Older Adults at Risk of Complications From Microbial Foodborne Illness

Jean C. Buzby

Although younger individuals usually face far higher rates of infection from foodborne pathogens (bacteria, fungi, parasites, viruses, and their toxins), older adults, along with the very young and the immuno-compromised, are more likely to have some of the more severe complications from these infections. In particular, some research has shown that the elderly are more vulnerable to gastroenteritis-induced deaths.

Data from the Centers for Disease Control and Prevention's (CDC) FoodNet surveillance system show that for some pathogens, older adults have lower culture-confirmed rates of infection than most or all of the other age groups, despite many age-related factors, such as decreased immune functioning and decreased stomach acid production, that predispose older persons to gastrointestinal infections and their more severe complications. These low rates may be partly due to older persons being more careful about food handling and food consumption than younger persons. Culture-confirmed rates of infection for people over age 60 range from 0.1 cases per 100,000 people for *Vibrio* and *Cyclospora* to 10.8 cases per 100,000 people for *Salmonella*. The infection rates for all Americans range from 0.04 cases per 100,000 people for *Cyclospora* to 17.4 cases per 100,000 people for *Salmonella*. Preliminary new FoodNet data from a separate telephone survey on diarrheal disease indicate that adults over the age of 65 have the lowest prevalence of diarrheal disease of any age group for monitored pathogens.

Older adults can benefit from education on safe food handling and food consumption behavior and, in turn, prevent some of the annual foodborne illnesses among this age category. In this article, the term "older adults" refers to individuals age 60 or older, following

Older adults' lower rates of infection for some foodborne pathogens may be partly explained by their more careful approach to food consumption and food handling.

Credit: PhotoDisc.

Jean C. Buzby (202) 694-5370 jbuzby@ers.usda.gov

The author is an agricultural economist with the Food and Rural Economics Division, Economic Research Service, USDA. Article developed in consultation with Dr. James Smith, Agricultural Research Service, USDA.

a category used by FoodNet. The growing number of older adults in the U.S. population suggests that preventing foodborne illness and death among older adults will remain an important challenge.

Foodborne Illness Can Have Secondary Complications

CDC estimates that each year in the United States, nine microbial pathogens cause an estimated 3.5 million foodborne illnesses, 33,000 associated hospitalizations, and over 1,200 deaths (table 1). Data are unavailable on what proportion of these illnesses and deaths afflict older adults.

Most cases of foodborne illnesses are classified as "acute." These cases are usually self-limiting and of short duration, although they can range from mild to severe. Gastrointestinal problems and vomiting are common acute symptoms of many foodborne illnesses. Deaths from acute foodborne illnesses are relatively rare and more typically occur in the very young, the elderly, or persons with compromised immune systems.

The U.S. Food and Drug Administration estimates that 2-3 percent of all acute foodborne illnesses develop secondary long-term illnesses and complications called chronic sequellae. These sequellae can occur in any part of the body, such as the joints, nervous system, kidneys, or heart. One chronic sequella from *Campylobacter* infections that particularly afflicts older adults is Guillain-Barré Syndrome (GBS), which is an auto-immune reaction that can cause paralysis. GBS may afflict patients for the remainder of their lives and may result in premature death. Other causes of GBS have been documented, such as an auto-immune response to respiratory infections.

Rates of Infection Tell Part of the Story

The 1999 FoodNet data provide information on the annual cases per 100,000 U.S. persons in nine U.S. sites by age distribution for nine foodborne pathogens (see box on FoodNet). The foundation for these estimates are U.S. foodborne illnesses that were identified by clinical laboratory tests, or "culture confirmed," and recorded by FoodNet surveillance personnel in each site. To estimate the number of cases per 100,000 people for each age category, the number of reported cases in each age category was divided by the population for each age category according to the 1999 Census population estimates.

