelberg (102 outbreaks [8%]), and Newport (93 outbreaks [7%]). Outbreaks caused by *Salmonella* resulted in the largest number of reported hospitalizations (4,034 of 9,109 hospitalizations [44%]), followed by STEC (1,271 [14%] hospitalizations), and norovirus (1,028 [11%] hospitalizations). *Salmonella* also caused the most deaths (60 [30%] deaths), followed by *Listeria* (48 [24%] deaths), and

*The term “pathogen-commodity pair” as used in this report includes reported etiologic agents that are not pathogens, including chemicals and toxins (e.g., pesticides or ciguatoxin).

STEC (22 [11%] deaths). The percentage of illnesses leading to hospitalization was highest for outbreaks caused by *Listeria* (61%) (Table 1).

The percentage of outbreaks for which an etiology was confirmed or suspected increased significantly from 40% in 1998 to 67% in 2002 ($p < 0.0001$), after which it remained level (Figure 3). Among outbreaks with a confirmed or suspected etiology, the percentage caused by a viral etiology increased markedly (Figure 4) because the percentage of outbreaks with a confirmed or suspected etiology that were reported as norovirus infections increased from 28% during 1998–2000 to 50% during 2006–2008 ($p < 0.001$). Although the percentage of outbreaks with a confirmed single etiology that were caused by *Salmonella* remained relatively constant over time (22% during 1998–2000 and 19% during 2006–2008), the percentage of outbreaks caused by *Salmonella* serotype Enteritidis decreased from 44% during 1998–2000 to 24% during 2006–2008 (Figure 5).

Multistate Foodborne Disease Outbreaks

The annual number of multistate outbreaks reported increased from nine in 1998 to 17 in 2008 (Figure 6). Of the 128 multistate outbreaks reported, 68 (53%) were caused by *Salmonella*, and 37 (29%) were caused by STEC O157. Other etiologies reported in multistate outbreaks were *Listeria monocytogenes* (seven outbreaks), *Shigella sonnei* (three outbreaks), norovirus (three outbreaks), *Vibrio parahaemolyticus* (two outbreaks), hepatitis A virus (two outbreaks), *Clostridium botulinum* (two outbreaks), *Campylobacter jejuni* (two outbreaks), paralytic shellfish poisoning toxin (one outbreak), and an unknown chemical agent (one outbreak). The most common *Salmonella* serotypes reported in multistate outbreaks were Newport (10 outbreaks [15%]), Typhimurium (eight outbreaks [12%]), Enteritidis (seven outbreaks [10%]), Saintpaul (five outbreaks [7%]), and Poona (four outbreaks [6%]).

Settings

Of the 13,405 outbreaks, a single place of food preparation was reported for 11,627 (86%) (Table 2). Of these, 7,939 (68%) were associated with food prepared in a restaurant or deli, 1,058 (9%) with food prepared in a private home, 794 (7%) with food prepared by a catering or banquet facility, and the remainder with food prepared in another place (Table 2). Among the 2,930 norovirus outbreaks with a reported single place of food preparation, the most common places were a restaurant or deli (1,885 [63%]) and a catering or banquet facility (318 [11%]). Among the 1,147 outbreaks of *Salmonella* infection with a single place of food preparation, the most common places were a restaurant or deli (623 [54%] outbreaks) and a private home (232 [20%] outbreaks). Among the 231 outbreaks of STEC

infection with a single place of food preparation, the most common places were a restaurant or deli (86 [37%] outbreaks) and a private home (57 [25%] outbreaks). A private home was the most common place of food preparation for only one etiology, ciguatoxin (135 [81%] outbreaks).

The average outbreak size varied by place of food preparation. The largest outbreaks occurred in institutional settings, including prisons or jails (median: 45 illnesses), schools (median: 38 illnesses), and camps (median: 25 illnesses) (Table 4). Outbreaks in which the food was prepared in restaurants were among the smallest reported (median: five illnesses). Outbreaks in which the food was prepared in a private home had a median of eight illnesses.

Reporting Rates

During 1998–2008, the number of outbreaks reported declined 23%; the number of outbreaks reported did not exceed the median of the 11-year period (1,267 outbreaks) in any year after 2004. Florida contributed the most to the observed decrease in reporting, from 21% of outbreaks reported nationally in 1998 to 7% in 2008. Data from eight states and DC were excluded from further analyses evaluating reporting changes over time because they did not report any outbreaks for 2 or more years during the surveillance period (Table 5). Although the median number of outbreaks reported annually by each state varied from year to year (Figure 7), no patterns were observed over time. However, within-state comparisons of the median annual percentage change in reporting rates during the first (1998–2003) and the second (2004–2008) half of the surveillance period indicated that 16 states decreased annual reporting during 2004–2008 while 26 states either did not change or increased their reporting rate during 2004–2008 (Table 5). Of the 16 states that decreased reporting in the second half of the study period, two (California and Florida) together accounted for 28% of the total number of outbreaks reported nationally during the surveillance period.

Foods

A food vehicle was reported for 7,724 (58%) outbreaks. The percentage of outbreaks with an implicated food decreased from 63% in 1998 to 46% in 2008 (Figure 8). The food vehicle could be assigned to one of the 17 commodities in 3,264 (42%) outbreaks (Table 6). The commodities implicated most commonly in outbreaks were poultry (19%; CI = 17.4–20.3), fish (19%; CI = 17.2–20), and beef (12%; CI = 10.8–13.1) (Figure 9). Among the 67,752 illnesses in outbreaks assigned to one of the 17 commodities, the commodities associated with the most outbreak-related illnesses were poultry (17%), leafy vegetables (13%), beef (12%), and fruits/nuts (11%).

The pathogen-commodity pairs responsible for the most outbreaks were scombroid toxin/histamine and fish (317 outbreaks), ciguatoxin and fish (172 outbreaks) (Table 7), *Salmonella* and poultry (145 outbreaks) (Table 8), and norovirus and leafy vegetables (141 outbreaks) (Table 9). The pathogen-commodity pairs responsible for the most outbreak-related illnesses were norovirus and leafy vegetables (4,011 illnesses) (Table 9), *Clostridium perfringens* and poultry (3,452 illnesses) (Table 8), *Salmonella* and vine-stalk vegetables (3,216 illnesses) (Table 9), and *Clostridium perfringens* and beef (2,963 illnesses) (Table 8). The pathogen-commodity pairs responsible for the most hospitalizations were *Salmonella* and fruits/nuts (452 hospitalizations), *Salmonella* and vine-stalk vegetables (441 hospitalizations), STEC and beef (340 hospitalizations), and STEC and leafy vegetables (301 hospitalizations). The pathogen-commodity pairs responsible for the most deaths were *Listeria* and poultry (16 deaths), *Salmonella* and fruits/nuts (14 deaths), and STEC and leafy vegetables (seven deaths).

Estimated CIs for the percentage of outbreaks associated with each commodity were greatest for time periods, etiologies, and food commodities with fewer reported outbreaks. Consequently, few comparisons over time yielded significant results. Nonetheless, compared with the first 2 years of the study period (1998–1999), the percentage of outbreaks associated with leafy vegetables was significantly higher during the last 3 years (2006–2008), from 6% (CI = 4.4–8.1) during 1998–1999 to 11% (CI = 8.6–13.2) during 2006–2008. Similarly, the percentage of outbreaks associated with dairy increased from 3.6% (CI = 2.3–5.0) during 1998–1999 to 7% (CI = 5.4–9.3) during 2006–2008. The percentage of outbreaks associated with eggs decreased from 6% (CI = 3.9–7.3) during 1998–1999 to 2% (CI = 1.3–3.5) during 2006–2008 (Figure 10).

Among the outbreaks caused by norovirus, leafy vegetables (32%; CI = 27.8–36.6) were the most commonly implicated commodity (Figure 11), followed by fruits/nuts (17%; CI = 13.7–20.8) and mollusks (13%; CI = 9.5–15.7). Although the percentage of outbreaks caused by norovirus associated with these commodities varied across the time intervals, there were no significant differences over time in the estimated percentage of outbreaks attributed to these three commodities (Figure 12).

Outbreaks caused by *Salmonella* were associated most commonly with poultry (30%; CI = 25.7–34.2) and eggs (24%; CI = 20.5–28.3) (Figure 13). The percentage of outbreaks caused by *Salmonella* attributed to poultry varied over the four time intervals, ranging from 24% (CI = 15.5–32.7) to 33% (CI = 24.2–42.0) (Figure 14). The percentage of outbreaks caused by *Salmonella* attributed to eggs declined significantly from 33% (CI = 24.0–42.9) during 1998–1999

to 15% (CI = 8.0–22.0) during 2006–2008 (Figure 14). Although the percentage of outbreaks caused by *Salmonella* attributed to pork increased over the study period, this change was not significant.

Outbreaks caused by *Salmonella* serotype Enteritidis were attributed commonly to eggs (64%; CI = 56.4–71.7) and poultry (18%; CI = 12.1–24.9) (Figure 15). Poultry was also the commodity implicated most commonly in outbreaks caused by serotype Typhimurium (36%; CI = 21.9–49), but poultry was not implicated significantly more often than pork or dairy (Figure 16).

The largest percentage of foodborne disease outbreaks caused by STEC was attributed to beef (58%; CI = 50–66.7) (Figure 17). Leafy vegetables were the second most common food commodity associated with outbreaks caused by STEC (17%; CI = 10.9–23.2), but this percentage was not significantly greater than the percentages for dairy or for fruits/nuts, the next most common commodities. There were no significant changes in the observed percentage of outbreaks caused by STEC associated with any commodity during the surveillance period (Figure 18).

Beef was responsible for the highest percentage of outbreaks caused by *Clostridium perfringens* (41.3%; CI = 35.2–47.5), followed by poultry (30%; CI = 24.1–35.9), and pork (16.3%; CI = 11.7–21.1) (Figure 19). The percentage of outbreaks caused by *Clostridium perfringens* that was attributed to beef declined over time while poultry-associated outbreaks increased (Figure 20); however, these changes were not significant.

Discussion

Foodborne disease outbreaks remain an important public health burden in the United States. The average annual number of outbreaks reported to CDC during 1998–2008 was more than double the average annual number reported during 1973–1997. This increase reflects in part measures to enhance outbreak surveillance, including transitioning the system to electronic reporting and implementation of routine data cleaning and follow-up procedures with reporting states (4–6). The marked increase in the number of outbreaks reported in 1998 indicates that the increase was largely a surveillance artifact because of the transition to electronic reporting rather than a true increase in the number of foodborne disease outbreaks during 1997–1998 (7) (Figure 21).

Although the total number of foodborne disease outbreaks reported annually declined gradually within the period 1998–2008, there were no consistent national trends in outbreak reporting that contributed to this decline. For 26 of the 42 states evaluated, state outbreak reporting rates were fairly

stable or increased in the second half of the surveillance period (2004–2008). A decline in the number of reported outbreaks by one of the most populous states (Florida) accounted for much of the overall decrease in outbreaks reported in 2008 compared with 1998. A portion of the decline in the number of reported outbreaks over this period reflects efforts to improve data quality in certain states, including Florida, by reducing the number of reports that do not meet the definition of a foodborne outbreak. However, this decline might represent a true decrease in the number of foodborne disease outbreaks.

Changes in the number of foodborne disease outbreaks reported by a state also might be caused by changes in resources at state and local health departments. The median number of outbreaks reported by each state was highest nationally in 2004, the year that federal emergency preparedness funding to states peaked (16). In 2006, states reported that 71% of their funding for epidemiologic capacity came from federal sources, and more recent reports have documented declines in capacity as this funding has decreased (17–19).

Among outbreaks with a single confirmed or suspected etiology, the number caused by viruses increased dramatically, with viruses replacing bacterial pathogens as the most common etiology group reported in foodborne disease outbreaks. This increase was likely in large part caused by increased norovirus diagnostic capacity in state health department laboratories (20) and improved strategies to obtain specimens for diagnostic testing (21). The number of outbreaks with unknown etiology decreased proportionately as the number of viral etiology outbreaks increased. The number of foodborne disease outbreaks confirmed to be caused by norovirus during this period highlights the importance of expanded laboratory diagnostics to elucidate outbreak etiologies. The fact that norovirus was among the leading cause of outbreaks across a wide range of foods and settings indicates that reliance solely on routine culture for enteric bacteria is inadequate during foodborne disease outbreak investigations. Since 1997, when CDC began a technical support program to assist state public health laboratories in using reverse transcription-polymerase chain reaction technology, the number of states with such capacity has increased steadily (20). Although all 50 states and the District of Columbia now have capacity for norovirus diagnostics at their respective state public health laboratories, resource limitations and competing priorities continue to hamper consistent, widespread application of these assays.

Although no significant trend was apparent, there were marked increases in norovirus outbreaks during 2004 and 2006, concurrent with the emergence of new norovirus strains within genogroup II genotype 4, which have been associated with worldwide increases in norovirus outbreaks (22). CaliciNet, CDC's laboratory network for genotyping noroviruses

implicated in outbreaks, can help provide ongoing surveillance for the emergence of new norovirus strains and potentially identify links between outbreaks associated with common food vehicles. Information about CaliciNet is available at <http://www.cdc.gov/norovirus/php/reporting.html#surveillance>.

The number of multistate foodborne disease outbreaks reported nearly doubled from 1998 to 2008, following the advent of PulseNet (available at <http://www.cdc.gov/pulsenet>), the national network of public health and food regulatory agencies that perform standardized molecular subtyping for enteric bacteria (23). Although multistate outbreaks represented only 1%–2% of all outbreaks with a known etiology, these outbreaks contributed disproportionately more deaths and hospitalizations than other outbreaks. Coordinated multistate outbreak investigations are resource-intensive at local, state, and federal levels. As molecular subtyping methods become more advanced and available for more pathogens, it is likely that the number of multistate outbreaks detected will continue to increase (23,24). However the vast majority of recognized outbreaks are still local, requiring epidemiology, laboratory, and environmental health capacity at the local and state levels.

Poultry and fish were the commodities associated most commonly with outbreaks; however, the most common food commodities varied by etiology group. For example, poultry and beef were associated most commonly with outbreaks caused by bacteria, leafy vegetables were implicated most commonly in viral outbreaks, and fish was implicated most commonly in scombroid and ciguatoxin outbreaks.

Different attribution percentages are estimated when the number of illnesses is used as the unit of attribution rather than the number of outbreaks. Specifically, when illnesses are used as the unit of attribution, food commodities associated commonly with frequent, small outbreaks have lower attribution percentages, and large but relatively rare outbreaks can drive attribution estimates. For example, although fish is the second most common cause of outbreaks attributed to a single food commodity, fish ranks eighth as a cause of outbreak-associated illnesses because scombroid and ciguatoxin outbreaks associated with fish tend to be small. In contrast, leafy vegetables are implicated commonly in large outbreaks caused by norovirus and are the second most common cause of outbreak-associated illnesses but ranked fifth as a cause of foodborne outbreaks. Other food commodities (e.g., fruits/nuts, vine-stalk vegetables, and dairy) also contribute to a relatively larger percentage of illnesses than outbreaks. These differences are highlighted by the results of a recently published analysis that used information from the outbreaks reported during this surveillance period to estimate the number of domestically acquired foodborne illnesses associated with each commodity (14). Based on the percentage of outbreak-related illnesses associated with each commodity rather than the percentage of outbreaks,

the analysis attributed the majority of foodborne illnesses to leafy vegetables, dairy, fruits/nuts, and poultry.

This study examined changes in the percentages of outbreaks associated with specific food commodities over time. The increase in the number of outbreaks caused by norovirus during the surveillance period resulted in an increase over time in the percentage of outbreaks attributed to leafy vegetables. The significant decrease in the percentage of outbreaks attributed to eggs was largely the result of a decrease in the percentage of outbreaks caused by *Salmonella* attributed to eggs; the number of reported outbreaks caused by *Salmonella* serotype Enteritidis, a serotype strongly associated with eggs, decreased over the study period, and the number of outbreaks caused by *Salmonella* serotypes associated less strongly with eggs increased.

Significant changes in source attribution during the surveillance period were not detected among most food commodities. However, robust estimates of foodborne illness source attribution using outbreak data are limited by data quantity and quality. For example, approximately 40% of reports lacked information on implicated food vehicles. Moreover, only half of reported foods could be assigned to one of the 17 defined commodities used in this analysis, often because the implicated food contained ingredients from more than one commodity. This analysis did not use methods to assign foods containing more than one commodity as was done previously (14).

Limitations

The findings in this report are subject to at least three limitations. First, for many reports, information on certain aspects of the outbreak (e.g., the etiology or the implicated food vehicle) is missing or incomplete; conclusions drawn from outbreaks with a confirmed or suspected etiology or food vehicle might not apply to outbreaks of unknown etiology or food source. A lack of information about the specific contaminated ingredients in many of the reports also limited the ability to assign foods to one of the 17 commodities and thus to draw conclusions about the associations between specific food commodities and pathogens. Similarly, because outbreaks in some settings (e.g., restaurants and schools) are more likely to be recognized and investigated, data on the places where outbreaks occurred might not fully reflect the settings in which contaminated food is prepared and consumed. Second, only a small percentage of foodborne illnesses reported each year are identified as associated with outbreaks. For example, in FoodNet sites during 2008, only 7% of *Salmonella* illnesses and 26% of STEC O157 illnesses were part of a recognized outbreak (3). Outbreaks caused by certain pathogens or vehicles might be more likely to be recognized or investigated. In addition, some illnesses reported as sporadic likely are not recognized as being part of a reported outbreak or are part of undetected outbreaks.

