

## PEER-REVIEWED ARTICLE

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# A Historical Look at the Prevalence of Foodborne Disease Outbreaks Associated with Asian Foods in the United States

## ABSTRACT

Asian foods have become a popular dining option for Americans in recent years. We examined foodborne illness outbreak data reported by the Centers for Disease Control and Prevention, cross-checked them, and analyzed them on the basis of number of outbreaks, cases per outbreak, etiology, outbreak location, and food vehicles to evaluate recent food safety trends associated with Asian food. From 1990 to 2008, 8.7% of the foodborne disease outbreaks in the U.S. (17,640 total outbreaks) were associated with three popular ethnic food categories (Italian, Mexican, and Asian). Asian foods represented approximately 20.6% of outbreaks (315 outbreaks) and 9.6% of cases (3,529 cases) of the totals associated with ethnic foods. The majority of outbreaks originated in restaurants/delicatessens (60%) and were of unknown etiologies (62.2%). Bacterial agents were the most prevalent of the known etiologies (77%), followed by viruses (18%) and then by

chemicals and toxins (5%). Asian foods most frequently associated with illness were Asian-style cooked and fried rice (40%) and sushi (15%). This epidemiological analysis suggests the need for further examination of special issues concerning ingredients, preparation, cooking, serving, and handling of Asian foods in the United States.

## INTRODUCTION

In 2010, the U.S. Census Bureau determined that 4.8% of the total U.S. population can be characterized as Asian (Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, and other Asian categories, or a combination of Asian categories), constituting 14,674,252 people out of a total population of 308,745,538 (32). This percentage was predicted to increase to 5.6% by 2012, with 17.3 million residents identifying as Asian (8). The continuous increase of this sector of the population and the general public's growing interest in ethnic flavors has made ethnic foods, and Asian foods in particular, mainstream in the U.S. It is no longer sufficient to label something as "ethnic," as the public is increasingly familiar

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with specific ingredients and items that are part of traditional ethnic cuisines (28). This strong influence of ethnic cuisines on the American diet is a direct result of what is known as the globalization effect, which involves many different factors, from international trade to travel to immigration (12, 13).

In addition to Asian foods becoming a conventional option for Americans, they have also become much more available than in the past, whether in stores or in restaurants. In 2007, there were at least 43,139 Chinese restaurants in the country, which represented approximately \$17.5 billion in annual sales, or one-fourth of the total sales generated by the ethnic restaurant sector in the U.S. (20). These numbers reflect only the influence of Chinese restaurants; however, many other Asian ethnicities are now represented in the gastronomic scene, including Vietnamese, Korean, Taiwanese, Japanese, and Thai. A 2013 survey found that 45% of adults in the U.S. say that restaurants are an essential part of their lives, and 68% of adults say they look for flavors and taste sensations they themselves cannot create at home when they go out to eat in restaurants (22). Americans of all backgrounds, whether of foreign descent or not, have been influenced by the globalization of culture, and the increased spending power of certain sectors of the population means that many people eat out quite frequently. By 2020, spending per capita is predicted to increase by 18% at full-service restaurants and by 6% at fast food restaurants (26, 31).

In the United States, consumers' concept of Asian cuisine encompasses foods from various Asian countries, including China, Vietnam, Korea, Thailand, and Japan, of which Chinese and Japanese cuisines are the most popular. Chinese and Japanese foods involve ingredients and cooking styles that are characteristic of the geographical region from which they originate. However, "Americanized" versions of these cuisines are common in the U.S. For example, original recipes have been modified to include more monosodium glutamate (MSG) to boost flavors, and more deep fat frying is used in the Americanized versions than in traditional versions of these cuisines (17).

Asian cuisine may include rice as the main starchy food in almost every dish, pork and poultry as the protein sources of choice, various dried beans and nuts, and fruits and vegetables (8). The Center for Science in the Public Interest (CSPI) reports that between 2001 and 2010, fresh produce was the food category causing the largest number of outbreaks (696) and illnesses (25,222), followed by seafood (657 outbreaks and 5,603 illnesses), poultry (458 outbreaks and 11,338 illnesses), and pork (176 outbreaks and 3,794 illnesses). Fresh produce items are among the top ingredients in Asian foods; however, because most of them are cooked before serving, the general commodity associated report (2) may not explain foodborne illness data for Asian foods. In addition, these numbers may be relative to their magnitude of consumption (29). Rice has been identified as a prevalent vehicle for food poisoning caused by *B. cereus*