According to CDC, FoodNet data have three limitations. First, current reporting captures roughly 13 percent of the U.S. population, meaning that the data may not be nationally representative. Second, FoodNet data are limited to laboratory-confirmed illnesses that are reported by surveillance personnel. However, most individuals with foodborne illnesses are never tested to determine the type of pathogen that caused their illness, and even if the illness is laboratory confirmed, an unknown portion of these illnesses is not reported to surveillance personnel. Additionally, individuals of different age groups may not all be tested at the same rate. For example, children may be tested for foodborne illness more frequently than older adults. Third, some laboratory-confirmed illnesses reported to FoodNet can be acquired through nonfoodborne

Table 1—Nine Foodborne Pathogens Cause Over 3.5 Million Illnesses

Pathogen	Estimated total annual foodborne illnesses		
	Cases	Hospitalizations	Deaths
		Number	
Campylobacter spp.	1,963,141	10,539	99
Salmonella, nontyphoidal	1,341,873	15,608	553
Shigella	89,648	1,246	14
Yersinia	86,731	1,105	2
E. coli O157:H7	62,458	1,843	52
Cryptosporidium	30,000	199	7
Cyclospora	14,638	15	0
Vibrio	5,218	125	31
Listeria	2,493	2,298	499
Total	3,596,200	32,978	1,257

Source: CDC estimates for annual cases, hospitalizations, and deaths for people of all ages, www.cdc.gov/ncidod/eid/vol5no5/mead.htm

FoodNet Data

The Foodborne Diseases Active Surveillance Network (FoodNet) is the principal foodborne-disease component of the Centers for Disease Control and Prevention's (CDC) Emerging Infections Program (EIP). FoodNet is a collaborative project among CDC, the nine EIP State health department sites, USDA's Food Safety and Inspection Service (FSIS), and the U.S. Food and Drug Administration. The nine locations consist of select counties or statewide sites in California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New York, Oregon, and Tennessee. The total population of the current catchment is 37.8 million persons, or 13 percent of the U.S. population.

FoodNet is a sentinel network that is producing more stable and accurate national estimates of the burden and sources of specific foodborne diseases in the United States through active surveillance and additional studies. Pathogens reported under FoodNet are *Campylobacter, Cryptosporidium, Cyclospora, E. coli* O157:H7, *Listeria, Salmonella, Shigella, Vibrio,* and *Yersinia.*

For more information on FoodNet, see the CDC Web site: http://www.cdc.gov/foodnet/

routes, such as contaminated water, person-to-person contact, and direct exposure to infected animals. Therefore, the reported rates do not represent foodborne sources exclusively.

For most of the nine pathogens (see box on pathogens), rates of infection are relatively high for children under age 10 and relatively low for older adults, despite many risk factors that predispose older persons to these illnesses (table 2). These lower rates for older adults may be partially explained by their reported safer food handling and food consumption behavior described later in this article. Also, nursing homes may take additional precautions to ensure food safety, such as serving only irradiated poultry.

Of the nine pathogens, *Salmonella* (nontyphoid) had the highest rate of infection for adults age 60 and older (10.8 cases per 100,000 people); *Campylobacter* had the second highest rate (9.7 cases per 100,000 people). These findings are not surprising as *Campylobacter* and *Salmonella* cause far more total illnesses each year in the United States than the other seven FoodNet pathogens.

Although younger individuals usually face far higher infection rates from these pathogens, older adults are more likely to have some of the more severe complications. For example, many studies have found that GBS has a bimodal age distribution with the highest peak for people older than 50 and that older patients are more likely than younger patients to require a ventilator and to have a poor prognosis. In a 1997 *FoodReview* article, USDA's Economic Research Service (ERS) incorporated a bimodal age distribution when estimating the annual costs of foodborne *Campylobacter*-associated GBS. ERS researchers estimated that medical costs, productivity losses, and the value of premature deaths from *Campylobacter*-associated GBS total $0.1-$1.3 billion each year. Other studies suggest that the elderly are far more susceptible to death from *Salmonella* infections than the general population.