All outbreak-related illnesses might not be identified during an investigation, smaller outbreaks might not come to the attention of public health authorities, and some might not be investigated or reported to CDC. Whether the distributions of food vehicles and preparation and consumption settings implicated in foodborne disease outbreaks reflect the same sources of infection and settings of sporadic illnesses is unknown. Consequently, the impact of the assumption that the reported outbreaks and implicated food commodities are a random sample of all outbreaks occurring in the population is uncertain. Thus, interpretation of statistical differences in outbreak reporting and the implicated food commodities contributing to outbreak illnesses over time should be made with caution. Finally, CDC's outbreak surveillance database is dynamic; agencies can submit new reports and can change or delete previous reports whenever new information becomes available. Therefore, the results of this analysis represent data available at a single point in time and might differ from those published earlier or later.

Conclusion

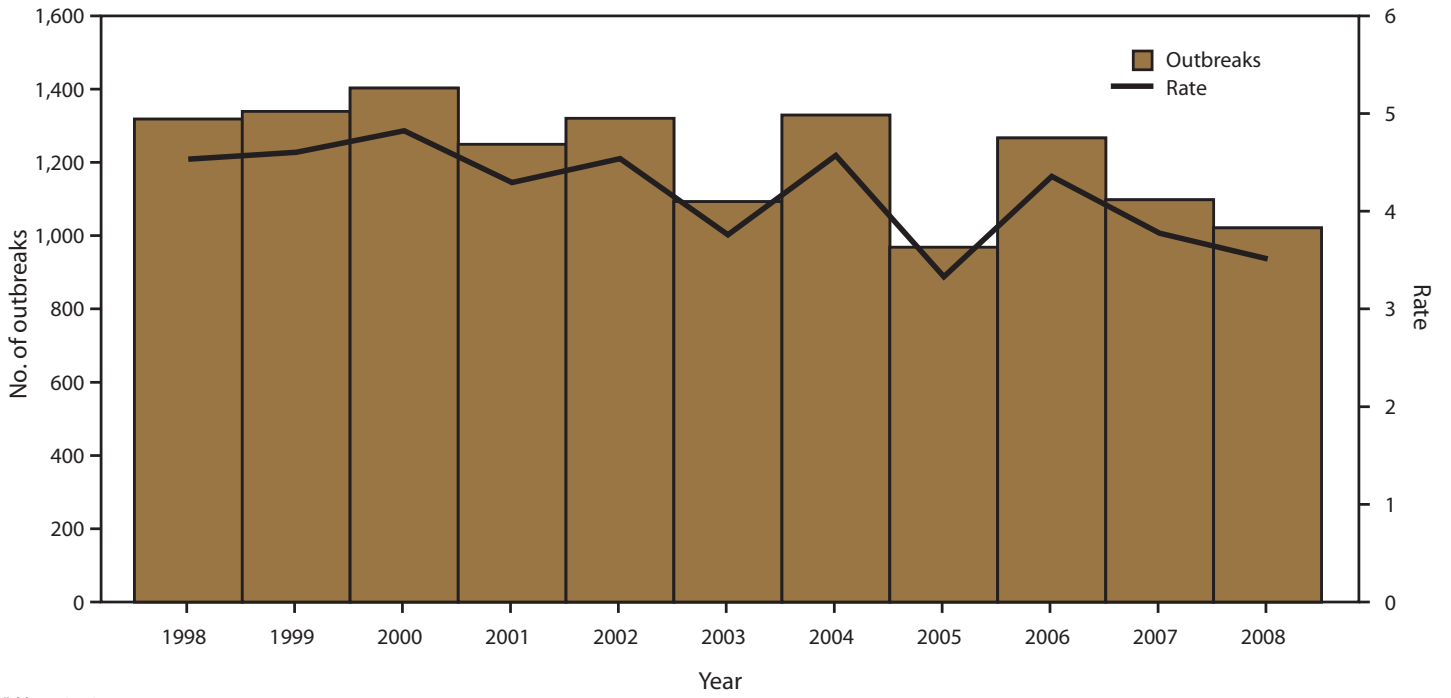
Analysis of foodborne disease outbreak investigations reported by state and local health departments provides information that enhances understanding of the epidemiology of foodborne disease in the United States. These findings underline the importance of targeted prevention measures for the specific foods that are associated with the most outbreaks and illnesses (i.e., beef, poultry, fish, and produce) and provide insights into changes in causes of outbreaks over time (i.e., outbreaks associated with leafy vegetables and dairy increased during the surveillance period, while those associated with eggs decreased). Most foodborne illnesses are preventable, and timely investigation and reporting of foodborne disease outbreaks provides information that might help to reduce foodborne illnesses. Public health agencies, regulatory agencies, and the food industry can use these data to help target efforts to prevent contamination of foods on the farm, in processing, and in restaurants and homes. Continued surveillance for foodborne disease outbreaks is important to understand changes in the foods, settings, and pathogens associated with illness (25). An annual listing of foodborne disease outbreaks reported to CDC is available at <http://wwwn.cdc.gov/foodborneoutbreaks>.

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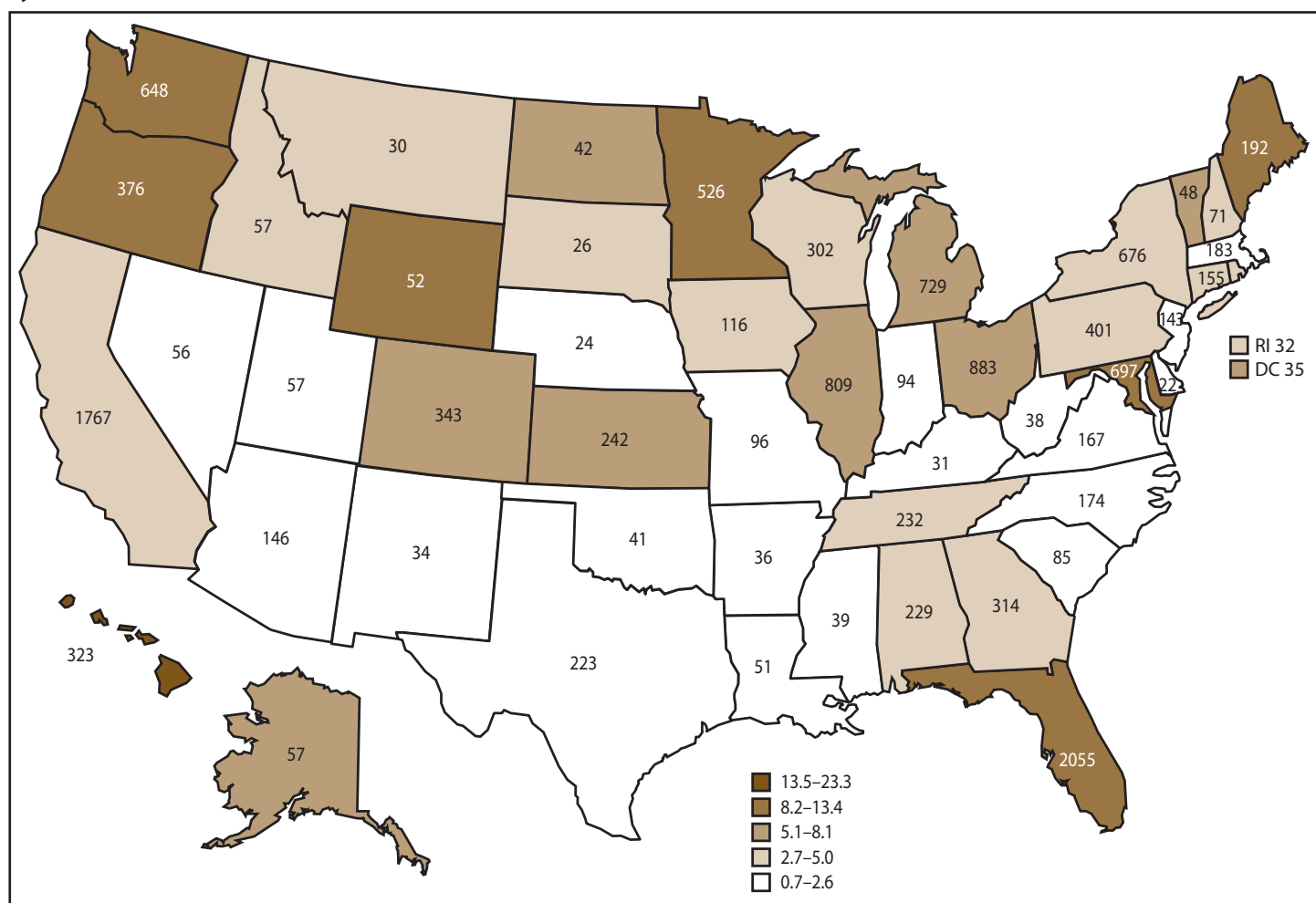
FIGURE 1. Number* and rate† of foodborne disease outbreaks, by year — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008



* N = 13,405.

† Per 1 million population.

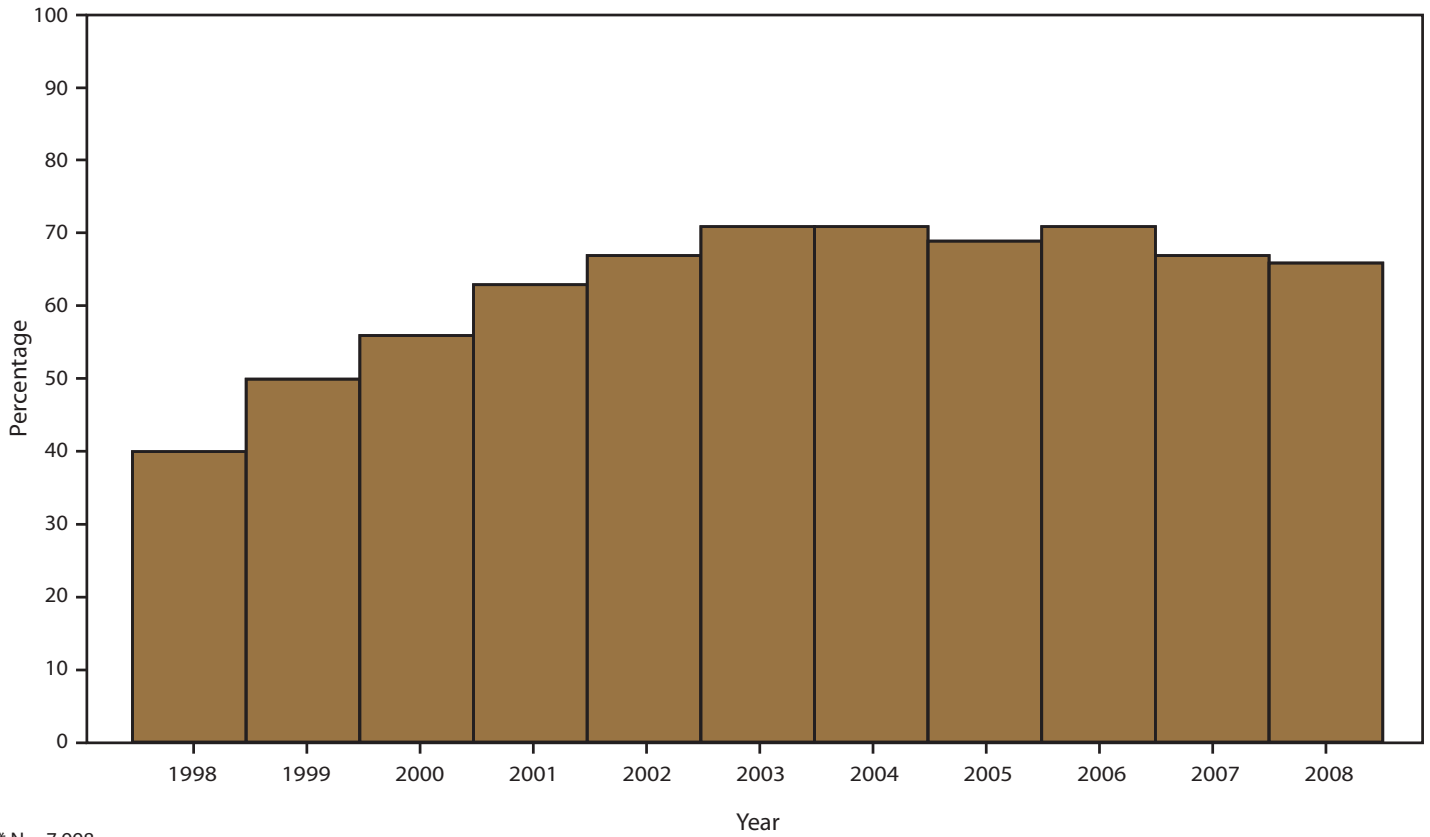
FIGURE 2. Average annual rate* of foodborne disease outbreaks and number of outbreaks per state† — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008



* Per 1 million population. Cutpoints for outbreak rate categories determined using Jenks Natural Breaks Optimization in ArcGIS.

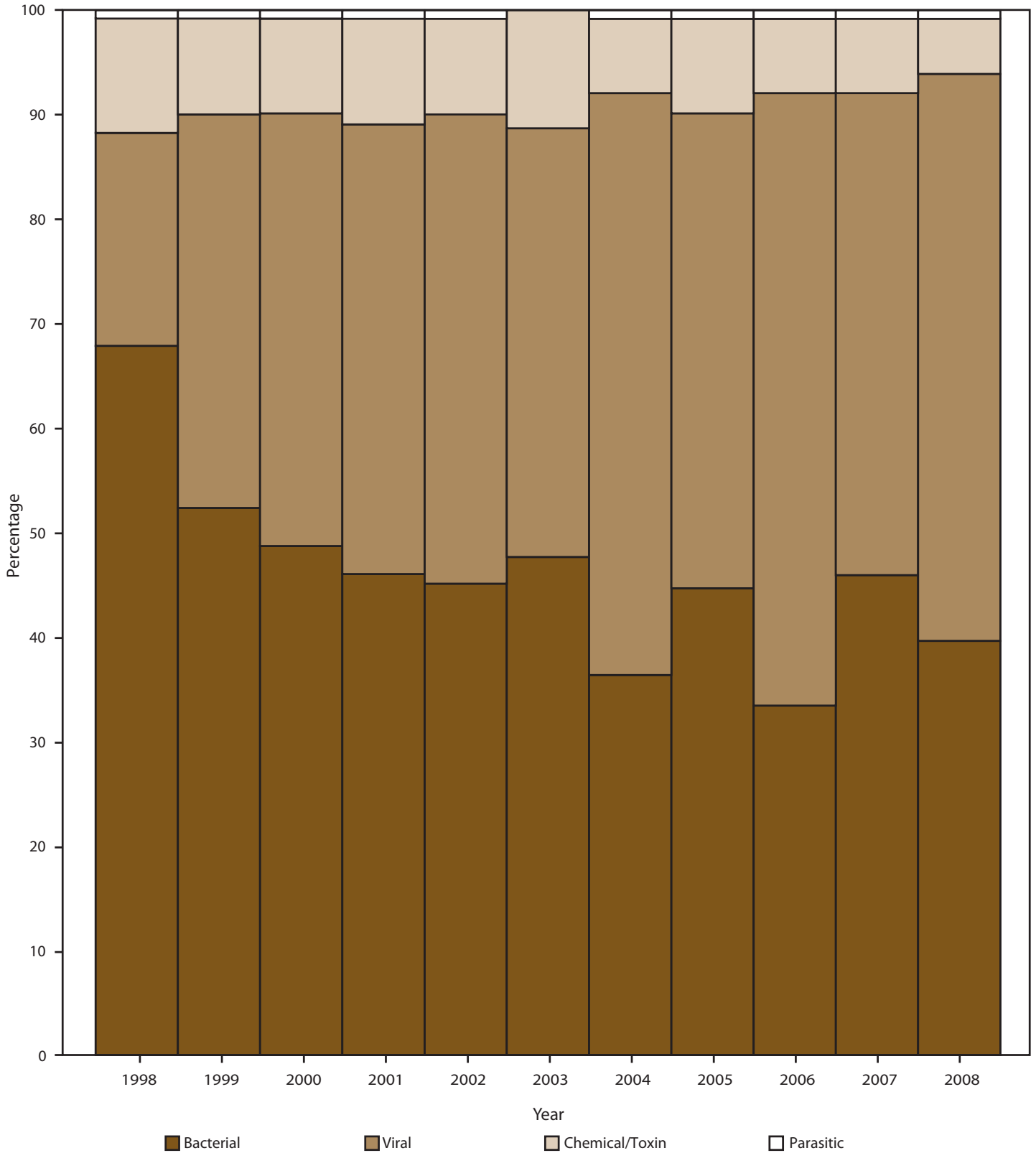
† N = 14,205. Number on each state is the number of outbreaks reported. Includes 128 multistate outbreaks that are assigned as an outbreak to each state involved. Excludes 25 outbreaks reported by Guam, 26 reported by Puerto Rico, and 2 reported by the Republic of Palau.

FIGURE 3. Percentage of foodborne disease outbreak reports that included at least one confirmed or suspected etiology, by year — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



* N = 7,998.

FIGURE 4. Percentage of confirmed and suspected foodborne disease outbreaks, by etiology group and year — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



* N = 7,998; does not include 368 multiple etiology outbreaks.