(a spore former). Contamination of rice with *Bacillus* spp. can occur at any point from harvesting through cooking and serving (1), and the spores of *Bacillus* spp. can survive even cooking at high temperatures, after which germination and multiplication can occur if the food is improperly cooled. In order for *Bacillus* spp. to cause both emetic and diarrheal illness, it need only be present at concentrations of  $10^5$ – $10^8$  colony forming units (CFU) per gram of ingested food. Some emetic cases have been reported to be caused by as little as  $10^3$  CFU/g of food ingested. The association of rice with *Bacillus* spp. has mainly been attributed to improper holding conditions, such as keeping rice at room temperature after it has been boiled and before it has been fried for consumption. This practice is customary in Asian cuisine to prevent clumping of the rice (6). Even though this epidemiological information indicates the incidence of foodborne illness associated with various ingredients common to Asian cuisine, there is no clear breakdown of foodborne illness data associated with these ingredients when used in Asian cuisine.

In 2011, the Centers for Disease Control and Prevention reported that approximately 1 in 6 Americans gets sick every year from foodborne diseases, 128,000 are hospitalized, and 3,000 die (2). A study of CDC foodborne illness data from 1990 to 2000 found that the three main types of ethnic foods most frequently associated with foodborne illness outbreaks are Mexican, Italian, and Asian. These three ethnic food groups averaged 15 to 100 cases per outbreak during the same time period (27). The number of cases per outbreak does not necessarily correlate with the severity of the outbreaks. Breaking down foodborne illness data according to specific ethnic food type can help us understand the impact on public health from foodborne illnesses spread by these ethnic foods and narrow down the root problems that make them susceptible to food safety issues.

In spite of growing interest in ethnic foods and their accessibility to consumers today, epidemiological information on these trending cuisines is currently extremely scanty in the U.S. (10). In particular, food safety information associated with Asian foods is scarcely available to the public. The objective of this study was to examine foodborne illness data reported by the CDC between 1990 and 2008 in order to: (1) determine the proportion of foodborne disease outbreaks associated with Asian foods; (2) assess the etiology, bacterial agent distribution, and food vehicles in Asian foods that contributed to foodborne outbreaks in the U.S., and (3) investigate the circumstances that make Asian food items prone to food safety risks.

## MATERIALS AND METHODS

Data on the incidence of foodborne illness outbreaks associated with Asian and other ethnic foods (Italian and Mexican) between 1990 and 2008 were gathered from the Centers for Disease Control and Prevention (CDC) Foodborne Outbreak Online Database (FOOD) (3). For the

purpose of this research, Asian cuisine refers to both Chinese and non-Chinese foods, including Vietnamese, Korean, Thai, and Japanese, among others, and the ingredients commonly used in such cuisines. Throughout our data analysis, foods identified as Asian were examined against Webster's New World Dictionary of Culinary Arts to corroborate their proper culinary origin (15). Data obtained from FOOD were current up to the year 2010. Moreover, outbreaks found on FOOD were cross-checked against data reported by the Center for Science in the Public Interest in the Outbreak Alert! Database, which is current up to the year 2009 (5). Outbreak data for the years 2007 and 2008 were further verified with the U.S. Food and Drug Administration Recalls, Market Withdrawals and Safety Alerts 2004–2011 (33). The data for the total foodborne disease outbreaks and cases reported each year from 1990 to 2008 were obtained from the CDC's *Morbidity and Mortality Weekly Report (MMWR)* (4). Additional data related to Asian cuisine were extracted from previous publications (7, 27). All data were collected and grouped by type of ethnic food (Asian, Italian, or Mexican). Subsequently, data associated with Asian foods were sorted into categories as to number of outbreaks and cases, etiology, outbreak location, and outbreak-associated food vehicle. The data associated with Asian foods were analyzed by calculating percentages relative to the total number of outbreaks and cases each year, as well as the prevalence of etiology, outbreak location, and food vehicle within the data pertaining to Asian foods. It is relevant that some of the outbreaks reported by the CDC may have involved more than one type of food or may not have been able to be placed in the categories chosen for this study; therefore, a degree of error ( $\pm 5\%$ ) is expected. Throughout this article, an outbreak is defined as "the occurrence of two or more cases of a similar illness resulting from the ingestion of a common food" (4).