E. coli O157:H7 has the third-highest rate of infection for older adults, 1.8 cases per 100,000 people. Some studies suggest that nursing home residents and other elderly individuals appear to be particularly vulnerable to fatal *E. coli* O157:H7 infections. *Shigella* and *Listeria* have roughly the same rate of infection for older adults, though the rates are far lower than the associated infection rates for newborns. Shigellosis is a relatively mild foodborne illness, with an estimated 14 deaths each year for people of all ages. Listeriosis is more severe, with the second-highest number of estimated annual deaths of the nine FoodNet pathogens (table 1). Although we do not have firm estimates of the number of deaths from *Listeria* by age category, a few studies found that mortality from this pathogen was highest in the elderly.

Therefore, analyzing the rates of infection among the elderly is only part of the story, as illnesses vary in severity, with some posing higher risks of hospitalization and death. Although some research is available that provides a sense of the severity for select foodborne illnesses among older adults, more information is needed to determine the distribution of severity of illness among different age groups. In particular, the annual number of foodborne illnesses and deaths among older adults is needed to estimate the economic burden of these illnesses in older adults.

Elderly Susceptible to Foodborne Illness

According to a study by James Smith, a microbiologist with USDA's Agricultural Research Service, the elderly are more vulnerable to death from gastroenteritis than younger individuals. Smith outlines this increased susceptibility as arising from a variety of factors, though he cautions that the elderly are a very heterogeneous population in terms of physiological functions, health, and susceptibility to disease.

Poor nutrition and decreased food consumption, combined with normal age-related decreases in

Table 2—Older Americans Have Lower Rates of Infection for Several Foodborne Illnesses

	Foodborne illness cases per 100,000 people by age group (years)							
Pathogen	0 to <1	1 to <10	10 to <20	20 to <30	30 to <40	40 to <50	50 to <60	60+
				Number				
Salmonella, nontyphoidal	143.2	33.4	10.1	13.3	11.0	9.1	8.6	10.8
Campylobacter spp.	40.5	18.1	9.1	19.2	17.1	14.0	12.5	9.7
E. coli O157:H7	3.7	5.5	2.4	1.6	.5	.9	1.3	1.8
Shigella	7.3	12.9	1.7	4.0	3.6	2.2	1.6	1.3
Listeria	3.4	.1	0	.1	.2	.2	.6	1.2
Yersinia	14.6	.8	.4	.3	.2	.3	.3	.7
Cryptosporidium	3.4	2.4	.8	1.4	2.8	1.5	.6	.4
Cyclospora	0	0	0	.1	.1	0	0	.1
Vibrio	.8	.1	.1	.1	.2	.3	.2	.1

Source: *CDC Foodnet 1999 Final Report.*

immune system functioning, may weaken older adults' ability to fight foodborne pathogens. According to Smith, the elderly are particularly at risk for decreased nutritional intake because of such factors as digestive disorders (malabsorption, dental problems, greater difficulty swallowing); medication (nausea, loss of appetite, malabsorption); early satiety; living alone/social isolation; altered senses of smell and taste, which decrease the enjoyment of eating; and physical disabilities, which make it more difficult to shop and prepare food. Additionally, dehydration resulting from decreased consumption of fluids can also reduce immune functioning. The sensation of feeling thirsty commonly declines with age, putting older adults at risk of dehydration if they rely on thirst to govern liquid intake.

A person's immune system functioning decreases with age, and therefore people have decreased resistance to pathogens as they age. Also, decreased contractions that push food through the intestines slow the time it takes to eliminate pathogens from the intestinal tract, allowing more time for toxin formation and damage. Stomach acid production declines with age, allowing more ingested pathogens to enter the intestinal tract. The use of antimotility drugs to relieve diarrhea or drugs that decrease stomach acidity can lead to further increases in susceptibility to foodborne disease.

Also, major surgery often leaves patients with a short period of lowered immune functioning, and when coupled with any lowered immune functioning because of age, may put older adults at a relatively greater risk of foodborne illness and other infections. And, studies show that antibiotic use among the elderly is less effective and may interfere with normal colonization of bacteria in the intestinal tract, perhaps predisposing the elderly to some foodborne infections.