FIGURE 5. Percentage of *Salmonella* outbreaks caused by the four most common *Salmonella* serotypes — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

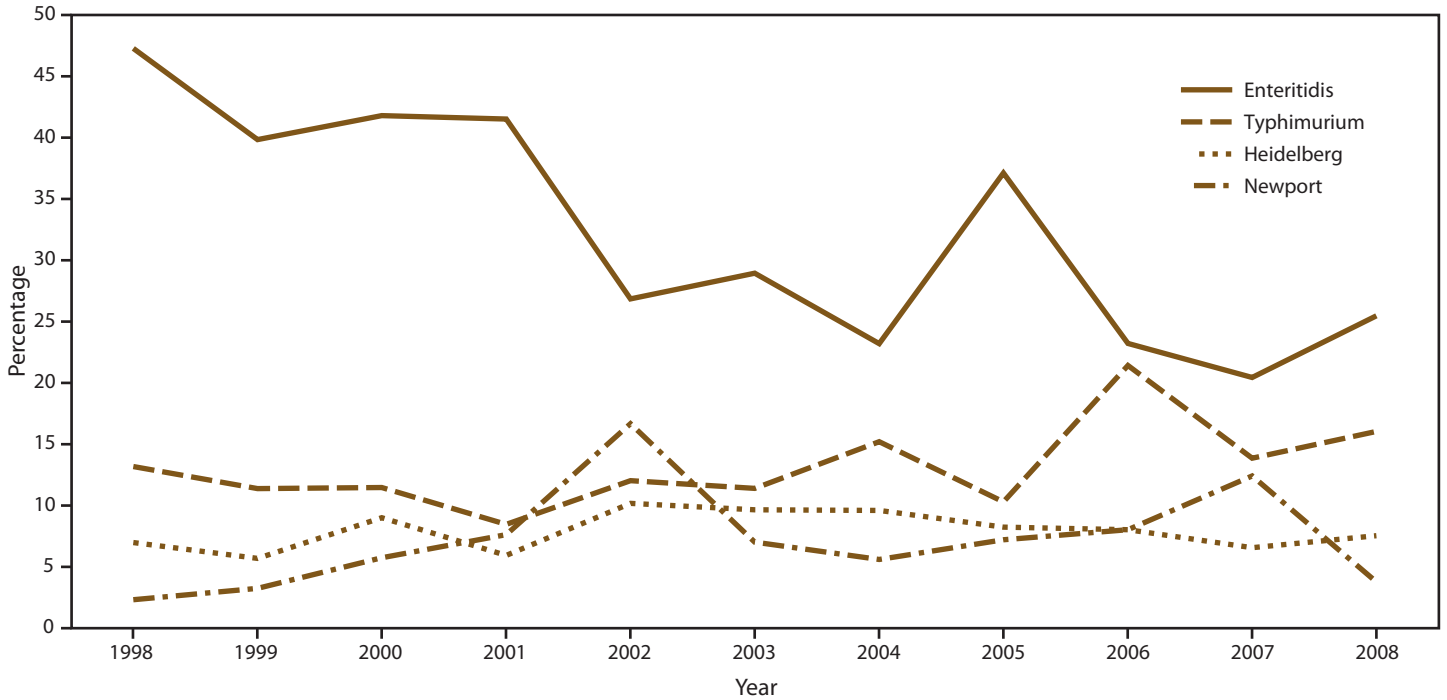
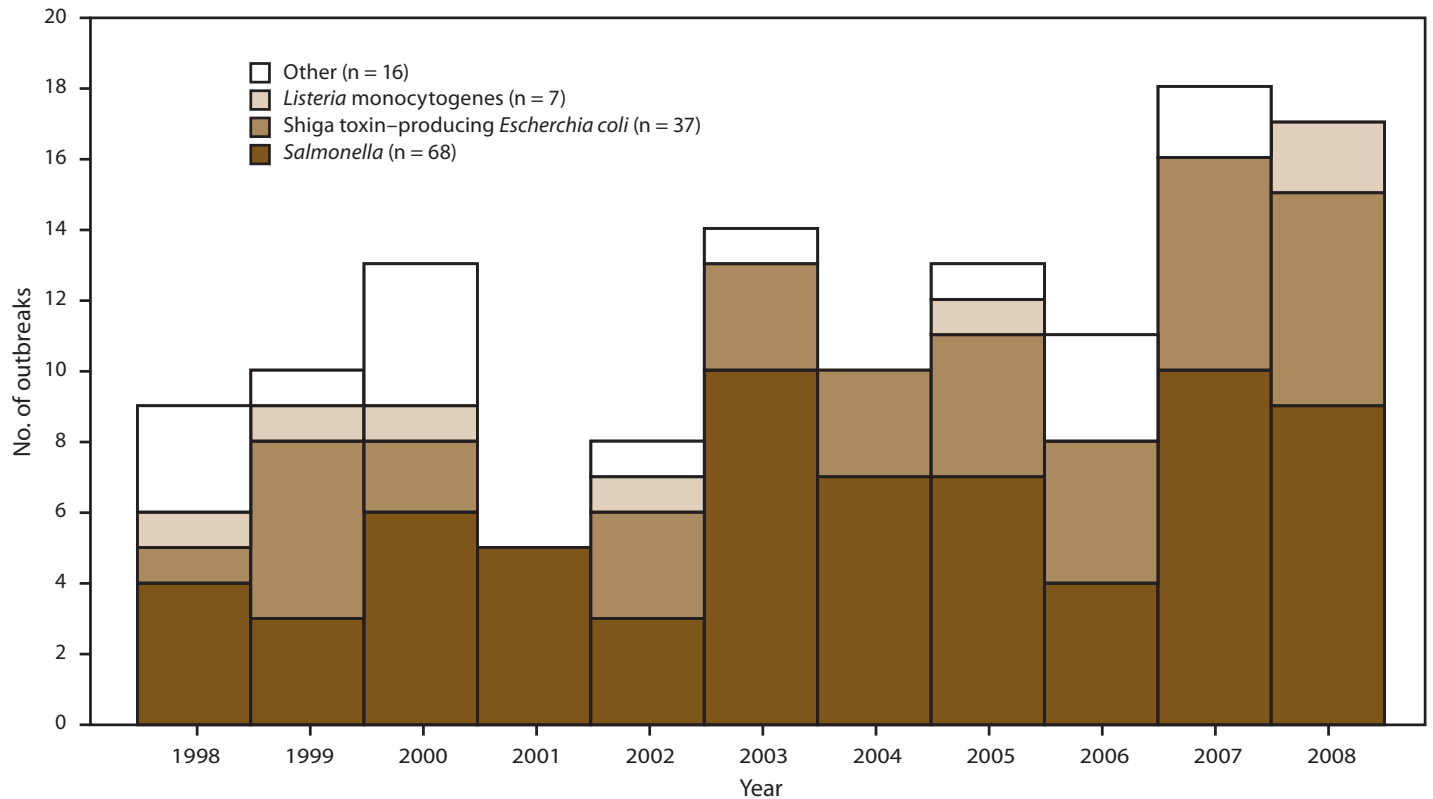


FIGURE 6. Number* of multistate foodborne disease outbreaks, by year and pathogen — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008



*N = 128.

FIGURE 7. Median number of foodborne disease outbreaks reported by each state and estimated interquartile range, by year — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

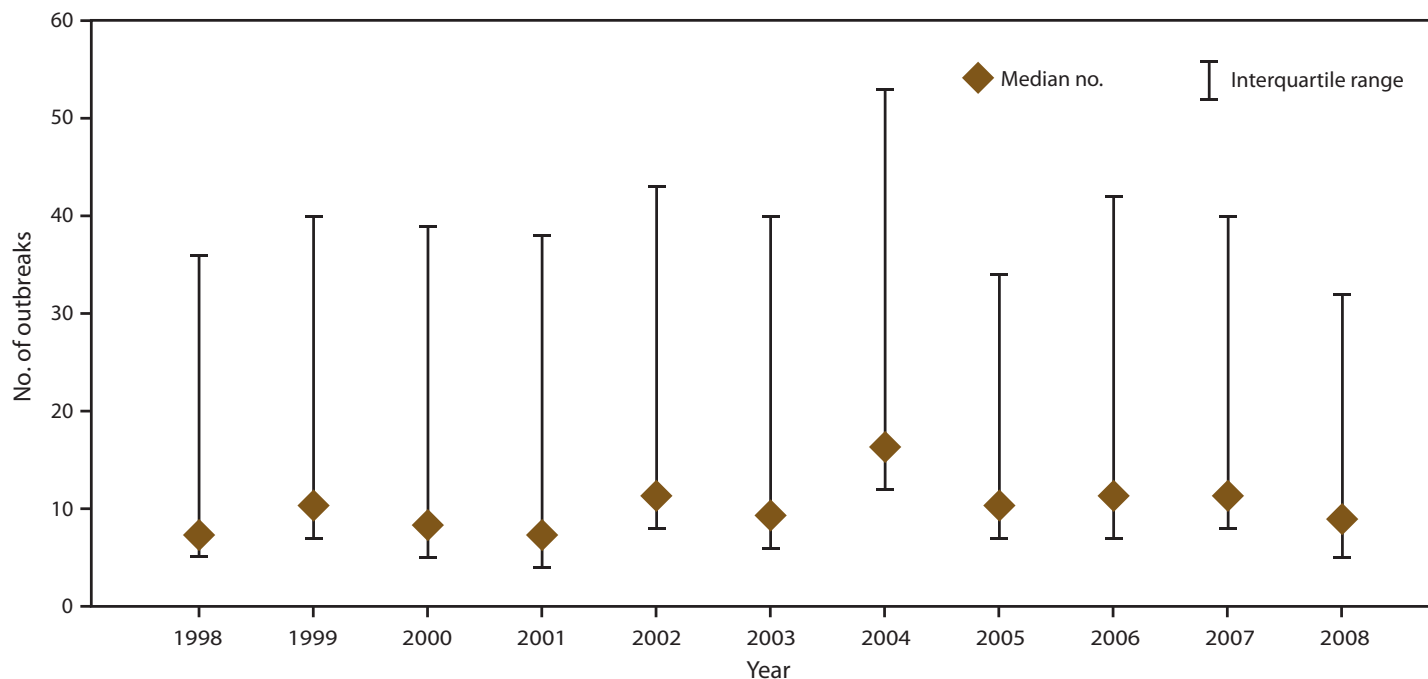
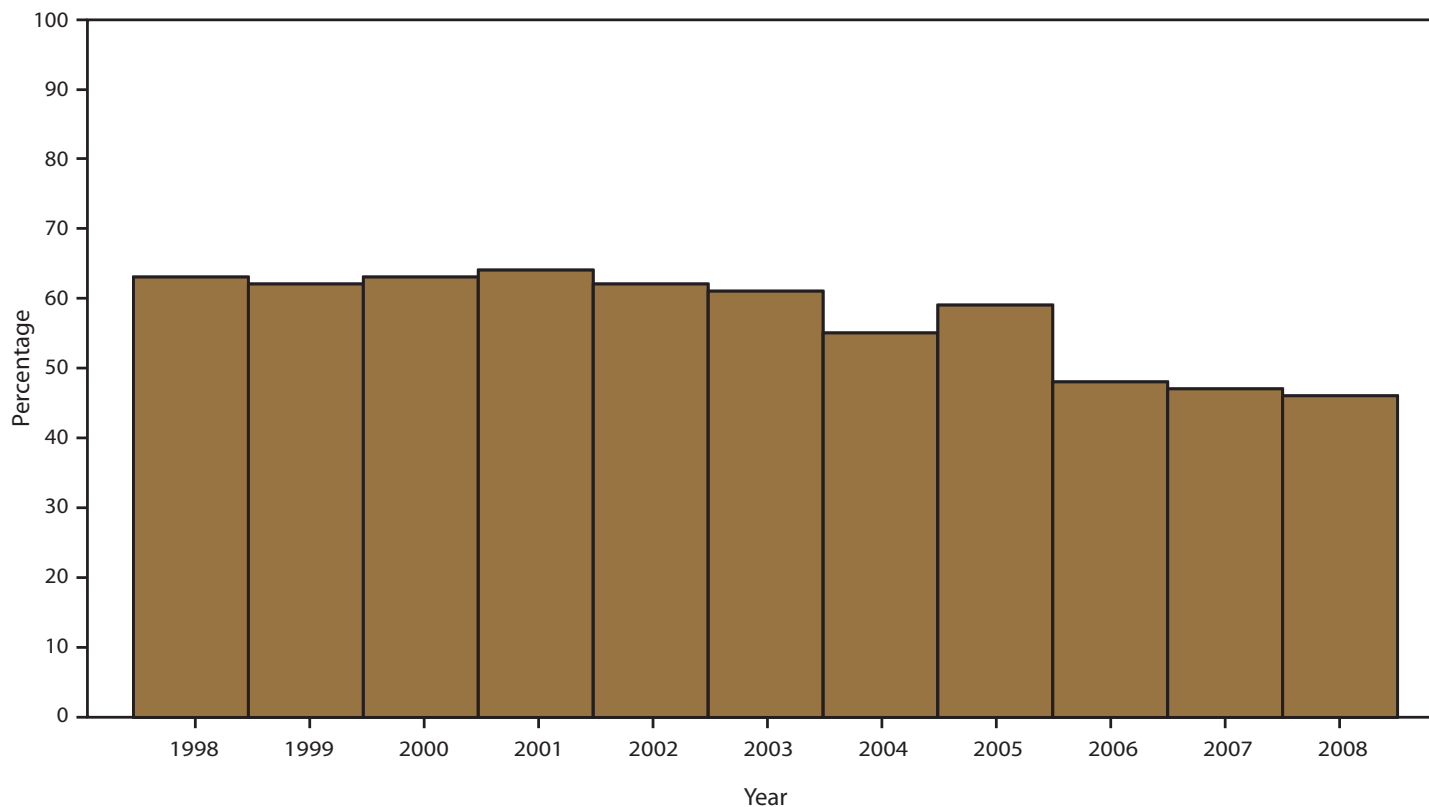
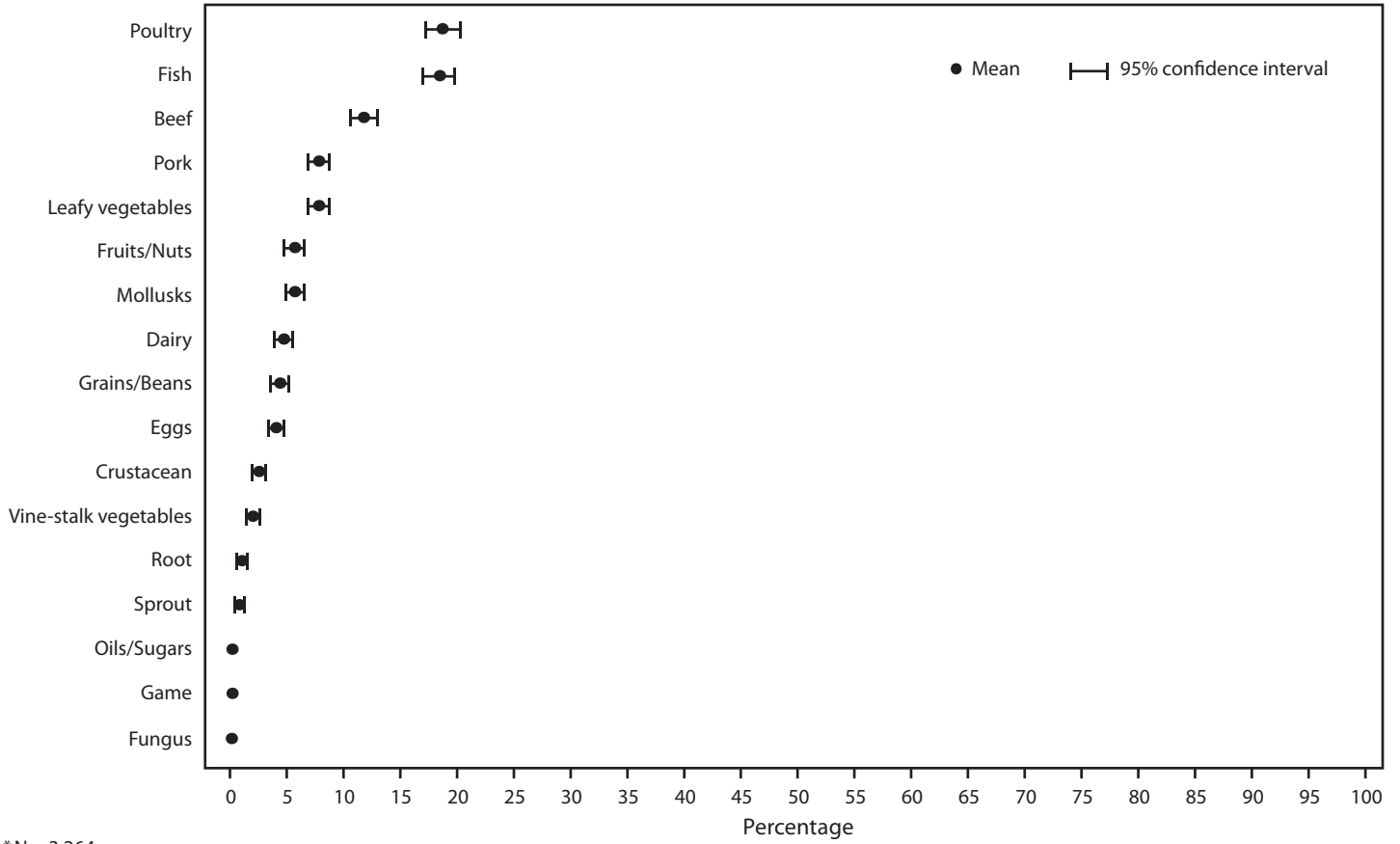