## RESULTS AND DISCUSSION

Between 1990 and 2008, the CDC reported a total of 17,640 foodborne illness outbreaks, with 403,449 illness cases; 1,529 of the outbreaks (36,549 cases) were associated with three common ethnic food categories: Italian, Mexican, and Asian. The outbreaks linked to these three types of ethnic foods were 8.7% of the total foodborne illness outbreaks reported during the 18-year period. Asian foods represented 1.79% of total foodborne illness outbreaks, and 20.60% of the outbreaks associated with the three major ethnic foods groups (315 outbreaks and 1,529 illness cases) between 1990 and 2008 (Fig. 1A and 1B). A considerable number of outbreaks associated with Asian foods occurred over the 18-year period, but these had fewer cases per outbreak than the other two commonly represented types of ethnic foods (Italian and Mexican) did. This difference could be attributed to less consumption of Asian foods than of the other two categories of foods. The years with the highest

percentages of outbreaks associated with Asian foods were 2001 and 2002, while 1997 and 2008 had the highest number of illness cases associated with Asian foods. Total numbers suggest an increasing trend in the incidence of disease caused by this type of ethnic cuisine between 1990 to 1998; however, from 1999 to 2008, numbers leveled off. The same trend is observed for the number of illnesses per outbreak during the same period of time. This trend can be attributed to increased consumption and availability of Asian foods over the period in question as well as increased food safety awareness by governmental agencies, food service industries, and consumers. Moreover, it has been suggested that the increased consumption of Asian foods cannot necessarily be attributed to an increasing Asian population in the U.S. since approximately 75% of ethnic foods are consumed by individuals not associated with the ethnicity of that food (20). An increase in the availability of Asian foods has been documented, with the number of Chinese restaurants in the U.S. now surpassing the number of McDonald's, Wendy's, and Burger King restaurants (20). Also, surveillance methods regarding foodborne diseases have improved considerably over the years, so that more information is now gathered and published on this matter than was collected almost two decades ago.

The number of foodborne illness outbreaks with unknown etiologies is higher than the number with known etiologies for Asian foods. Overall, 62.2% (196 outbreaks) of the total foodborne illness outbreaks linked to Asian foods were of unknown etiology, while in 37.8% of outbreaks (119 outbreaks) the microorganisms responsible for the foodborne illness were identified. The majority of outbreaks with known etiology were caused by bacteria (~77%), followed by viruses (18%), and finally, chemicals or toxins (5%). Moreover, the most prevalent known bacterial agents responsible for foodborne outbreaks associated with Asian foods between 1990 and 2008 were *Bacillus cereus* (45% incidence), *Salmonella* spp. (33% incidence) and *Staphylococcus* spp. (16% incidence). Other microorganisms, including *Clostridium* spp., *Campylobacter* spp., *Vibrio parahaemolyticus*, and *Plesiomonas shigelloides*, caused small numbers of outbreaks. These findings are consistent with a study of food safety trends associated with ethnic foods in which researchers found that *Bacillus* spp. were responsible for 50% of foodborne illness outbreaks associated with Asian foods from 1990 to 2000 (27). However, a 5% decrease in the incidence of outbreaks of foodborne illnesses related to this microorganism and to Asian foods was observed over the next 8 years. Eighteen percent of outbreaks associated with viral agents were caused by norovirus. These outbreaks were most likely caused by poor personal hygiene of food handlers and poor handwashing techniques. It has been suggested that personal hygiene and handwashing are practices of concern in ethnic food establishments and that specific handwashing techniques should be taught and refreshed regularly, as well