Nine Pathogens Covered by FoodNet

Salmonella. Poultry, meat, eggs, and milk are some of the major food vehicles of *Salmonella* transmission. Most persons infected with *Salmonella* develop diarrhea, fever, and abdominal cramps 12-72 hours after infection. The illness usually lasts 4-7 days, and most persons recover without treatment.

Campylobacter. Most cases are associated with handling raw poultry or eating raw or undercooked poultry meat. Symptoms tend to be relatively mild but can range from diarrhea and lethargy that lasts a day to severe diarrhea and abdominal pain (and occasionally fever) that lasts for several weeks. The incubation period is 1-10 days, with most cases occurring 3-5 days after exposure.

E. coli O157:H7. People can contract the disease from eating contaminated food, from person-to-person contact (for example, in nursing homes), and from swimming in contaminated water. Food vehicles include hamburger, unpasteurized apple cider and apple juice, hot dogs, raw milk, raw potatoes, and some salad bar items, such as ranch dressing and cantaloup. Acute symptoms include abdominal cramps, vomiting, diarrhea (often bloody), and sometimes fever. The incubation period is typically 3-5 days, and most cases are relatively mild, lasting days to weeks, and do not require medical care. More severe cases may develop hemorrhagic colitis (bloody inflammation of the colon). Some people develop hemolytic uremic syndrome (HUS), which is a life-threatening disease characterized by red blood cell destruction, kidney failure, and neurological complications, such as seizures and strokes. Some people may require lifelong dialysis or a kidney transplant.

Shigella. Most infections are not foodborne but are the result of *Shigella* passing from stools or soiled fingers of one person to the mouth of another person. Vegetables may become contaminated if harvested from a field contaminated with sewage. Food handlers can contaminate food if they do not wash their hands with soap after using the bathroom. Common symptoms include diarrhea (often bloody), fever, and stomach cramps starting a day or two after exposure. The illness usually lasts 5-7 days.

Listeria monocytogenes. Raw milk products, smoked seafood, soft cheeses, refrigerated pâté or meat spreads, and ready-to-eat foods, such as hot dogs and luncheon meats, are typically linked to infection from this bacteria. Milder cases of listeriosis are characterized by a sudden onset of fever, severe headache, vomiting, and other influenza-type symptoms. The incubation period for listeriosis is 4 days to several weeks and the infection tends to last days to several weeks.

Yersinia. Infection from *Yersinia* is most often acquired by eating contaminated food, especially raw or undercooked pork products. Unpasteurized milk has also been linked to this infection. On rare occasions, *Yersinia* infections can be transmitted person-to-person when basic hygiene and hand-washing habits are inadequate. In adults, right-sided abdominal pain and fever may be the predominant symptoms from infection from *Yersinia* and may be confused with appendicitis. Symptoms typically develop 4 to 7 days after exposure and may last 1 to 3 weeks or longer.

Cryptosporidium. This parasite is one of the most common causes of waterborne disease (drinking and recreational). If food becomes contaminated by this parasite and is undercooked, it may cause diarrheal illness. Symptoms generally begin 2-10 days after infection and last around 2 weeks.

Cyclospora. This parasite is transmitted through ingesting water or food that was contaminated with infected stool. Outbreaks of cyclosporiasis have been linked to various types of fresh produce. Common symptoms include diarrhea, vomiting, and stomach cramps. The incubation period is usually about 1 week and if not treated, the illness may last from a few days to a month or longer, and the person may experience relapses. Older adults appear to be particularly more susceptible to *Cyclospora* than other age categories.

Vibrio. People can become sick from *Vibrio* by eating contaminated seafood, particularly oysters and other shellfish, or by exposing an open wound to seawater. Symptoms typically include vomiting, diarrhea, and abdominal pain. Illness in immuno-compromised persons is typically more severe and life threatening. The incubation period is around a day and the infection generally lasts several days.