FIGURE 8. Percentage of foodborne disease outbreak reports that included at least one implicated food, by year — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



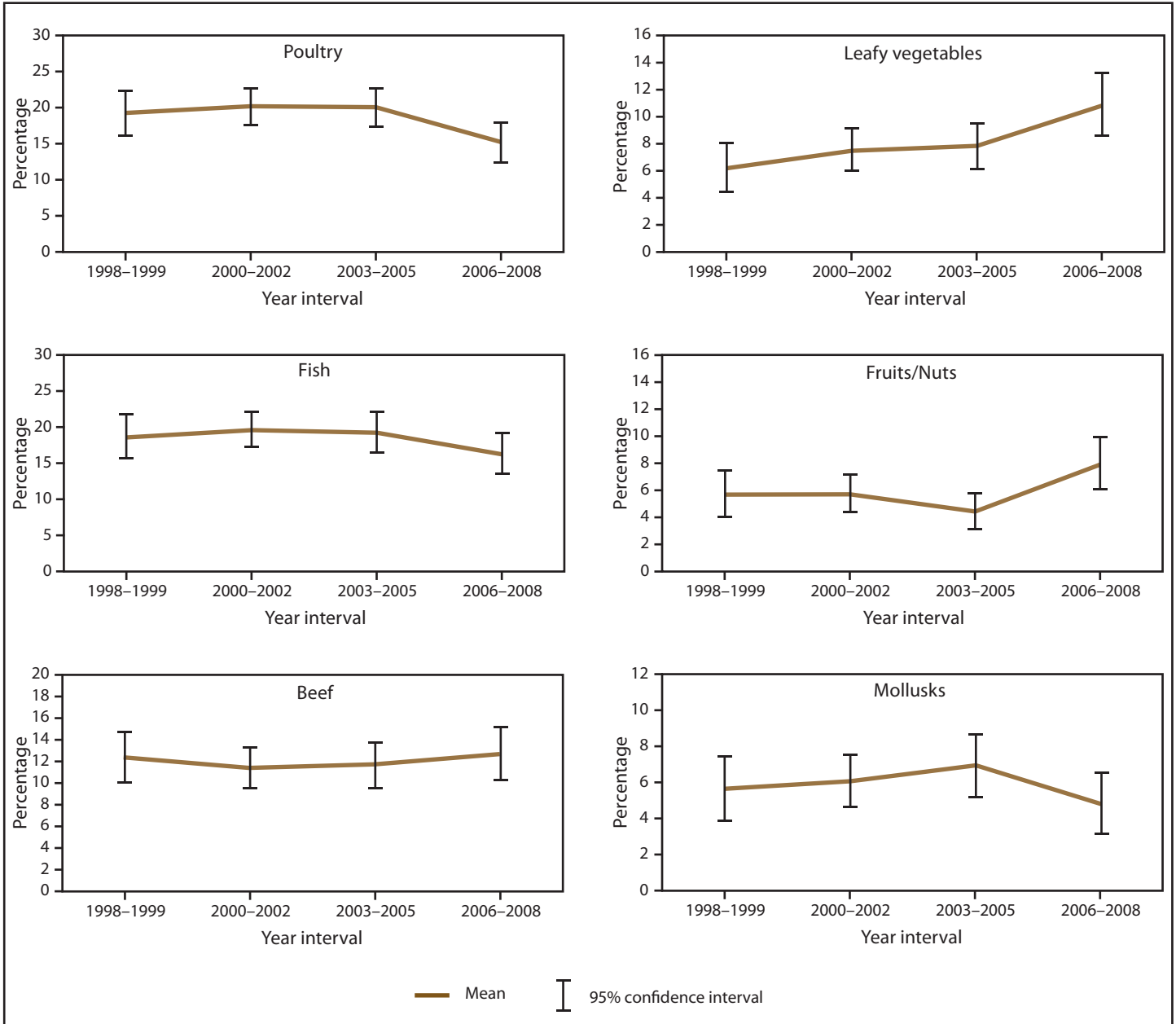
* Of 13,405 outbreaks during 1998–2008, an implicated food was reported for 7,724 outbreaks.

FIGURE 9. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks attributed to each food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



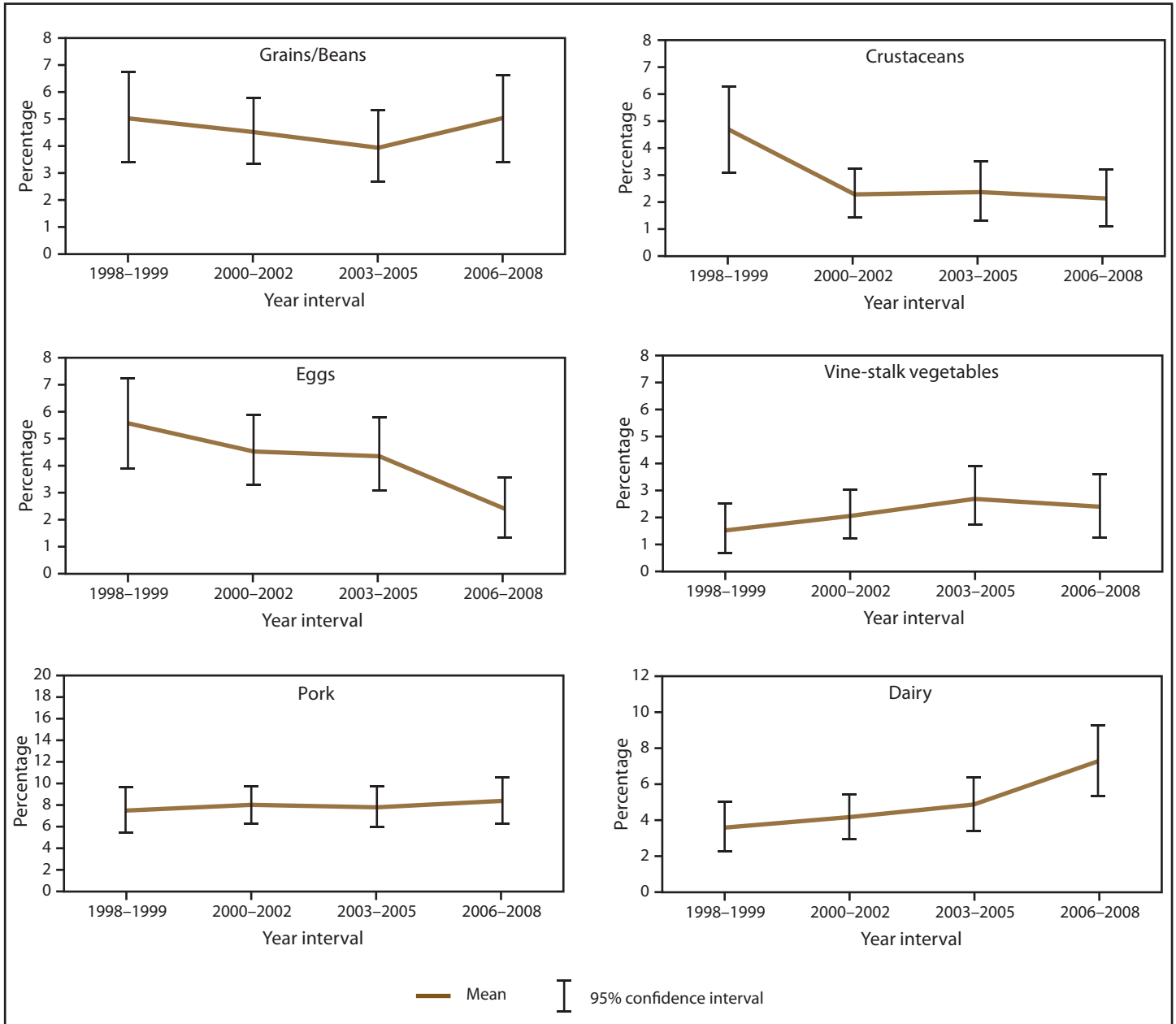
* N = 3,264.

FIGURE 10. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks attributed to each food commodity, by year interval — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



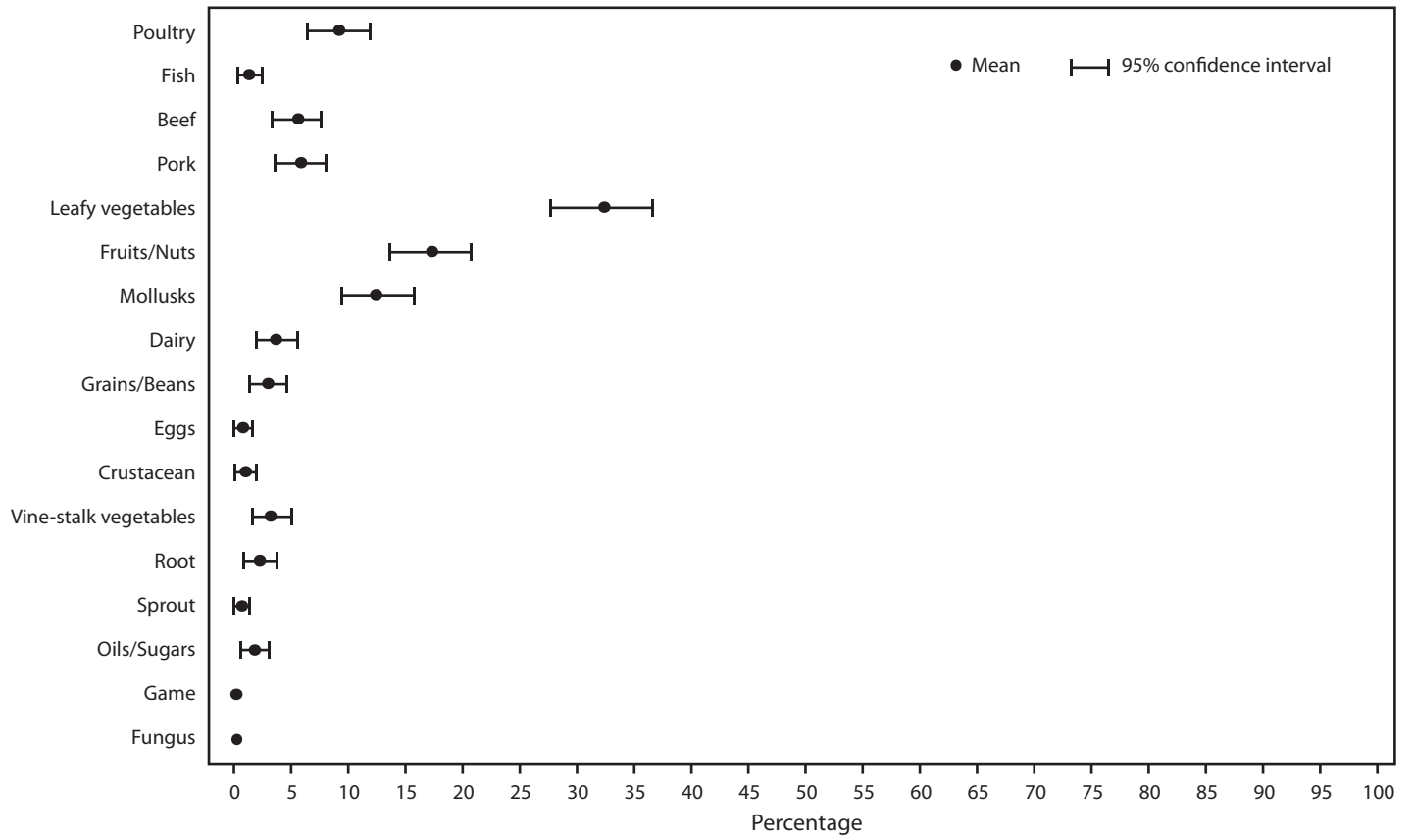
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FIGURE 10. (Continued) Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks attributed to each food commodity, by year interval — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



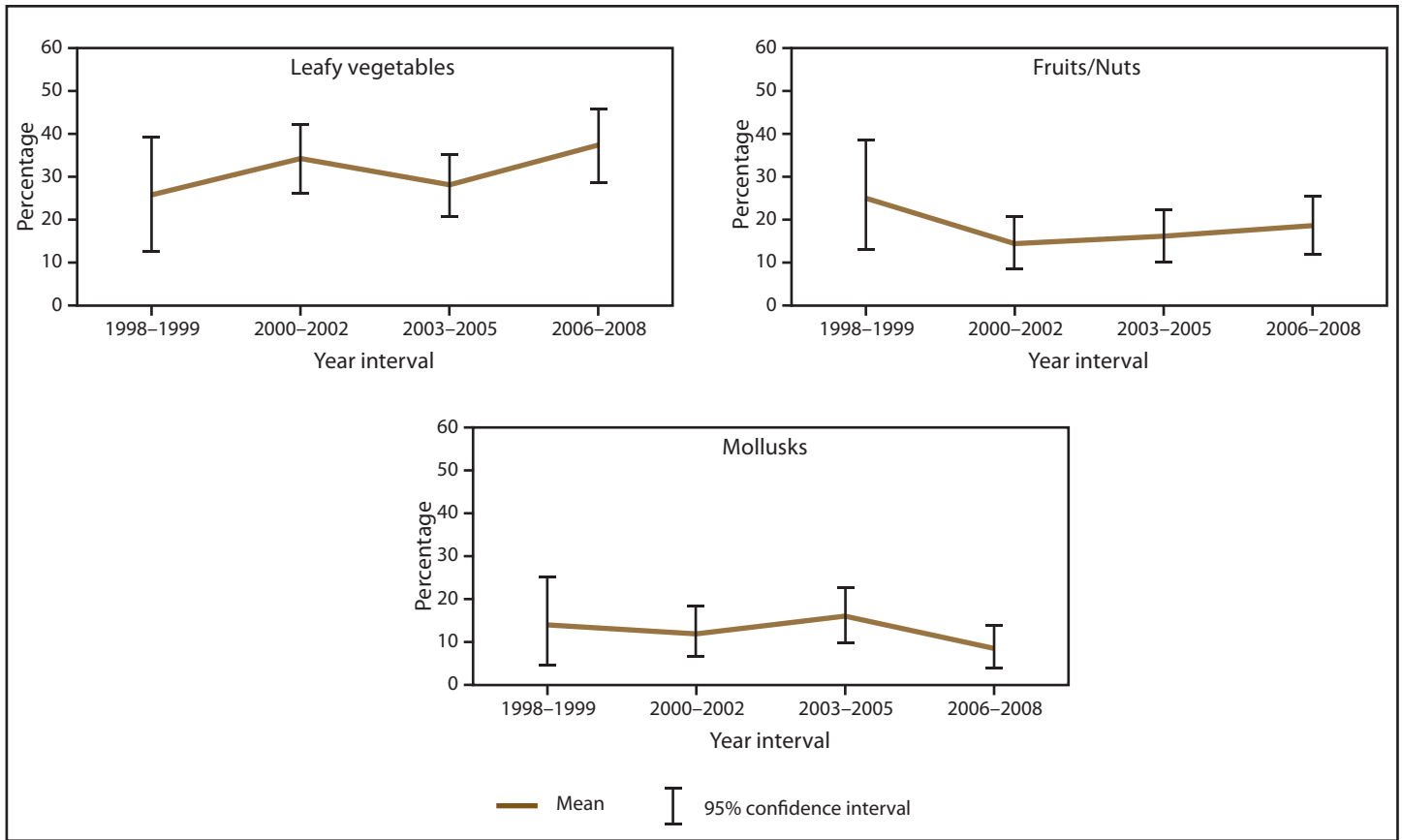
* 1998-1999 = 665 outbreaks; 2000-2002 = 1,029 outbreaks; 2003-2005 = 857 outbreaks; 2006-2008 = 713 outbreaks.