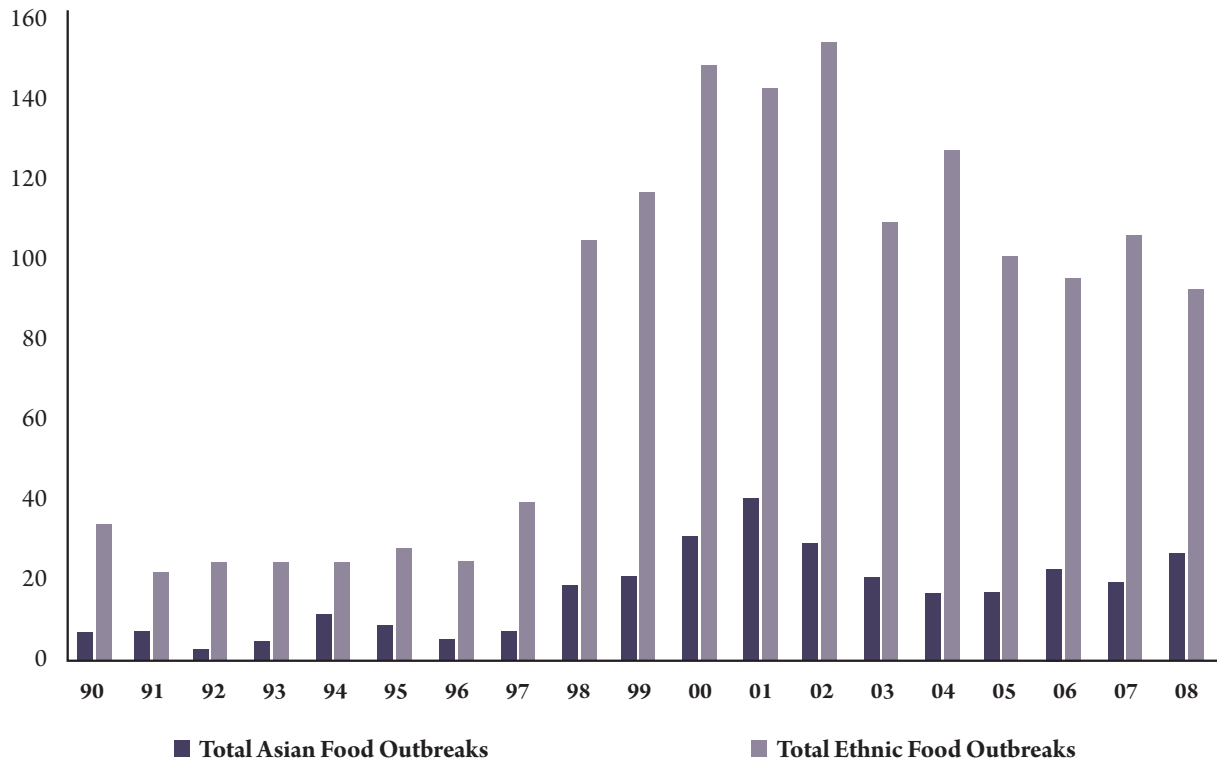


Figure 1A. Total foodborne illness outbreaks associated with Asian foods from 1990 to 2008 compared to total foodborne illness outbreaks associated with ethnic foods in the same period

