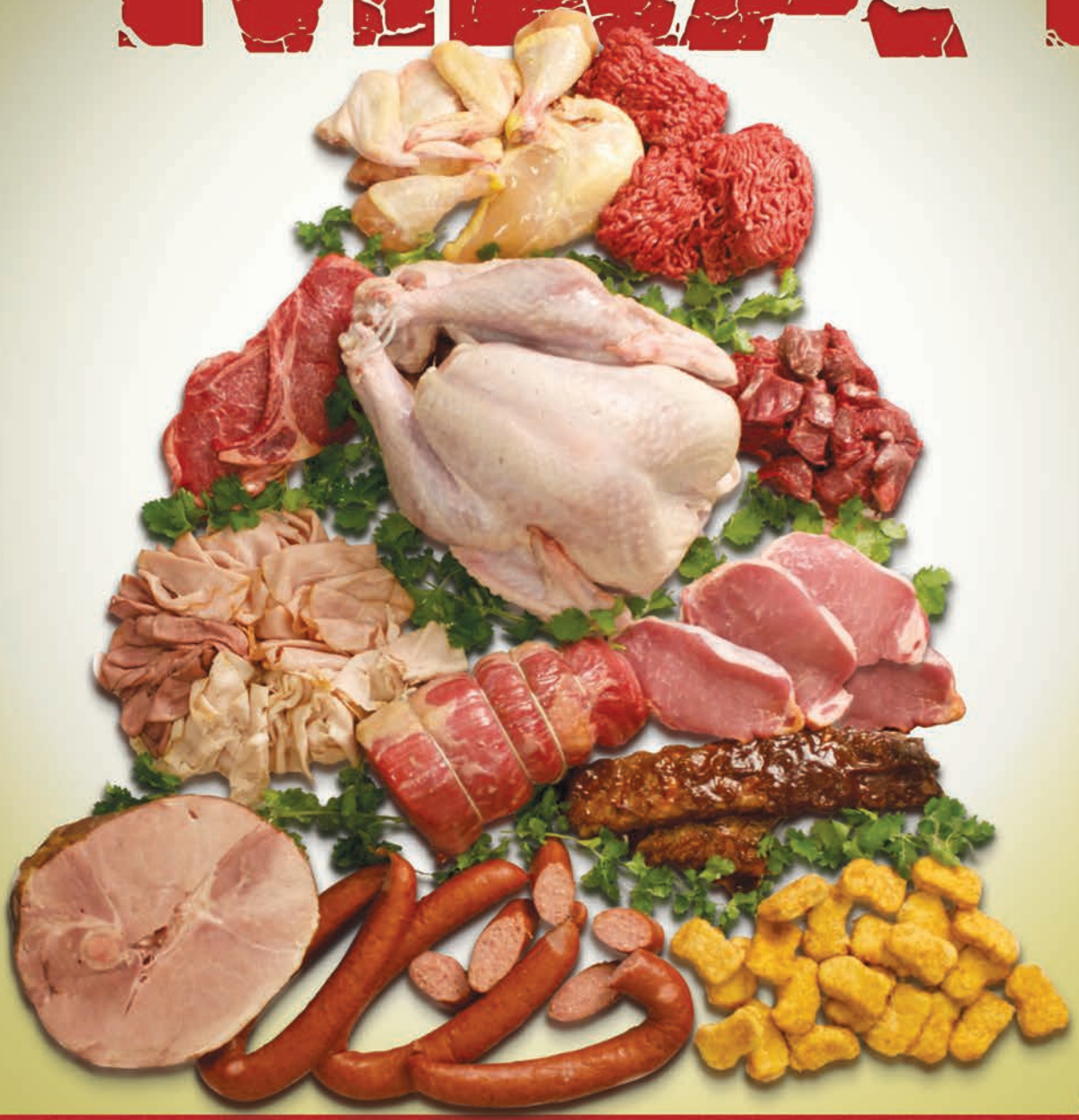
RISKY MEAT



A CSPI Field Guide to Meat and Poultry Safety

RISKY MEAT

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CENTER FOR Science IN THE Public Interest

Center for Science in the Public Interest (CSPI) is a non-profit organization based in Washington, DC. Since 1971, CSPI has been working to improve the public's health, largely through its work on nutrition and food-safety issues. CSPI is supported primarily by the 900,000 subscribers to its *Nutrition Action Healthletter* and by foundation grants. *Risky Meat* was made possible by a generous contribution from The Pew Charitable Trusts. The findings and conclusions are exclusively the work of the researchers and do not necessarily reflect the views of Pew.