Table 3—Older Americans Report Safer Food Handling and Food Consumption Behavior Than Younger Americans

	Age (years)		
	18-29	30-59	≥ 60[1]
	Percent		
Food handling behavior			
Not washing hands with soap after handling raw meat or chicken (n = 14,445)	22[2]	20[2]	13
Not washing cutting surface with soap/bleach after using it for cutting raw meat or chicken (n = 13,364)	26[2]	20[2]	13
Food consumption behavior			
Eating pink hamburgers (n = 18,397)	22[2]	22[2]	13
Eating undercooked eggs (n = 18,562)	49	51	49
Eating raw oysters (n= 16,812)	10[2]	9[2]	4
Drinking raw milk (n = 16,846)	2[2]	1	1

Note: n = sample size
[1]Reference group.
[2]Significantly different from reference group, $p < 0.05$.
Source: Altekruse et al., 1999.

Nursing Homes Pose Special Challenges

Roughly 5 percent of people age 65 and older and 20 percent of people age 85 and older are in nursing homes. Some aspects of the nursing home environment pose special challenges for health care professionals to ensure proper nutrition and the control of foodborne disease. Dr. Cynthia Henderson, chief operating officer of Oak Forest Hospital, Oak Forest, Illinois, found that the elderly in nursing homes may have decreased nutrient intake because of loss of control over food choices, inappropriate food temperatures or meal timing, the need for assistance with eating, unattractive eating surroundings, and the presence of noisy or disturbing patients during eating. Other important contributors to reduced meal intake, which result in malnutrition and dehydration, are chronic and acute disease processes, dementia, and use of multiple medications.

Nursing home residents are particularly vulnerable to foodborne illness because of underlying illnesses and age-related decreases in immune functioning, factors that may also help explain why these individuals reside in nursing homes. Also, foodborne infections may be spread among nursing home residents because of close confinement with others who may be ill.

Residents of nursing homes also face a higher risk of more severe outcomes from a foodborne illness. Charles Gerba, professor of soil, water, and environmental sciences at the University of Arizona, compared case-fatality rates for specific pathogens that cause intestinal illness in nursing home populations with case-fatality rates from the general population. Gerba found that case-fatality rates from specific foodborne pathogens were 10-100 times higher for nursing home residents than for the U.S. population as a whole. In particular, the case-fatality rate in nursing homes was 10 times higher for *Campylobacter* and 100 times higher for rotavirus (a virus that causes severe diarrheal illness, particularly in children).

On the other hand, nursing homes take positive measures to prevent foodborne illness and help ensure proper nutrition among residents. For example, trained dieticians plan the menus, and nursing homes follow procedures to reduce risks of foodborne illness, such as thoroughly cooking eggs. For the elderly who find it difficult to shop for food and prepare meals, nutritious meals prepared and served for them may be a welcome aspect of their nursing home stay.

Many Foodborne Illnesses in Older Adults Can Be Prevented

While people can't turn back the clock or stop aging, older adults can take several actions to prevent foodborne illness. They can practice a healthful lifestyle that includes exercising regularly, eating a balanced diet, obtaining regular health care, practicing good food sanitation and handling practices, and paying careful attention to personal hygiene. Additionally, many older adults could benefit from food safety education that would encourage them to reduce risky food handling or food consumption behavior. In 1995-96, over 19,000 adults in eight States were interviewed under the Behavioral Risk Factor Surveillance System study. This study found that 13 percent of respondents age 60 or older did not wash their hands with soap after handling raw meat or chicken, 13 percent did not wash cutting surfaces with soap or bleach after using them for cutting raw meat or chicken, 13 percent ate pink hamburgers, 49 percent ate undercooked eggs, 4 percent ate raw oysters, and 1 percent drank raw milk (table 3). Random-digit dialing techniques used to select respondents for the telephone interviews did not capture nursing home residents.

Older adults were significantly less likely than younger individuals to engage in these risky actions, with the exception of eating undercooked eggs, which showed no significant difference among age groups. Several factors may explain why people born before the mid-1930s are more careful with the handling and consumption of food than those born in later years. In the early 1900s, refrigeration was less common and there were fewer

processed foods, so people had to be careful with food and the custom was to thoroughly cook most foods. Additionally, older persons have had more time to acquire food safety knowledge and have had more opportunity to learn from past experiences with contaminated food, so perhaps they are more likely to implement safer food handling and food consumption practices.