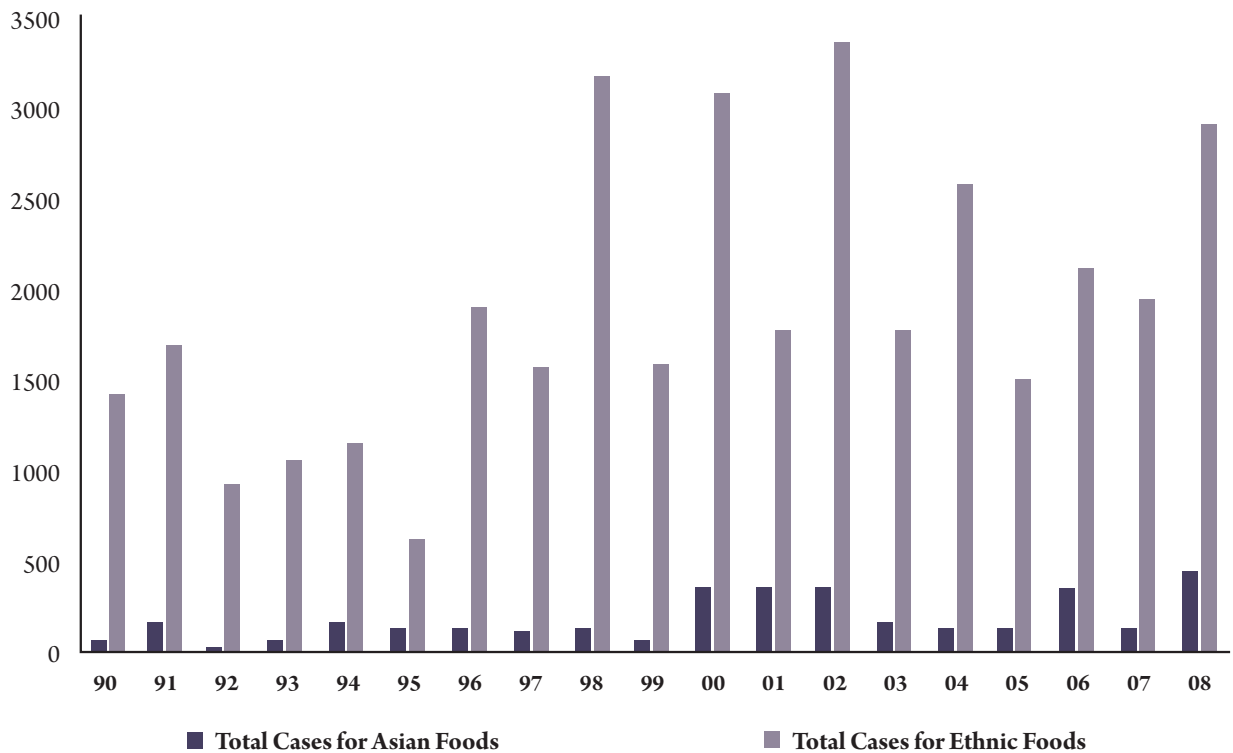


Figure 1B. Total foodborne illness cases associated with Asian foods from 1990 to 2008 compared to total cases associated with ethnic foods in the same period

as constantly encouraged in the food service field via posters or verbal reminders (21, 30).

However, proficient handwashing behavior, a challenge across the entire foodservice industry, is influenced by several factors, including training cost, high employee turnover, and diverse demographics. It has been reported that fewer than 30% of employees comply with the handwashing recommendations in the FDA Model Food Code (24). A study involving 300 restaurants in 6 states in the U.S. showed that food handlers attempted to wash their hands only 32% of the times when they should have washed their hands after contact with food; during these attempts, only 27% of food handlers actually washed their hands correctly (11). These studies suggest that there is a wide gap between training and compliance regarding handwashing practices in the foodservice industry. Most of the time, this disconnect is not due to a lack of training, so perhaps the type of training is what needs to change. Therefore, it has been suggested that training should focus not only on the education component, which imparts the pertinent information, but also on social behavior, motivated by the self-protection instinct and ultimately aimed at creating a habit, not just awareness (24). By creating better hand hygiene habits, as well as modifying training efforts to focus on social and cultural aspects, the high incidence of foodborne outbreaks associated with restaurants and other foodservice locations may be significantly reduced, especially in ethnic restaurants, where food safety practices can vary significantly from establishment to establishment.

The majority of foodborne illness outbreaks associated with Asian foods between 1990 and 2008 occurred in restaurants and delicatessens (60%), followed by private homes (16%), the workplace (8%), schools (4%), churches or temples (2%), and other locations, including hotels, conferences, camps, festivals, fairs, banquet facilities, prisons, or multiple settings, which together accounted for 7% of outbreaks. Restaurants and delicatessens were the location with the highest number of outbreaks associated with Asian foods, which correlates with the fact that more than half of the foodborne illness outbreaks reported by the CDC originate at restaurants and delicatessens (10). Previous studies on the incidence of foodborne illness outbreaks associated with ethnic foods, including Asian foods, have also pointed out consistently that restaurants are the location where the most foodborne illness outbreaks originate (7, 27). It is important to understand the contributing factors present in restaurants and delicatessens that lead to foodborne illness outbreaks; the most common factors are contamination of food by food handlers and cross-contamination or mishandling of food (9). Once these contributing factors are narrowed down, efforts can be focused on preventing such contributing factors in restaurants and establishments alike (9). Moreover, ethnic food restaurants, like many mainstream restaurants, may have compliance problems,

such as improper holding time and temperature, improper handwashing, poor personal hygiene, cross-contamination, inadequate cooking, and use of supplies and ingredients obtained from untrustworthy sources (23).