FIGURE 11. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by norovirus attributed to each food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



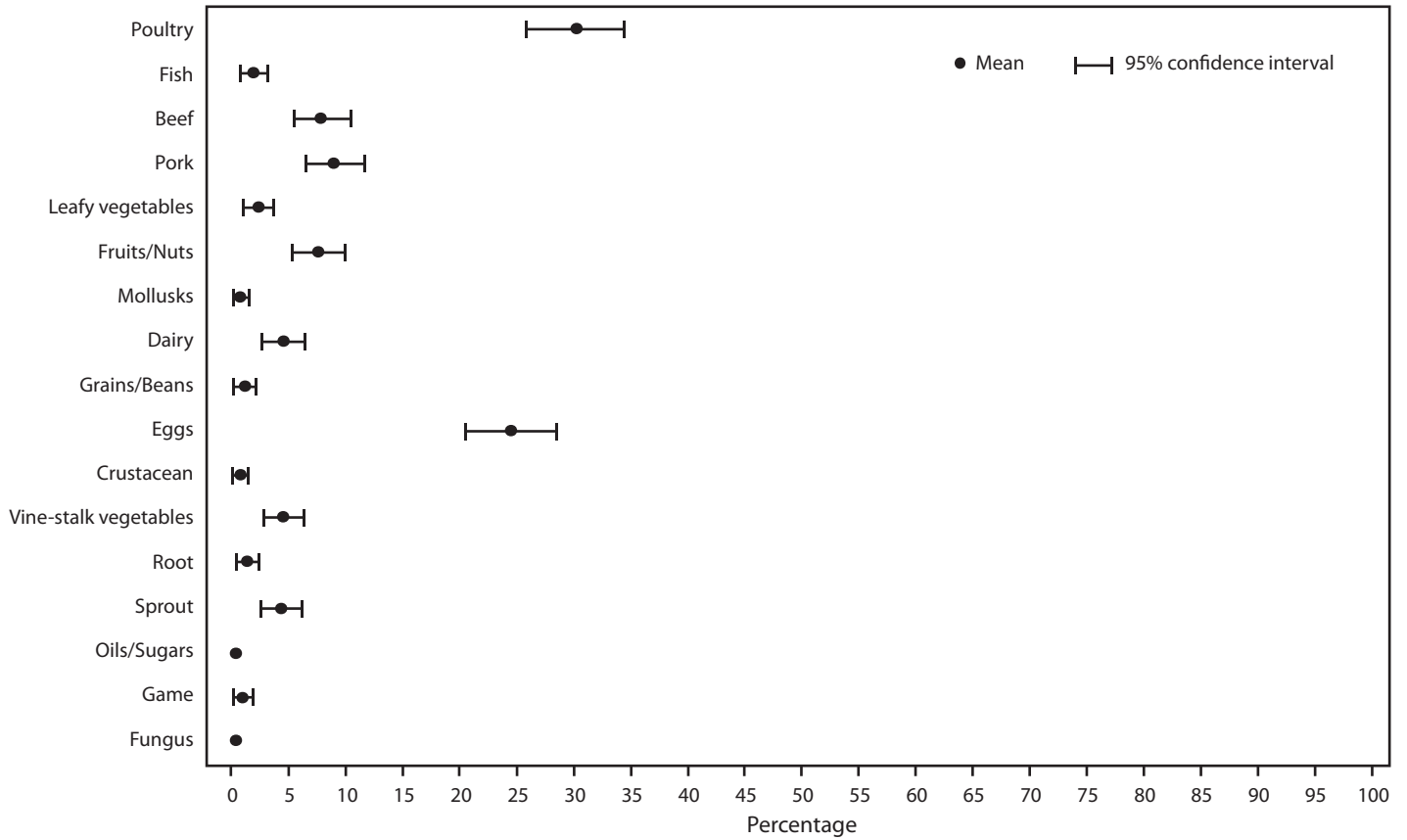
*N = 439.

FIGURE 12. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by norovirus attributed to selected food commodities, by year interval — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



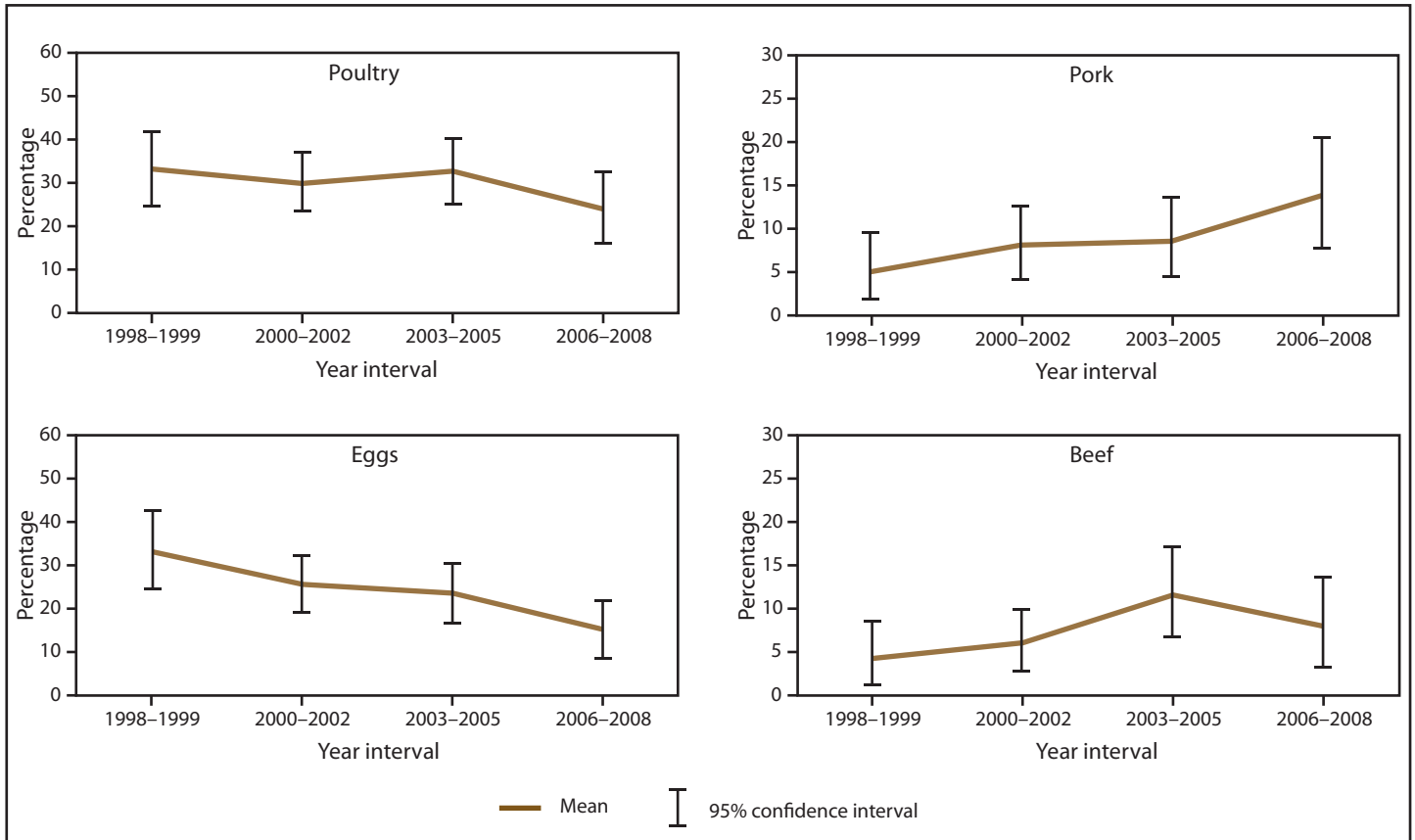
* 1998–1999 = 43 outbreaks; 2000–2002 = 132 outbreaks; 2003–2005 = 135 outbreaks; 2006–2008 = 129 outbreaks.

FIGURE 13. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by *Salmonella* attributed to each food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



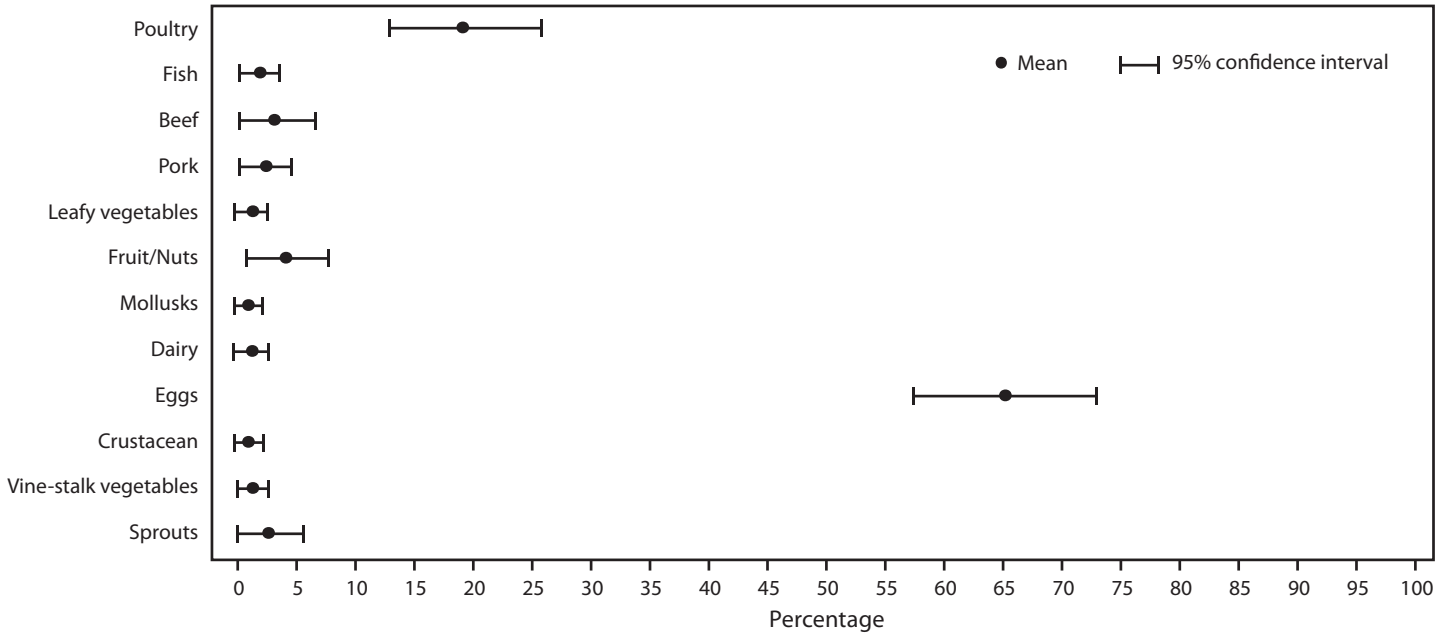
* N = 484.

FIGURE 14. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by *Salmonella* attributed to selected food commodities, by year interval — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



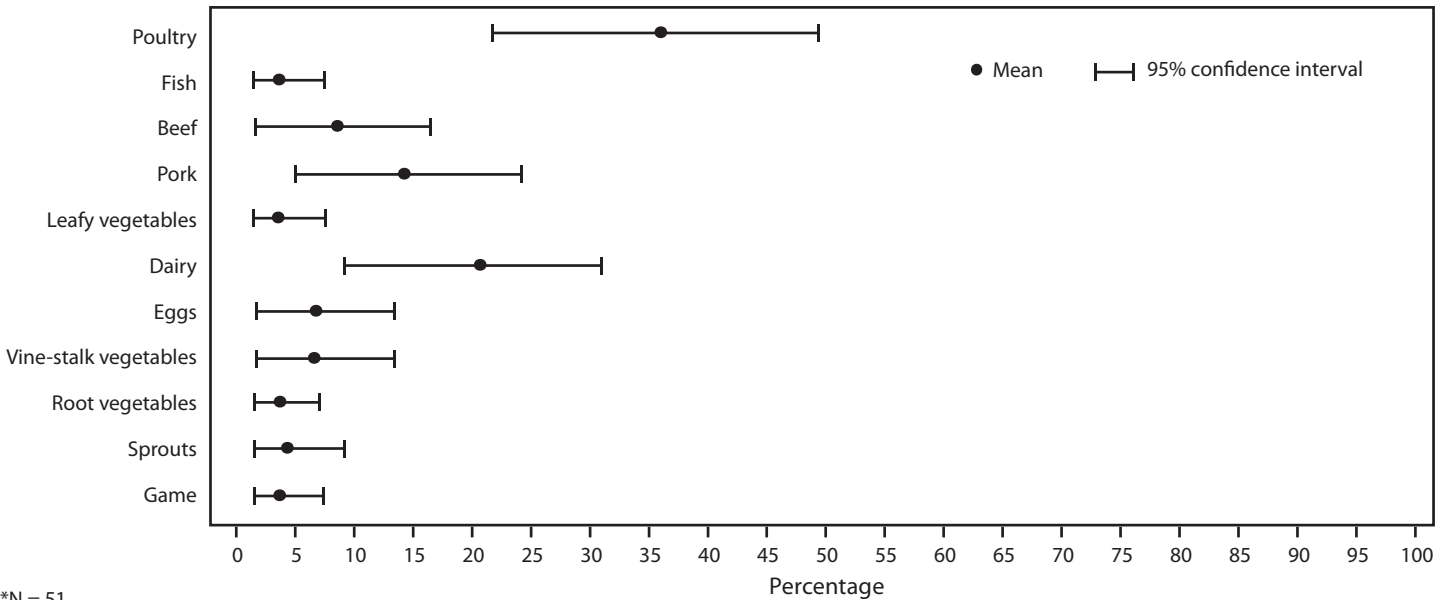
* 1998–1999 = 97 outbreaks; 2000–2002 = 148 outbreaks; 2003–2005 = 138 outbreaks; 2006–2008 = 101 outbreaks.

FIGURE 15. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by *Salmonella* serotype Enteritidis attributed to each food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



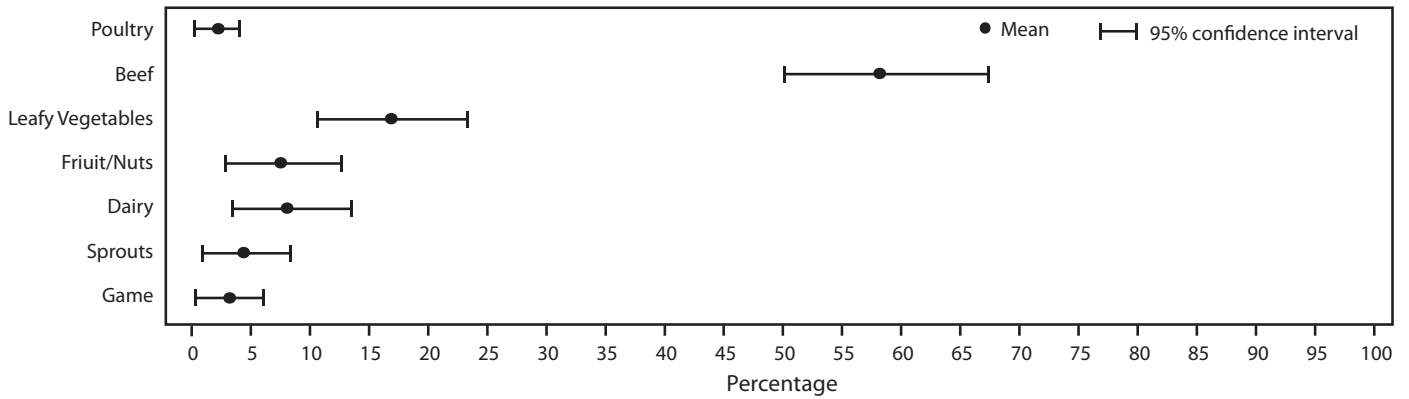
* N = 144.

FIGURE 16. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by *Salmonella* serotype Typhimurium attributed to each food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



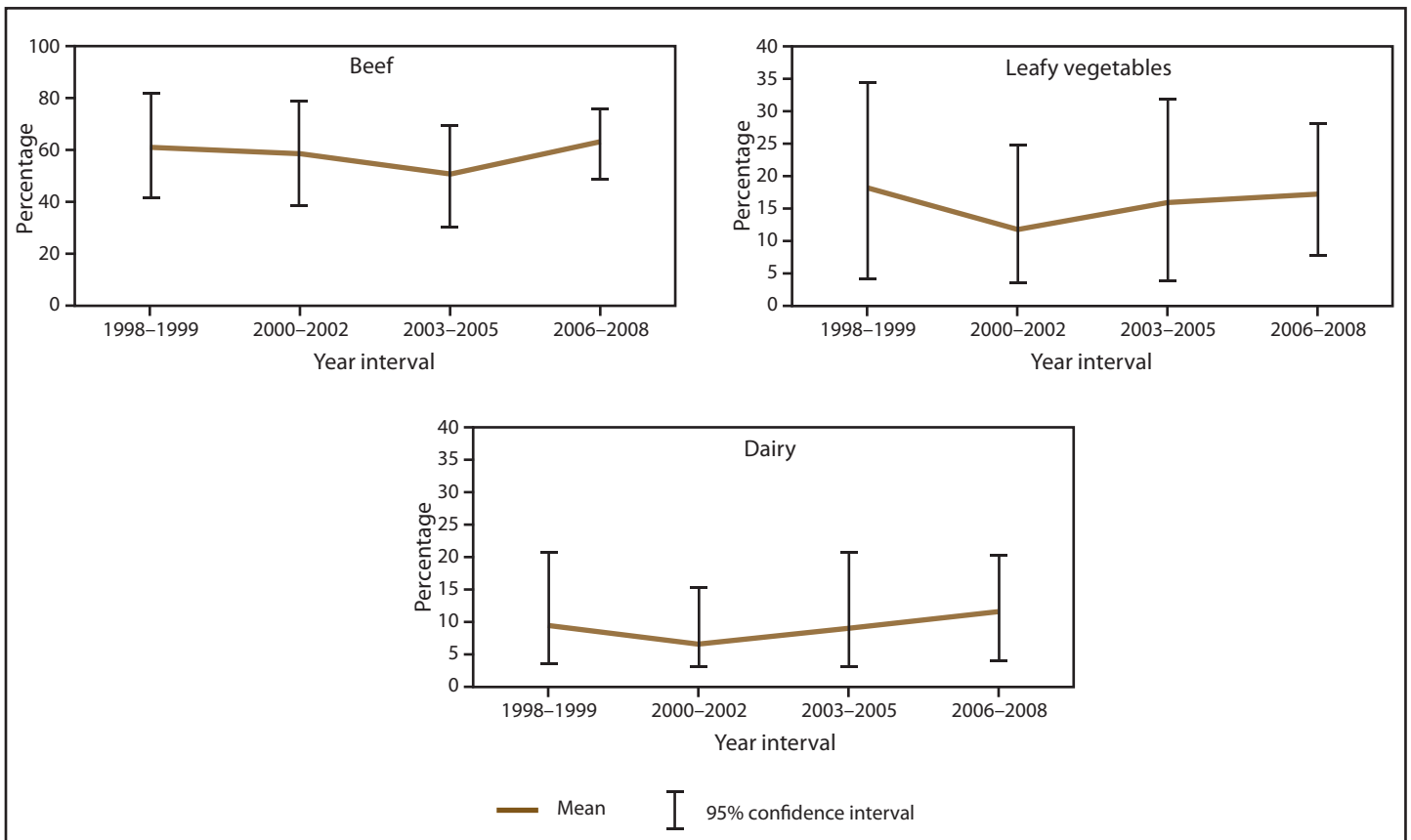
*N = 51.