A closer examination of the behavior risk study data on eggs, however, reveals that of older adults who ate undercooked eggs, 56 percent ate them more than four times a month. Of younger individuals who ate undercooked eggs, only 48 percent ate them four times a month. Undercooked eggs are a major source of *Salmonella* serotype *enteritidis*, and in the United States illness from this serotype continues to rise. Because older adults have a relatively high incidence rate for *Salmonella*, compared with other foodborne illnesses, and because they are more likely to frequently consume undercooked eggs, egg safety education efforts targeted at older adults may help reduce the incidence rate of this illness.

Older adults can also benefit from improved food safety practices of their caregivers. Many older people rely on family members or home health care workers to prepare food for them. For example, the individuals providing food for older people who live in adult care homes (residences with less than 10 occupants) may not have had training in food safety. The kitchens in these adult care homes are neither inspected nor subject to Government food regulations, as are the kitchens in assisted living facilities and nursing homes.

The U.S. population is aging—people are living longer and the proportion of older adults is rising (see "America's Older Population" elsewhere in this issue). By 2020, individuals over age 65 will make up 16.6 percent of the U.S. population. And as these individuals grow older, many of them will have less functional immune systems, many of them will be in nursing homes, and many of them will be frail; thus, they will be more susceptible to illnesses, including foodborne illness. This older population will need special care. Geriatric health care practitioners will be faced with the prospect of developing cost-effective care for this aging population.

Practicing a healthful lifestyle, which includes getting regular exercise and eating a nutritious diet, is among several steps older adults can take to reduce food safety risks.

Credit: ERS.

References

Altekruse, S.F., S. Yang., B. Timbo, and F.J. Angulo. "A Multi-State Survey of Consumer Food-Handling and Food-Consumption Practices," *American Journal of Preventive Medicine*, Vol. 16, No. 3, 1999, pp. 216-21.

Blackman, D.K, L.A. Kamimoto, and S.M. Smith. "Overview: Surveillance for Selected Public Health Indicators Affecting Older Adults —United States," *MMWR*, Vol. 48, No. SS08, December 17, 1999, pp. 1-6, Accessed Nov. 29, 2001, http://www.cdc.gov/mmwr/preview/mmwrhtml/ss4808a1.htm

Centers for Disease Control and Prevention. "1999 Annual Report," CDC/USDA/FDA Foodborne Diseases Active Surveillance Network, CDC's Emerging Infections Program, Accessed Nov. 29, 2001, http://www.cdc.gov/foodnet/annual/1999/pdf/99_annual_pdf.htm

Gerba, C.P., J.B. Rose, and C.N. Haas. "Sensitive Populations: Who Is at the Greatest Risk?" *International Journal of Food Microbiology*, Vol. 30, 1996, pp. 113-23.

Henderson, C.T. "Nutrition and Malnutrition in the Elderly Nursing Home Patient," *Clinical Geriatric Medicine*, Vol. 4, 1988, pp. 527-47.

Klontz, K.C., W.H. Adler, and M. Potter. "Age-Dependent Resistance Factors in the Pathogenesis of Foodborne Infectious Diseases," *Aging Clinical Experimental Research*, Vol. 9, No. 5, 1997, pp. 320-6.

Mead, P.S., L. Slutsker, V. Dietz, L.F. McCaig, J.S. Bresee, C. Shapiro, P.M. Griffin, and R.V. Tauxe. "Food-Related Illness and Death in the United States," *Emerging Infectious Diseases*, Vol. 5, No. 5, September-October 1999, pp. 607-25, Accessed Nov. 1, 2000, http://www.cdc.gov/ncidod/eid/vol5no5/mead.htm

Smith, J.L. "Foodborne Illness and the Elderly," *Journal of Food Protection*, Vol. 61, No. 9, 1998, pp. 1229-39. FR