Cultural differences sometimes can influence the approach taken toward food safety issues, such as food safety training and proper food handling, in ethnic restaurants. In a study surveying twenty Chinese restaurant owners/operators in the U.S., lack of money, time, labor, and energy, as well as varying education levels, were identified as major reasons why a third-party food safety training represents a challenge to their organizations. Some reported that they conduct internal trainings. However, some owners/operators did not deem food safety training (outside internal training) necessary and stated that they were confident that the food they served is safe. However, it was reported that these individuals may not have a complete grasp of the importance of proper food safety training and the impact it can have on their organizations (19). This is proof that cultural differences and socioeconomic circumstances represent major obstacles in communicating proper food safety training to food handlers in some Asian restaurants in the U.S., although lack of food safety knowledge among food handlers is not specific to ethnic food handlers. Educational programs to increase awareness and knowledge of food safety and proper food handling are needed throughout the food service sector, but they may be particularly needed in the ethnic food sector (preferably through methods using employees' native languages) to ensure complete understanding of the importance of preventing outbreaks of foodborne illness in consumers.

The data were further examined to better understand the observed trends in food safety related to Asian foods. The outbreaks were grouped according to the food vehicle identified as the culprit in the foodborne disease. Rice (including fried, white, and dark rice) was grouped as one category and accounted for 40% ( $n = 48$ ) of the outbreaks analyzed in this study, a finding in accordance with reports of *Bacillus cereus* frequently being linked to improper cooling practices for fried rice (14). Sushi was the food vehicle for 15% ( $n = 18$ ) of the outbreaks, noodles and noodle dishes for 8% ( $n = 9$ ), and eggrolls (spring rolls, tofu, chicken, and pork) for 7% ( $n = 8$ ) (Fig. 2). Other foods, caused smaller numbers of outbreaks, including wontons or wonton soup, chicken or beef with broccoli, Asian salads, ahi tuna, and mung bean sprouts, among others caused smaller numbers of outbreaks. Many of the foods reported as vehicles in the CDC data are made up of numerous ingredients, making it difficult to identify which specific ingredients could have been contaminated. However, it is likely that inadequate cooking, improper heating and cooling procedures, and/or poor personal hygiene and handwashing practices were behind the proliferation of foodborne pathogens in these foods.

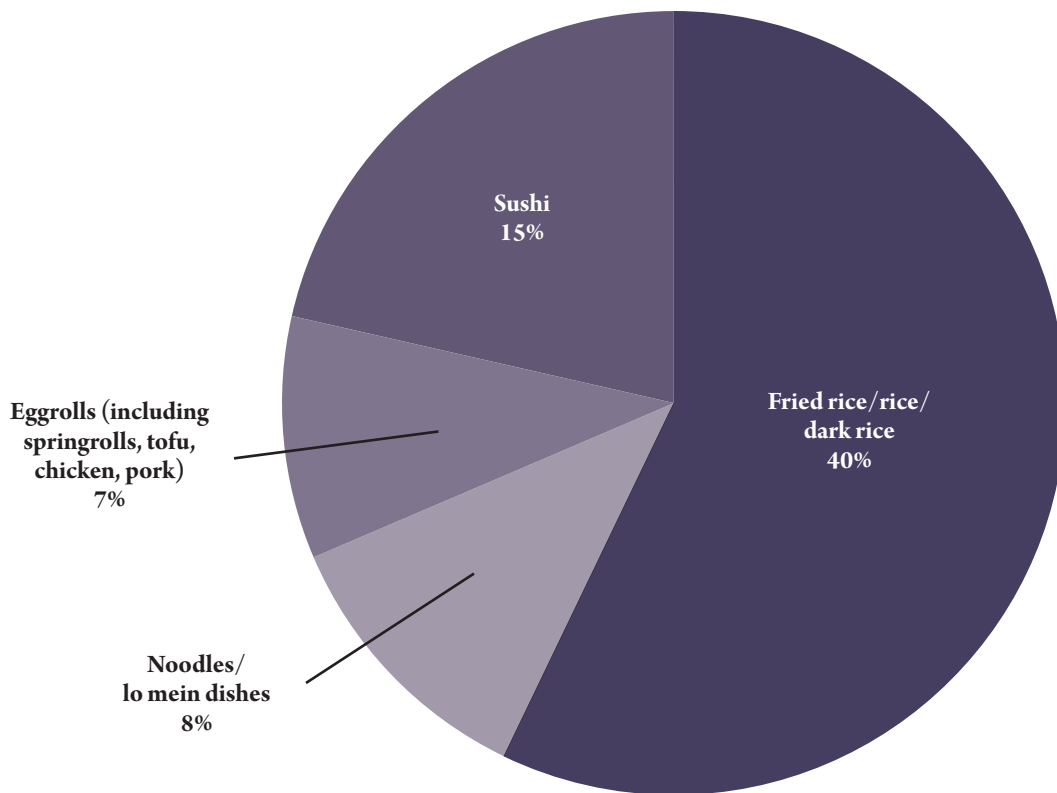


Figure 2. Most prevalent food vehicles of foodborne illness outbreaks of known etiology associated with Asian foods between 1990 and 2008