FIGURE 17. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by Shiga toxin-producing *Escherichia coli* O157 attributed to each food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



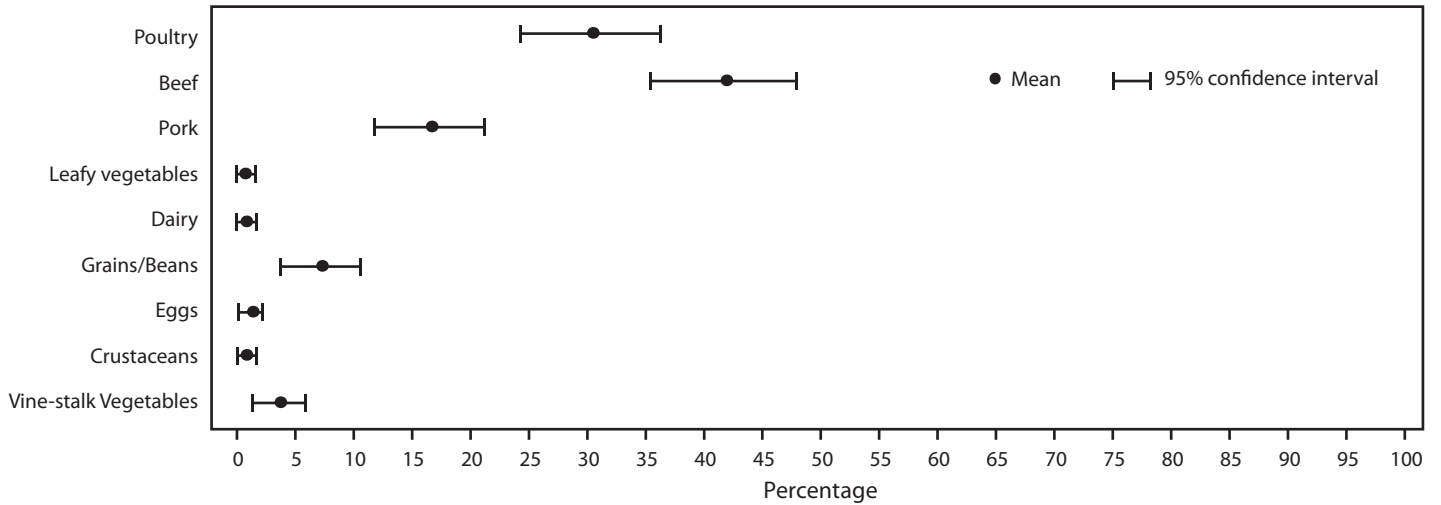
* N = 133.

FIGURE 18. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by Shiga toxin-producing *Escherichia coli* O157 attributed to selected food commodities, by year interval — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



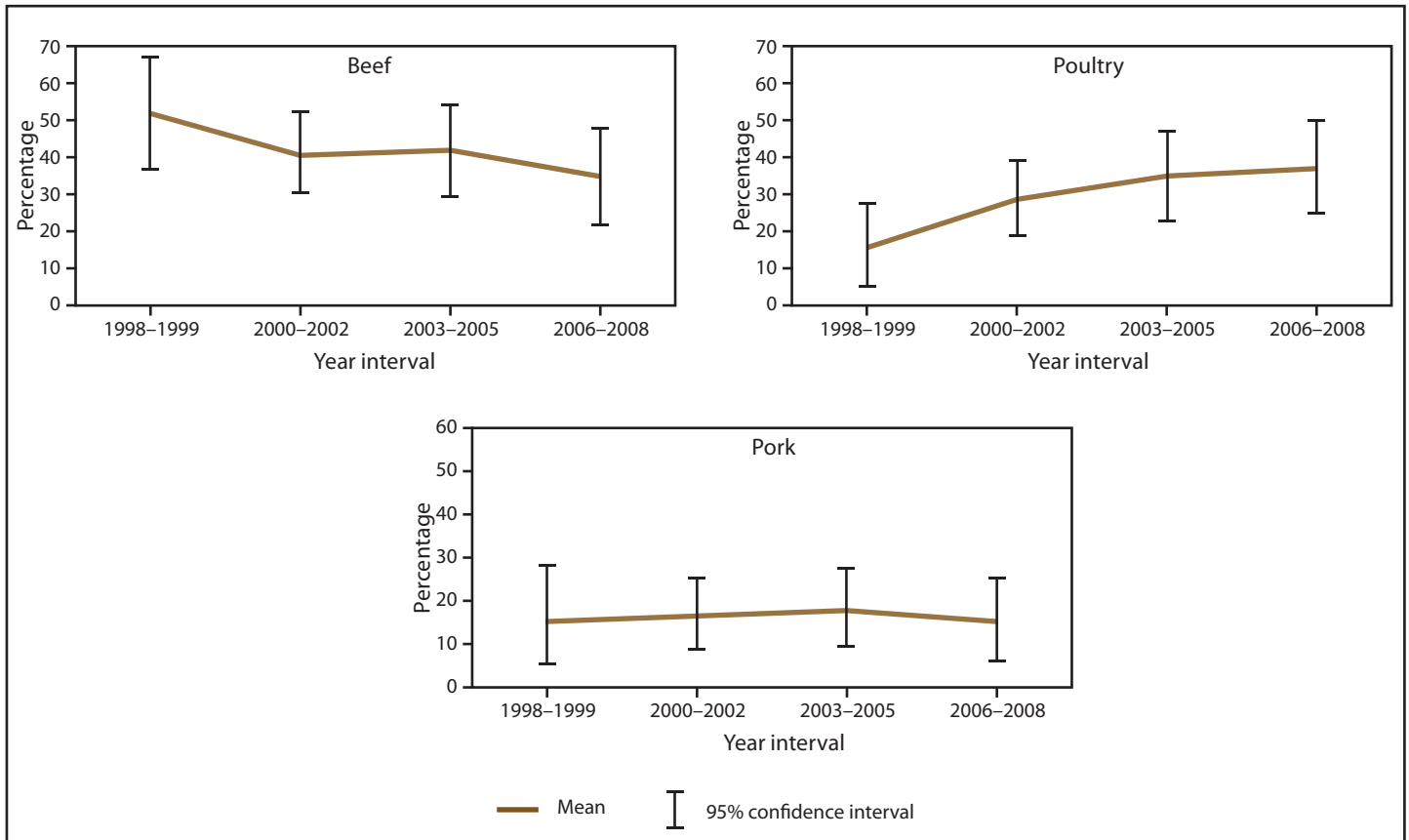
* 1998–1999 = 25 outbreaks; 2000–2002 = 28 outbreaks; 2003–2005 = 26 outbreaks; 2006–2008 = 54 outbreaks.

FIGURE 19. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by *Clostridium perfringens* attributed to each food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



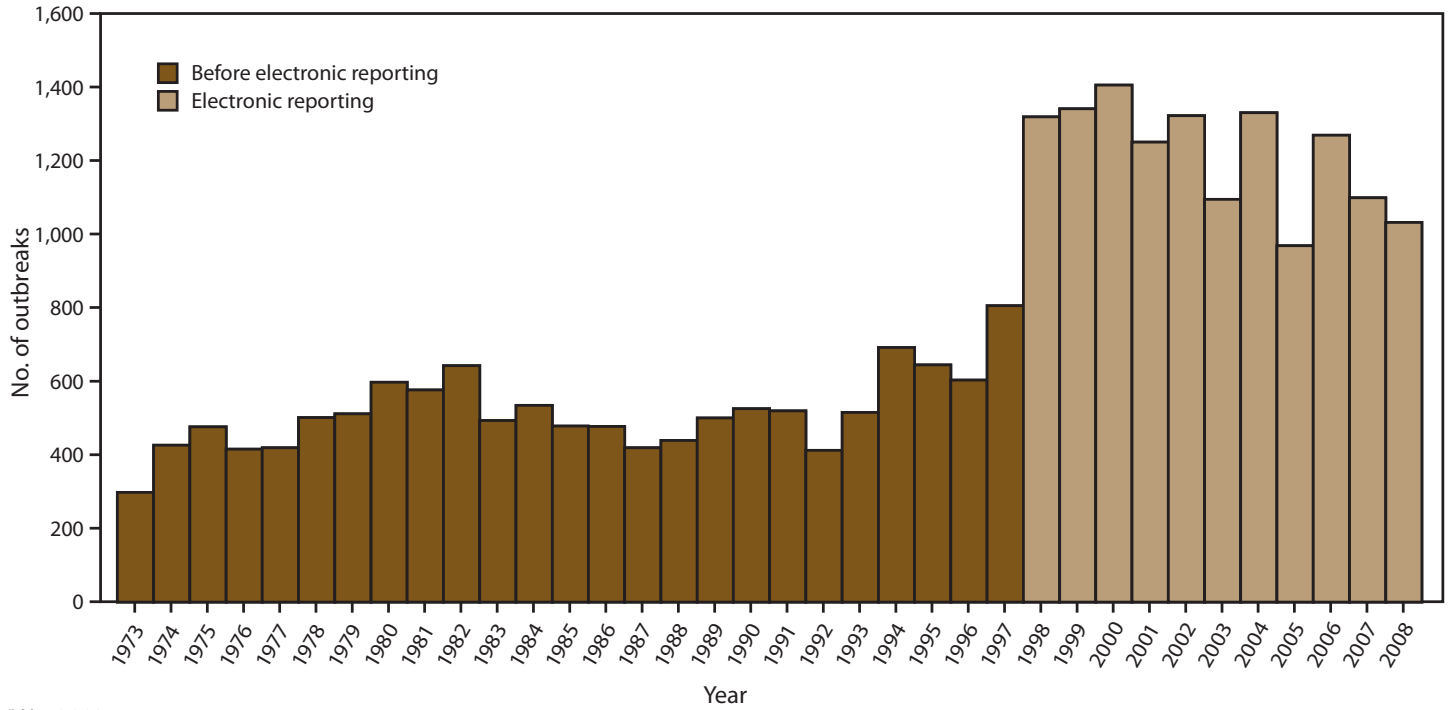
* N = 234.

FIGURE 20. Estimated mean percentage and 95% confidence intervals of foodborne disease outbreaks caused by *Clostridium perfringens* attributed to selected food commodities — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008*



* 1998–1999 = 39 outbreaks; 2000–2002 = 74 outbreaks; 2003–2005 = 68 outbreaks; 2006–2008 = 53 outbreaks.

FIGURE 21. Number of reported foodborne disease outbreaks, by year — Foodborne Disease Outbreak Surveillance System, United States, 1973–2008*



* N = 26,335.

Surveillance Summaries

TABLE 1. Number and percentage of foodborne outbreaks and outbreak-associated illnesses, hospitalizations, and deaths, by etiology* — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Etiology	Outbreaks				Illnesses				Hospitalizations				Deaths			
	CE	SE	Total†		CE	SE	Total†		CE	SE	Total†		CE	SE	Total†	
			No.	(%)			No.	(%)			No.	(%)			No.	(%)
Bacterial																
<i>Bacillus cereus</i>	56	179	235	(3)	881	1,169	2,050	(1)	7	10	17	(0)	0	0	0	(0)
<i>Brucella</i> spp [§]	4	0	4	(0)	14	0	14	(0)	6	0	6	(0)	0	0	0	(0)
<i>Campylobacter jejuni</i>	121	19	140	(2)	4,503	78	4,581	(2)	84	10	94	(1)	0	0	0	(0)
<i>Campylobacter</i> spp	46	22	68	(1)	509	96	605	(0)	28	7	35	(0)	0	0	0	(0)
<i>Clostridium botulinum</i>	29	4	33	(0)	106	15	121	(0)	84	4	88	(1)	5	1	6	(3)
<i>Clostridium perfringens</i>	253	283	536	(7)	13,182	7,862	21,044	(10)	74	14	88	(1)	5	3	8	(4)
<i>Escherichia coli</i> , Enterotoxigenic	13	6	19	(0)	1,400	647	2,047	(1)	11	3	14	(0)	0	0	0	(0)
<i>Escherichia coli</i> , Shiga toxin–producing	286	22	308	(4)	6,306	319	6,625	(3)	1,238	33	1,271	(16)	21	1	22	(11)
<i>Escherichia coli</i> , other	1	3	4	(0)	12	10	22	(0)	0	8	8	(0)	0	0	0	(0)
<i>Listeria</i>	24	1	25	(0)	350	3	353	(0)	216	0	216	(3)	48	0	48	(25)
<i>Salmonella</i>	1,291	158	1,449	(18)	37,394	1,732	39,126	(19)	3,952	82	4,034	(50)	58	2	60	(31)
<i>Shigella flexneri</i>	18	2	20	(0)	1,189	4	1,193	(1)	55	1	56	(1)	0	0	0	(0)
<i>Shigella sonnei</i>	86	10	96	(1)	4,663	248	4,911	(2)	117	4	121	(1)	1	0	1	(1)
<i>Shigella</i> spp	14	4	18	(0)	251	209	460	(0)	19	2	21	(0)	0	0	0	(0)
<i>Staphylococcus enterotoxin</i>	167	291	458	(6)	4,818	1,977	6,795	(3)	296	37	333	(4)	3	0	3	(2)
<i>Vibrio parahaemolyticus</i>	37	34	71	(1)	1,056	165	1,221	(1)	22	3	25	(0)	0	0	0	(0)
<i>Vibrio</i> spp	5	8	13	(0)	16	17	33	(0)	1	2	3	(0)	0	0	0	(0)
<i>Yersinia enterocolitica</i>	11	0	11	(0)	100	0	100	(0)	8	0	8	(0)	0	0	0	(0)
Other bacterial	4	101	105	(1)	77	715	792	(0)	4	4	8	(0)	0	0	0	(0)
Total bacterial	2,466	1,147	3,613	(45)	76,827	15,266	92,093	(45)	6,222	224	6,446	(80)	141	7	148	(77)
Viral																
Astrovirus	1	0	1	(0)	14	0	14	(0)	0	0	0	(0)	0	0	0	(0)
Hepatitis A	75	1	76	(1)	2,138	4	2,142	(1)	268	0	268	(3)	8	0	8	(4)
Norovirus	1,974	1,470	3,444	(43)	72,337	28,315	100,652	(49)	791	237	1,028	(13)	5	0	5	(3)
Rotavirus	3	7	10	(0)	146	82	228	(0)	0	4	4	(0)	6	1	7	(4)
Other viral	8	94	102	(1)	510	2,543	3,053	(1)	7	18	25	(0)	0	0	0	(0)
Total viral	2,061	1,572	3,633	(45)	75,145	30,944	106,089	(52)	1,066	259	1,325	(16)	19	1	20	(10)
Chemical and toxin																
Ciguatoxin	152	23	175	(2)	615	90	705	(0)	65	4	69	(1)	1	0	1	(1)
Cleaning agents	0	5	5	(0)	0	18	18	(0)	0	0	0	(0)	0	0	0	(0)
Heavy metals	8	1	9	(0)	98	6	104	(0)	1	0	1	(0)	0	0	0	(0)
Monosodium glutamate	1	0	1	(0)	2	0	2	(0)	0	0	0	(0)	0	0	0	(0)
Mycotoxins	11	5	16	(0)	72	56	128	(0)	39	11	50	(1)	2	1	3	(2)
Neurotoxic shellfish poison	3	3	6	(0)	19	7	26	(0)	10	1	11	(0)	0	0	0	(0)
Paralytic shellfish poison	9	3	12	(0)	28	28	56	(0)	17	7	24	(0)	0	0	0	(0)
Pesticides	2	0	2	(0)	45	0	45	(0)	3	0	3	(0)	0	0	0	(0)
Plant/Herbal toxins	2	1	3	(0)	21	4	25	(0)	7	4	11	(0)	0	0	0	(0)
Puffer fish tetrodotoxin	1	1	2	(0)	2	2	4	(0)	1	2	3	(0)	0	0	0	(0)
Scombroid toxin/Histamine	262	71	333	(4)	1,042	341	1,383	(1)	46	13	59	(1)	0	0	0	(0)
Other chemical	17	97	114	(1)	485	747	1,232	(1)	37	7	44	(1)	1	0	1	(1)
Other natural toxins	4	3	7	(0)	11	12	23	(0)	4	0	4	(0)	0	0	0	(0)
Total chemical and toxin	472	213	685	(9)	2,440	1,311	3,751	(2)	230	49	279	(3)	4	1	5	(3)
Parasitic																
<i>Anisakis</i>	1	0	1	(0)	14	0	14	(0)	0	0	0	(0)	0	0	0	(0)
<i>Cryptosporidium parvum</i>	8	2	10	(0)	308	14	322	(0)	5	0	5	(0)	0	0	0	(0)
<i>Cryptosporidium</i> spp	5	0	5	(0)	46	0	46	(0)	2	0	2	(0)	0	0	0	(0)
<i>Cyclospora cayentanensis</i>	21	3	24	(0)	1,289	37	1,326	(1)	15	0	15	(0)	0	0	0	(0)
<i>Giardia lamblia</i>	15	1	16	(0)	342	4	346	(0)	0	0	0	(0)	0	0	0	(0)
<i>Trichinella spiralis</i>	9	0	9	(0)	40	0	40	(0)	9	0	9	(0)	0	0	0	(0)
Other parasitic	1	1	2	(0)	18	3	21	(0)	2	1	3	(0)	0	0	0	(0)
Total parasitic	60	7	67	(1)	2,057	58	2,115	(1)	33	1	34	(0)	0	0	0	(0)
Known etiology[¶]	5,059	2,939	7,998	(60)	156,469	47,579	204,048	(75)	7,551	533	8,084	(89)	164	9	173	(87)
Unknown etiology**	— ^{††}	—	5,039	(38)	—	—	60,702	(22)	—	—	689	(8)	—	—	24	(12)
Multiple etiology	93	275	368	(3)	4,616	3,754	8,370	(3)	281	55	336	(4)	0	3	3	(2)
Total	5,152	3,214	13,405	(100)	161,085	51,333	273,120	(100)	7,832	588	9,109	(100)	164	12	200	(100)

Abbreviations: CE = confirmed etiology; SE = suspected etiology.

* Laboratory and clinical guidelines for confirming an etiology of a foodborne disease outbreak are specific for each bacterial, chemical/toxin, parasitic, and viral agent. Suspected etiologies are those that do not meet the confirmation guidelines (available at http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html).

† Because of rounding procedures, numbers might not add up to the etiology category total or the known etiology total.

§ Includes all species of a pathogen not otherwise specified individually.

¶ The denominator for the total etiology percentages is the known etiology total. The denominator for the known etiology, unknown etiology, and multiple etiologies percentages is the total.

** An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.

†† No outbreaks in the data reported fall in this category.

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TABLE 2. Number of foodborne disease outbreaks and outbreak-associated illnesses, by etiology* and number of places where food was prepared† Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Etiology	Total attributed to a single preparation location		Total attributed to multiple preparation locations		Total attributed to preparation location not known or reported		Total	
	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses
Bacterial								
<i>Bacillus cereus</i>	220	1,803	6	100	9	147	235	2,050
<i>Brucella</i> spp	4	14	—	—	—	—	4	14
<i>Campylobacter jejuni</i>	115	3,881	13	606	12	94	140	4,581
<i>Campylobacter</i> spp	56	435	5	130	7	40	68	605
<i>Clostridium botulinum</i>	31	114	1	5	1	2	33	121
<i>Clostridium perfringens</i>	475	18,094	51	2,551	10	399	536	21,044
<i>Escherichia coli</i> , Enterotoxigenic	14	1,832	5	215	—	—	19	2,047
<i>Escherichia coli</i> , Shiga toxin-producing	231	4,952	46	1,211	31	462	308	6,625
<i>Escherichia coli</i> , other	4	22	—	—	—	—	4	22
<i>Listeria</i>	17	250	5	86	3	17	25	353
<i>Salmonella</i>	1,147	28,468	160	6,196	142	4,462	1,449	39,126
<i>Shigella flexneri</i>	18	1,142	1	49	1	2	20	1,193
<i>Shigella sonnei</i>	72	2,564	3	675	21	1,672	96	4,911
<i>Shigella</i> spp	14	365	2	56	2	39	18	460
<i>Staphylococcus enterotoxin</i>	433	5,594	23	542	13	659	469	6,795
<i>Vibrio parahaemolyticus</i>	63	934	3	266	5	21	71	1,221
<i>Vibrio</i> spp	12	30	—	—	1	3	13	33
<i>Yersinia enterocolitica</i>	8	60	1	4	2	36	11	100
Other bacterial	88	722	3	44	3	26	94	792
Total bacterial	3,022	71,276	328	12,736	263	8,081	3,613	92,093
Viral								
Astrovirus	1	14	—	—	—	—	1	14
Hepatitis A	60	1,903	4	28	12	211	76	2,142
Norovirus	2,930	82,779	373	12,017	141	5,856	3,444	100,652
Rotavirus	9	212	—	—	1	16	10	228
Other viral	87	2,383	6	333	9	337	102	3,053
Total viral	3,087	87,291	383	12,378	163	6,420	3,633	106,089
Chemical and toxin								
Ciguatoxin	166	663	3	12	6	30	175	705
Cleaning agents	5	18	—	—	—	—	5	18
Heavy metals	8	102	1	2	—	—	9	104
Monosodium glutamate	1	2	—	—	—	—	1	2
Mycotoxins	14	123	—	—	2	5	16	128
Neurotoxic shellfish poison	6	26	—	—	—	—	6	26
Paralytic shellfish poison	9	46	—	—	3	10	12	56
Pesticides	2	45	—	—	—	—	2	45
Plant/Herbal toxins	2	10	—	—	1	15	3	25
Puffer fish tetrodotoxin	2	4	—	—	—	—	2	4
Scombroid toxin/Histamine	318	1,257	5	66	10	60	333	1,383
Other chemical	111	1,222	1	2	2	8	114	1,232
Other natural toxins	6	17	—	—	1	6	7	23
Total chemical and toxin	650	3,535	10	82	25	134	685	3,751
Parasitic								
<i>Anisakis</i>	1	14	—	—	—	—	1	14
<i>Cryptosporidium</i> spp	7	300	1	9	7	59	15	368
<i>Cyclospora cayatanensis</i>	18	1,133	5	176	1	17	24	1,326
<i>Giardia lamblia</i>	13	325	1	15	2	6	16	346
<i>Trichinella spiralis</i>	8	33	1	7	—	—	9	40
Other parasitic	1	3	1	18	—	—	2	21
Total parasitic	48	1,808	9	225	10	82	67	2,115
Known etiology[¶]	6,807	163,910	730	25,421	461	14,717	7,998	204,048
Unknown etiology**	4,492	48,899	245	4,419	302	7,384	5,039	60,702
Multiple etiology	328	6,788	32	1,335	8	247	368	8,370
Total	11,627	162,300	1,007	25,421	771	16,327	13,405	273,120

* Laboratory and clinical guidelines for confirming an etiology of a foodborne disease outbreak are specific for each bacterial, chemical/toxin, parasitic, and viral agent. Suspected etiologies are those that do not meet the confirmation guidelines (available at http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html).

† Reported settings were grouped as follows: restaurant or deli, private home, catering or banquet facility, institutional, other commercial setting, hospital or nursing home, and other private setting (see Table 4).

‡ No outbreaks in the data reported fall in this category.

¶ The denominator for the total etiology percentages is the known etiology total. The denominator for the known etiology, unknown etiology, and multiple etiologies percentages is the total.

** An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.

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TABLE 3. Number of foodborne disease outbreaks and outbreak-associated illnesses, by etiology* and place where food was prepared† — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Etiology	Restaurant or deli		Private home		Caterer or banquet facility		Institutional		Other commercial setting		Hospital or nursing home		Other private setting		Other	
	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI	NO	NI
Bacterial																
<i>Bacillus cereus</i>	189	1,062	5	40	8	199	7	337	2	10	— [‡]	—	4	55	5	100
<i>Brucella</i> spp	—	—	—	—	—	—	—	—	3	10	—	—	—	—	1	4
<i>Campylobacter jejuni</i>	40	643	19	185	6	96	7	2,032	11	328	—	—	4	89	28	508
<i>Campylobacter</i> spp	25	172	6	24	2	14	2	66	4	20	—	—	2	24	15	115
<i>Clostridium botulinum</i>	—	—	29	94	—	—	—	—	1	4	—	—	1	16	—	—
<i>Clostridium perfringens</i>	267	4,417	39	822	78	4,255	51	7,043	8	120	3	52	6	146	23	1,239
<i>Escherichia coli</i> , Enterotoxigenic	7	154	—	—	4	1,033	1	300	—	—	—	—	—	—	2	345
<i>Escherichia coli</i> , Shiga toxin-producing	86	2,241	57	953	2	33	28	849	18	269	3	51	10	161	27	395
<i>Escherichia coli</i> , other	2	7	1	12	—	—	—	—	1	3	—	—	—	—	—	—
<i>Listeria</i>	3	35	2	12	—	—	—	—	8	79	2	11	—	—	2	113
<i>Salmonella</i>	623	13,098	232	3,510	46	1,711	61	3,651	51	2,550	32	622	23	774	79	2,552
<i>Shigella flexneri</i>	16	1,083	—	—	—	—	—	—	—	—	—	—	1	52	1	7
<i>Shigella sonnei</i>	49	1,597	9	128	4	75	6	220	1	494	—	—	2	31	1	19
<i>Shigella</i> spp	10	116	—	—	—	—	1	200	—	—	—	—	—	—	3	49
<i>Staphylococcus enterotoxin</i>	312	2,163	32	717	21	881	27	782	18	192	3	109	11	478	9	272
<i>Vibrio parahaemolyticus</i>	50	467	6	19	—	—	—	—	2	4	—	—	1	14	4	430
<i>Vibrio</i> spp	9	20	1	6	—	—	—	—	—	—	—	—	—	—	2	4
<i>Yersinia enterocolitica</i>	2	14	5	32	1	14	—	—	—	—	—	—	—	—	—	—
Other bacterial	63	423	6	92	3	99	2	47	8	31	1	6	—	—	5	24
Total bacterial	1,753	27,712	449	6,646	175	8,410	193	15,527	136	4,114	44	851	65	1,840	207	6,176
Viral																
Astrovirus	1	14	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hepatitis A	49	1,832	1	2	1	8	3	15	2	6	—	—	—	—	4	40
Norovirus	1,885	41,354	183	2,988	318	11,714	184	11,860	67	1,451	83	3,366	22	645	188	9,401
Rotavirus	5	42	—	—	1	30	1	108	—	—	2	32	—	—	—	—
Other viral	52	980	3	44	16	839	1	18	2	25	3	48	—	—	10	429
Total viral	1,992	44,222	187	3,034	336	12,591	189	12,001	71	1,482	88	3,446	22	645	202	9,870
Chemical and toxin																
Ciguatoxin	19	137	135	468	—	—	5	16	3	10	—	—	1	3	3	29
Cleaning agents	3	7	—	—	—	—	1	4	—	—	—	—	—	—	1	7
Heavy metals	3	18	1	6	—	—	1	21	3	57	—	—	—	—	—	—
Monosodium glutamate	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mycotoxins	—	—	11	48	—	—	1	29	2	46	—	—	—	—	—	—
Neurotoxic shellfish poison	1	2	5	24	—	—	—	—	—	—	—	—	—	—	—	—
Paralytic shellfish poison	—	—	8	40	—	—	—	—	—	—	—	—	—	—	1	6
Pesticides	1	31	1	14	—	—	—	—	—	—	—	—	—	—	—	—
Plant/Herbal toxins	—	—	2	10	—	—	—	—	—	—	—	—	—	—	—	—
Puffer fish tetrodotoxin	1	2	1	2	—	—	—	—	—	—	—	—	—	—	—	—
Scombroid toxin/Histamine	256	876	26	77	3	34	11	112	8	30	2	7	1	8	11	113
Other chemical	63	373	10	57	2	33	11	427	14	124	—	—	2	149	9	59
Other natural toxins	3	8	3	9	—	—	—	—	—	—	—	—	—	—	—	—
Total chemical and toxin	351	1,456	203	755	5	67	30	609	30	267	2	7	4	160	25	214
Parasitic																
<i>Anisakis</i>	—	—	1	14	—	—	—	—	—	—	—	—	—	—	—	—
<i>Cryptosporidium</i> spp	1	12	2	13	1	37	—	—	1	6	—	—	—	—	2	232
<i>Cyclospora cayentanensis</i>	7	737	2	7	5	236	—	—	2	11	1	116	—	—	1	26
<i>Giardia lamblia</i>	6	92	2	9	—	—	2	86	—	—	—	—	1	48	2	90
<i>Trichinella spiralis</i>	—	—	4	14	—	—	—	—	—	—	—	—	—	—	4	19
Other parasitic	—	—	—	—	—	—	—	—	1	3	—	—	—	—	—	—
Total parasitic	14	841	11	57	6	273	2	86	4	20	1	116	1	48	9	367
Known etiology[¶]	4,110	74,231	850	10,492	522	21,341	414	28,223	241	5,883	135	4,420	92	2,693	443	16,627
Unknown etiology^{**}	3,608	25,407	180	1,896	245	6,028	160	10,067	106	1,140	18	361	12	333	163	3,667
Multiple etiology	221	2,453	28	574	27	1,483	17	1,043	15	432	2	150	4	79	14	574
Total	7,939	102,091	1,058	12,962	794	28,852	591	39,333	362	7,455	155	4,931	108	3,105	620	20,868

Abbreviations: NO = number of outbreaks; NI = number of illnesses.

* Laboratory and clinical guidelines for confirming an etiology of a foodborne disease outbreak are specific for each bacterial, chemical/toxin, parasitic, and viral agent. Suspected etiologies are those that do not meet the confirmation guidelines (available at http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html).

† Reported settings were grouped as follows: restaurant or deli, private home, catering or banquet facility, institutional, other commercial setting, hospital or nursing home, and other private setting (see Table 4).

‡ No outbreaks in the data reported fall in this category.

¶ The denominator for the total etiology percentages is the known etiology total. The denominator for the known etiology, unknown etiology, and multiple etiologies percentages is the total.

** An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.

TABLE 4. Number of foodborne disease outbreaks and number and median of outbreak-associated illnesses, by place where food was prepared — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Preparation location	No. outbreaks	No. illnesses	Median outbreak size
Restaurant or deli	7,939	102,091	5
Private home	1,058	12,962	8
Catering or banquet facility			
Catering facility	669	23,899	23
Banquet facility	125	4,953	23
Institutional			
Camp	89	3,385	25
Day care center	21	348	13
Prison or jail	125	15,529	45
School	286	17,266	38
Workplace cafeteria	22	908	16
Workplace, not cafeteria	48	1,897	15
Other commercial setting			
Grocery store	185	2,132	6
Fair, festival, or temporary mobile service	47	1,141	9
Foreign country site	7	136	5
Plant or facility that makes a commercial product not requiring further preparation	116	3,935	7
Wedding reception facility	7	111	18
Hospital or nursing home			
Hospital	28	763	11
Nursing home	127	4,168	24
Other private setting			
Place of worship	79	2,496	21
Picnic	29	609	13

TABLE 5. Median average percentage change (APC) in the annual number of outbreaks reported by each state during 1998–2003 and 2004–2008 — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

State	Median APC 1999–2003	Median APC 2004–2008	Relative change in APC during 2004–2008
Alabama	-19	-18	Decreased
Alaska	0	33	Increased
Arizona	-33	53	Increased
Arkansas	0	-33	Decreased
California	17	-17	Decreased
Colorado	-13	67	Increased
Connecticut	0	0	No change
Delaware	—*	—	—
District of Columbia	—	—	—
Florida	-5	-13	Decreased
Georgia	19	0	No change
Hawaii	3	-20	Decreased
Idaho	0	38	Increased
Illinois	19	7	Increased
Indiana	—	—	—
Iowa	0	-29	Decreased
Kansas	-23	18	Increased
Kentucky	—	—	—
Louisiana	33	33	Increased
Maine	-22	50	Increased
Maryland	-21	11	Increased
Massachusetts	0	0	No change
Michigan	-8	-14	Decreased
Minnesota	-3	5	Increased
Mississippi	0	-50	Decreased
Missouri	13	100	Increased
Montana	—	—	—
Nebraska	—	—	—
Nevada	—	—	—
New Hampshire	-40	-13	Decreased
New Jersey	0	40	Increased
New Mexico	8	0	No change
New York	-17	7	Increased
North Carolina	-33	4	Increased
North Dakota	—	—	—
Ohio	-15	4	Increased
Oklahoma	33	-38	Decreased
Oregon	5	-6	Decreased
Pennsylvania	0	-31	Decreased
Rhode Island	—	—	—
South Carolina	0	20	Increased
South Dakota	-50	0	No change
Tennessee	52	-11	Decreased
Texas	30	-5	Decreased
Utah	25	-60	Decreased
Vermont	0	33	Increased
Virginia	0	0	No change
Washington	-5	2	Increased
West Virginia	0	33	Increased
Wisconsin	-9	-13	Decreased
Wyoming	-43	25	Increased

* States reporting no outbreaks for 2 or more years during the study period and multistate outbreaks were excluded from analyses of changes in reporting.