As the number of consumers who enjoy eating ethnic foods (especially in ethnic restaurants) increases, food safety practices must be maintained and better enforced in such establishments. It has been reported that restaurant operations are responsible for 52–59% of foodborne illness outbreaks in the United States (25). Restaurant sanitation inspections are one way the Department of Health enforces the exercise of food safety practices in restaurants and food service establishments. The results (scores) of such inspections, which are posted in restaurants as well as in the media (16), allow consumers to evaluate the commitment of an establishment to food safety, therefore creating a sense of trust that can lead to an increase in business (18). A study found that independent ethnic restaurants in 14 counties in the state of Kansas had significantly higher numbers of inspections and food code violations than non-ethnic, chain non-ethnic, and chain ethnic restaurants, which indicates that it is particularly difficult for independent ethnic restaurant to adhere to proper food safety practices. Therefore, better food safety programs need to focus more specifically than they do at present on educating food handlers and managers of ethnic restaurants (25). It has, in fact, been demonstrated that inspection scores significantly improve after managers and food handlers are trained in food sanitation practices (14).

## CONCLUSION

A review of CDC data on foodborne illness outbreaks associated with Asian foods from 1990 to 2008 suggests the incidence of disease linked to this cuisine increased between 1990 and 1998 and then stabilized over the next 10 years. Overall, 62.2% of total foodborne illness outbreaks linked to Asian foods were of unknown etiology, while 37.8% of outbreaks had a known microbiological culprit. The majority of outbreaks occurred in restaurants or delicatessen establishments (60%), followed by private homes and the workplace. Seventy-seven percent of the total outbreaks associated with Asian foods were caused by bacterial agents, including *Bacillus cereus* (45%), *Salmonella* spp. (33%), and *Staphylococcus* spp. (16%). It was expected that *Bacillus cereus* would be the most common pathogen-causing illness, since most Asian dishes are either accompanied by rice or based on rice, which is the preferred substrate for this organism. The reasons for these outbreaks presumably include inadequate cooking, improper heating and cooling procedures, and poor personal hygiene and handwashing practices, especially in food service establishments. Therefore, food safety training that emphasizes these practices and is better aimed at creating proper food safety behavior should be encouraged and actively enforced in all ethnic restaurants, with specific food safety

issues pertinent to each cuisine and culture emphasized in the training programs. This approach will not only reduce the risk of causing foodborne illness in consumers, but also lead to better inspection scores, which will build consumer trust and create more business for the establishment.

This epidemiological study is important because it aids in understanding the risks associated with ethnic foods, particularly Asian foods. Because the number of restaurants serving this cuisine is constantly growing, the conclusions obtained through this analysis suggest that further examination of special issues concerning ingredients, preparation, cooking, serving, and handling of Asian foods is needed. Also, the focus of food training effort should shift from being purely educational to creating awareness, changing social behavior, increasing the understanding of food safety risks, and ultimately changing the culture of each establishment. Therefore, continuous monitoring of available foodborne illness outbreak data associated with ethnic foods (specifically the popular Asian food sector) is needed in order to increase awareness of emerging food safety trends in this type of cuisine. Efforts to improve food safety training techniques for foodservice staff and management at ethnic food establishments should also be increased.

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## Limitations

This study is limited by the data available through the CDC's databases and the data this agency is able to collect. In numerous instances, the data were exceedingly general, particularly in regard to the food vehicles involved in the outbreaks and the ingredients they contained; therefore, it was difficult to narrow the source of the outbreak to specific ingredients rather than a whole dish. Also, many cases go unreported, as the public does not necessarily associate illness with food and may forget having eaten something that could have caused the illness. In addition, many people affected by foodborne illness do not go to a hospital for treatment, thus increasing the number of unreported cases. Therefore, the conclusions drawn from this analysis can only suggest trends established by tallying of the data; no quantitative statistical inferences should be made from the results presented in this article.

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