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TABLE 6. Number of foodborne disease outbreaks and outbreak-associated illnesses, by etiology* and food commodity status — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Etiology	Outbreaks (illnesses)							
	Attributed to a single commodity		Attributed to food vehicle containing >1 commodity		Not attributed to a commodity		Total	
	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses
Bacterial								
<i>Bacillus cereus</i>	77	807	119	838	39	405	235	2,050
<i>Brucella</i> spp	4	14	— [†]	—	—	—	4	14
<i>Campylobacter jejuni</i>	77	3,726	23	430	40	425	140	4,581
<i>Campylobacter</i> spp	27	193	11	110	30	302	68	605
<i>Clostridium botulinum</i>	18	55	9	44	6	22	33	121
<i>Clostridium perfringens</i>	234	9,109	226	9,681	76	2,254	536	21,044
<i>Escherichia coli</i> , Enterotoxigenic	2	366	8	1,450	9	231	19	2,047
<i>Escherichia coli</i> , Shiga toxin-producing	133	3,818	60	978	115	1,829	308	6,625
<i>Escherichia coli</i> , other	1	12	2	7	1	3	4	22
<i>Listeria</i>	14	206	6	119	5	28	25	353
<i>Salmonella</i>	484	15,743	392	13,488	573	9,895	1,449	39,126
<i>Shigella flexneri</i>	4	948	6	134	10	111	20	1,193
<i>Shigella sonnei</i>	17	913	27	1,566	52	2,432	96	4,911
<i>Shigella</i> spp	4	10	4	290	10	160	18	460
<i>Staphylococcus enterotoxin</i>	146	2,553	232	3,234	91	1,008	469	6,795
<i>Vibrio parahaemolyticus</i>	54	1,115	15	102	2	4	71	1,221
<i>Vibrio</i> spp	11	28	1	2	1	3	13	33
<i>Yersinia enterocolitica</i>	7	68	1	9	3	23	11	100
Other bacterial	17	253	30	295	47	244	94	792
Total bacterial	1,331	39,937	1,172	32,777	1,110	19,379	3,613	92,093
Viral								
Astrovirus	—	—	—	—	1	14	1	14
Hepatitis A	13	1,140	15	176	48	826	76	2,142
Norovirus	439	11,814	977	28,901	2,028	59,937	3,444	100,652
Rotavirus	2	7	3	141	5	80	10	228
Other viral	12	150	22	393	68	2,510	102	3,053
Total viral	466	13,111	1,017	29,611	2,150	63,367	3,633	106,089
Chemical and toxin								
Ciguatoxin	172	696	2	7	1	2	175	705
Cleaning agents	—	—	1	3	4	15	5	18
Heavy metals	3	33	3	10	3	61	9	104
Monosodium glutamate	—	—	—	—	1	2	1	2
Mycotoxins	15	121	1	7	—	—	16	128
Neurotoxic shellfish poison	5	24	1	2	—	—	6	26
Paralytic shellfish poison	12	56	—	—	—	—	12	56
Pesticides	1	14	1	31	—	—	2	45
Plant/Herbal toxins	1	6	1	15	1	4	3	25
Puffer fish tetrodotoxin	—	—	2	4	—	—	2	4
Scombroid toxin/Histamine	318	1,330	14	51	1	2	333	1,383
Other chemical	31	244	39	404	44	584	114	1,232
Other natural toxins	6	17	—	—	1	6	7	23
Total chemical and toxin	564	2,541	65	534	56	676	685	3,751
Parasitic								
<i>Anisaksis</i>	1	14	—	—	—	—	1	14
<i>Cryptosporidium parvum</i>	1	144	1	8	8	170	10	322
<i>Cryptosporidium</i> spp	—	—	1	5	4	41	5	46
<i>Cyclospora cayetanensis</i>	12	938	5	229	7	159	24	1,326
<i>Giardia lamblia</i>	1	3	3	71	12	272	16	346
<i>Trichinella spiralis</i>	7	35	1	3	1	2	9	40
Other parasitic	1	18	1	3	—	—	2	21
Total parasitic	23	1,152	12	319	32	644	67	2,115
Known etiology[§]	2,384	56,741	2,266	63,241	3,348	84,066	7,998	204,048
Unknown etiology[¶]	791	8,318	1,528	16,553	2,720	35,831	5,039	60,702
Multiple etiology	89	2,693	129	3,246	150	2,431	368	8,370
Total	3,264	67,752	3,923	83,040	6,218	122,328	13,405	273,120

* Laboratory and clinical guidelines for confirming an etiology of a foodborne disease outbreak are specific for each bacterial, chemical/toxin, parasitic, and viral agent. Suspected etiologies are those that do not meet the confirmation guidelines (available at http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html).

[†] No outbreaks in the data reported fall in this category.

[§] The denominator for the total etiology percentages is the known etiology total. The denominator for the known etiology, unknown etiology, and multiple etiologies percentages is the total.

[¶] An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.

Surveillance Summaries

TABLE 7. Number of foodborne disease outbreaks and outbreak-associated illnesses attributed to aquatic animals, by etiology* — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Etiology	Shellfish					
	Fish		Crustacean		Mollusks	
	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses
Bacterial						
<i>Bacillus cereus</i>	2	9	1	118	— [†]	—
<i>Brucella</i> spp	—	—	—	—	—	—
<i>Campylobacter jejuni</i>	—	—	—	—	3	273
<i>Campylobacter</i> spp	1	3	—	—	—	—
<i>Clostridium botulinum</i>	10	32	—	—	—	—
<i>Clostridium perfringens</i>	—	—	1	55	—	—
<i>Escherichia coli</i> , Enterotoxigenic	—	—	—	—	—	—
<i>Escherichia coli</i> , Shiga toxin–producing	—	—	—	—	—	—
<i>Escherichia coli</i> , other	—	—	—	—	1	12
<i>Listeria</i>	—	—	—	—	—	—
<i>Salmonella</i>	9	223	3	13	3	31
<i>Shigella flexneri</i>	—	—	—	—	—	—
<i>Shigella sonnei</i>	2	55	—	—	—	—
<i>Shigella</i> spp	—	—	—	—	2	6
<i>Staphylococcus enterotoxin</i>	5	12	6	31	5	16
<i>Vibrio parahaemolyticus</i>	—	—	15	242	38	826
<i>Vibrio</i> spp	1	2	1	6	9	20
<i>Yersinia enterocolitica</i>	—	—	—	—	—	—
Other bacterial	1	5	—	—	3	8
Total bacterial	31	341	27	465	64	1,192
Viral						
Astrovirus	—	—	—	—	—	—
Hepatitis A	—	—	—	—	2	46
Norovirus	6	453	4	62	55	751
Rotavirus	1	5	—	—	1	2
Other viral	—	—	1	3	3	21
Total viral	7	458	5	65	61	820
Chemical and toxin						
Ciguatoxin	172	696	—	—	—	—
Cleaning agents	—	—	—	—	—	—
Heavy metals	1	2	—	—	—	—
Monosodium glutamate	—	—	—	—	—	—
Mycotoxins	—	—	—	—	—	—
Neurotoxic shellfish poison	—	—	1	2	4	22
Paralytic shellfish poison	5	30	—	—	7	26
Pesticides	—	—	—	—	—	—
Plant/Herbal toxins	—	—	—	—	—	—
Puffer fish tetrodotoxin	—	—	—	—	—	—
Scombroid toxin/Histamine	317	1,321	1	9	—	—
Other chemical	8	40	2	5	—	—
Other natural toxins	3	9	—	—	—	—
Total chemical and toxin	506	2,098	4	16	11	48
Parasitic						
<i>Anisaksis</i>	1	14	—	—	—	—
<i>Cryptosporidium parvum</i>	—	—	—	—	—	—
<i>Cyclospora cayetanensis</i>	—	—	—	—	—	—
<i>Giardia lamblia</i>	—	—	—	—	1	3
<i>Trichinella spiralis</i>	—	—	—	—	—	—
Other parasitic	—	—	1	18	—	—
Total parasitic	1	14	1	18	1	3
Known etiology[§]	545	2,911	37	564	137	2,063
Unknown etiology[¶]	58	267	50	291	53	283
Multiple etiology	5	141	2	12	2	147
Total	608	3,319	89	867	192	2,493

* Laboratory and clinical guidelines for confirming an etiology of a foodborne disease outbreak are specific for each bacterial, chemical/toxin, parasitic, and viral agent. Suspected etiologies are those that do not meet the confirmation guidelines (available at http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html).

[†] No outbreaks in the data reported fall in this category.

[§] The denominator for the total etiology percentages is the known etiology total. The denominator for the known etiology, unknown etiology, and multiple etiologies percentages is the total.

[¶] An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.

Surveillance Summaries

TABLE 8. Number of foodborne disease outbreaks and outbreak-associated illnesses attributed to land animals, by etiology* — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Etiology	Dairy		Eggs		Beef		Game		Pork		Poultry	
	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses
Bacterial												
<i>Bacillus cereus</i>	2	18	— [†]	—	4	100	—	—	4	94	15	132
<i>Brucella</i> spp	4	14	—	—	—	—	—	—	—	—	—	—
<i>Campylobacter jejuni</i>	46	2,690	—	—	—	—	1	2	—	—	16	110
<i>Campylobacter</i> spp	16	87	—	—	—	—	—	—	1	27	6	53
<i>Clostridium botulinum</i>	—	—	—	—	—	—	1	4	—	—	—	—
<i>Clostridium perfringens</i>	1	24	2	38	96	2,963	—	—	38	972	71	3,452
<i>Escherichia coli</i> , Enterotoxigenic	—	—	—	—	—	—	—	—	—	—	—	—
<i>Escherichia coli</i> , Shiga toxin-producing	11	324	—	—	78	1,611	4	25	—	—	2	38
<i>Escherichia coli</i> , other	—	—	—	—	—	—	—	—	—	—	—	—
<i>Listeria</i>	6	52	—	—	1	4	—	—	1	3	5	127
<i>Salmonella</i>	21	682	117	2,938	37	1,138	4	48	43	1,043	145	2,580
<i>Shigella flexneri</i>	1	7	—	—	1	49	—	—	—	—	—	—
<i>Shigella sonnei</i>	1	77	1	5	2	32	—	—	—	—	4	54
<i>Shigella</i> spp	1	2	—	—	—	—	—	—	1	2	—	—
<i>Staphylococcus enterotoxin</i>	4	15	1	15	18	278	2	9	56	1,420	39	655
<i>Vibrio parahaemolyticus</i>	—	—	—	—	—	—	—	—	—	—	1	47
<i>Vibrio</i> spp	—	—	—	—	—	—	—	—	—	—	—	—
<i>Yersinia enterocolitica</i>	—	—	—	—	—	—	—	—	7	68	—	—
Other bacterial	2	8	—	—	4	119	—	—	1	16	5	82
Total bacterial	116	4,000	121	2,996	241	6,294	12	88	152	3,645	309	7,330
Viral												
Astrovirus	—	—	—	—	—	—	—	—	—	—	—	—
Hepatitis A	—	—	—	—	—	—	—	—	—	—	—	—
Norovirus	16	862	3	61	25	398	1	17	26	564	40	645
Rotavirus	—	—	—	—	—	—	—	—	—	—	—	—
Other viral	1	6	—	—	1	2	—	—	—	—	—	—
Total viral	17	868	3	61	26	400	1	17	26	564	40	645
Chemical and toxin												
Ciguatoxin	—	—	—	—	—	—	—	—	—	—	—	—
Cleaning agents	—	—	—	—	—	—	—	—	—	—	—	—
Heavy metals	—	—	—	—	—	—	—	—	—	—	—	—
Monosodium glutamate	—	—	—	—	—	—	—	—	—	—	—	—
Mycotoxins	—	—	—	—	—	—	—	—	—	—	—	—
Neurotoxic shellfish poison	—	—	—	—	—	—	—	—	—	—	—	—
Paralytic shellfish poison	—	—	—	—	—	—	—	—	—	—	—	—
Pesticides	—	—	—	—	—	—	—	—	—	—	—	—
Plant/Herbal toxins	—	—	—	—	—	—	—	—	—	—	—	—
Puffer fish tetrodotoxin	—	—	—	—	—	—	—	—	—	—	—	—
Scombroid toxin/ Histamine	—	—	—	—	—	—	—	—	—	—	—	—
Other chemical	—	—	—	—	—	—	1	15	—	—	3	116
Other natural toxins	—	—	—	—	—	—	—	—	1	2	—	—
Total chemical and toxin	—	—	—	—	—	—	1	15	1	2	3	116
Parasitic												
<i>Anisakis</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Cryptosporidium parvum</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Cyclospora cayetanensis</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Giardia lamblia</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Trichinella spiralis</i>	—	—	—	—	—	—	6	28	1	7	—	—
Other parasitic	—	—	—	—	—	—	—	—	—	—	—	—
Total parasitic	—	—	—	—	—	—	6	28	1	7	—	—
Known etiology[§]	133	4,868	124	3,057	267	6,694	20	148	180	4,218	352	8,091
Unknown etiology[¶]	25	153	13	93	108	1,110	1	2	70	761	235	2,588
Multiple etiology^{¶¶}	3	110	1	157	14	229	—	—	10	150	29	623
Total	161	5,131	138	3,307	389	8,033	21	150	260	5,129	616	11,302

* Laboratory and clinical guidelines for confirming an etiology of a foodborne disease outbreak are specific for each bacterial, chemical/toxin, parasitic, and viral agent. Suspected etiologies are those that do not meet the confirmation guidelines (available at http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html).

[†] No outbreaks in the data reported fall in this category.

[§] The denominator for the total etiology percentages is the known etiology total. The denominator for the known etiology, unknown etiology, and multiple etiologies percentages is the total.

[¶] An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.

Surveillance Summaries

TABLE 9. Number of foodborne disease outbreaks and outbreak-associated illnesses attributed to plants, by etiology* and food commodity — Foodborne Disease Outbreak Surveillance System, United States, 1998–2008

Etiology	Grains/Beans		Oil/Sugar		Fruits/Nuts		Fungus		Leafy vegetables		Root		Sprout		Vine-stalk vegetables	
	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses	No. outbreaks	No. illnesses
Bacterial																
<i>Bacillus cereus</i>	44	281	—†	—	—	—	—	—	—	—	4	51	—	—	1	4
<i>Brucella</i> spp	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Campylobacter jejuni</i>	2	123	—	—	2	29	—	—	6	363	1	136	—	—	—	—
<i>Campylobacter</i> spp	—	—	1	3	—	—	—	—	1	7	—	—	—	—	1	13
<i>Clostridium botulinum</i>	1	2	—	—	—	—	1	2	—	—	2	6	—	—	3	9
<i>Clostridium perfringens</i>	16	457	—	—	—	—	—	—	1	33	—	—	—	—	8	1,115
<i>Escherichia coli</i> , Enterotoxigenic	—	—	—	—	—	—	—	—	1	66	—	—	—	—	1	300
<i>Escherichia coli</i> , Shiga toxin-producing	—	—	—	—	10	891	—	—	22	874	—	—	6	55	—	—
<i>Escherichia coli</i> , other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Listeria</i>	—	—	—	—	—	—	—	—	—	—	—	—	1	20	—	—
<i>Salmonella</i>	5	259	1	14	36	2,359	1	10	11	306	6	172	21	711	21	3,216
<i>Shigella flexneri</i>	—	—	—	—	—	—	—	—	1	6	—	—	—	—	1	886
<i>Shigella sonnei</i>	1	11	—	—	1	56	—	—	5	623	—	—	—	—	—	—
<i>Shigella</i> spp	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Staphylococcus enterotoxin</i>	3	14	—	—	1	2	—	—	1	50	4	34	—	—	1	2
<i>Vibrio parahaemolyticus</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Vibrio</i> spp	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Yersinia enterocolitica</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other bacterial	—	—	—	—	—	—	—	—	—	—	1	15	—	—	—	—
Total bacterial	72	1,147	2	17	50	3,337	2	12	49	2,328	18	414	28	786	37	5,545
Viral																
Astrovirus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hepatitis A	—	—	—	—	3	40	—	—	6	734	1	297	—	—	1	23
Norovirus	13	157	8	291	76	2,816	1	16	141	4,011	10	263	—	—	14	447
Rotavirus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other viral	—	—	—	—	1	32	—	—	—	—	—	—	—	—	1	3
Total viral	13	157	8	291	80	2,888	1	16	150	4,822	12	566	—	—	16	473
Chemical and toxin																
Ciguatoxin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cleaning agents	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Heavy metals	—	—	1	10	1	21	—	—	—	—	—	—	—	—	—	—
Monosodium glutamate	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mycotoxins	—	—	—	—	3	75	12	46	—	—	—	—	—	—	—	—
Neurotoxic shellfish poison	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Paralytic shellfish poison	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pesticides	—	—	—	—	—	—	—	—	1	14	—	—	—	—	—	—
Plant/Herbal toxins	—	—	—	—	—	—	—	—	1	6	—	—	—	—	—	—
Puffer fish tetrodotoxin	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scombroid toxin/Histamine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other chemical	3	24	6	13	6	20	1	2	—	—	—	—	—	—	1	9
Other natural toxins	—	—	—	—	1	4	—	—	—	—	1	2	—	—	—	—
Total chemical and toxin	3	24	7	23	11	120	13	48	2	20	1	2	—	—	1	9
Parasitic																
<i>Anisakiasis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Cryptosporidium parvum</i>	—	—	—	—	1	144	—	—	—	—	—	—	—	—	—	—
<i>Cyclospora cayetanensis</i>	1	4	—	—	7	269	—	—	4	665	—	—	—	—	—	—
<i>Giardia lamblia</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Trichinella spiralis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other parasitic	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total parasitic	1	4	—	—	8	413	—	—	4	665	—	—	—	—	—	—
Known etiology[§]	89	1,332	17	331	149	6,758	16	76	205	7,835	31	982	28	786	54	6,027
Unknown etiology[¶]	51	693	7	81	38	402	3	31	53	958	10	104	1	2	15	499
Multiple etiology	11	139	—	—	4	430	—	—	4	43	1	35	1	40	2	437
Total	151	2,164	24	412	191	7,590	19	107	262	8,836	42	1,121	30	828	71	6,963

*Laboratory and clinical guidelines for confirming an etiology of a foodborne disease outbreak are specific for each bacterial, chemical/toxin, parasitic, and viral agent. Suspected etiologies are those that do not meet the confirmation guidelines (available at http://www.cdc.gov/outbreaknet/references_resources/guide_confirming_diagnosis.html).

† No outbreaks in the data reported fall in this category.

§ The denominator for the total etiology percentages is the known etiology total. The denominator for the known etiology, unknown etiology, and multiple etiologies percentages is the total.

¶ An etiologic agent was not confirmed or suspected based on clinical, laboratory, or epidemiologic information.

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