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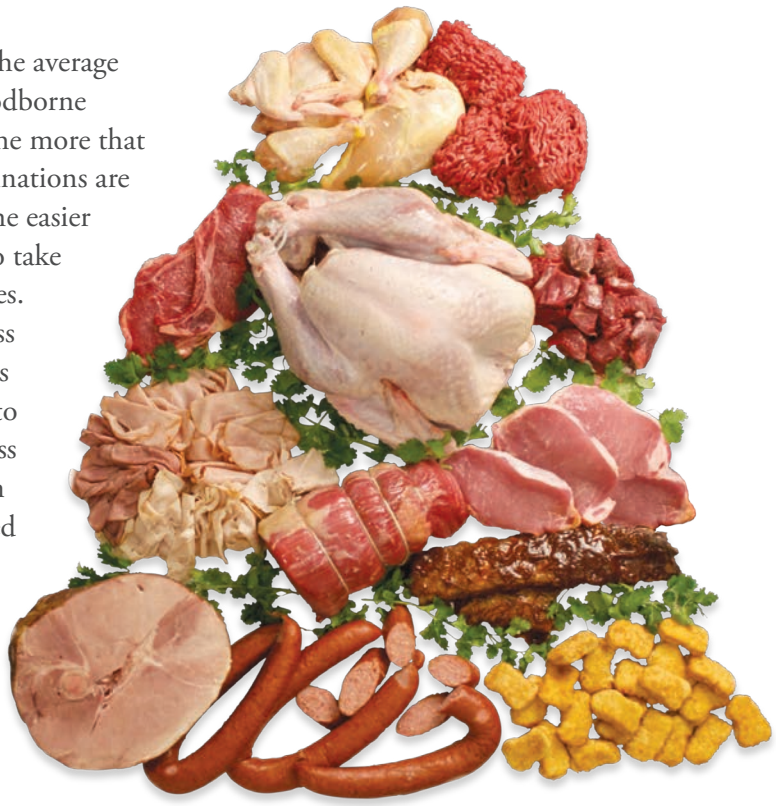
Executive Summary

Meat and poultry foods are a significant part of the average American diet. But they can also be linked to foodborne illnesses, ranging from inconvenient to deadly. The more that is understood about which food-pathogen combinations are likely to make people sick ("food attribution"), the easier it is for policymakers, industry, and consumers to take appropriate measures to reduce the risk of illnesses. This report examines 12 years of foodborne-illness outbreak data—over 1,700 outbreaks—and ranks meat and poultry foods on a scale from Highest to Low Risk. Each food's risk of causing severe illness was determined by calculating the hospitalization rate from the pathogen-specific illnesses attributed to outbreaks in the food groups. Some food-pathogen combinations may cause many illnesses, but those illnesses are less likely to result in hospitalization. Conversely, some food-pathogen combinations may be rare, but cause more severe symptoms requiring hospital treatment.



Analysis of the outbreak data reveal the following ranking of risky meats and poultry foods:

Highest Risk: Chicken, Ground Beef
High Risk: Beef (Other), Steak, Turkey
Medium Risk: Barbecue (Beef or Pork), Deli Meat, Pork, Roast Beef
Low Risk: Chicken Nuggets, Ham, Sausage

Introduction

American consumers may now be accustomed to hearing about the health risks posed by meat and poultry, but that was not always the case. The dangers from undercooked meats became shockingly clear in 1993, when a horrific foodborne-illness outbreak due to *E. coli* O157:H7 in hamburgers served at Jack in the Box restaurants sickened 700 people and killed four children (9). That outbreak was a watershed event: it made consumers aware like never before that pathogens commonly found in food animals could cause severe illness and death, especially in children. The victims of that outbreak provided irrefutable evidence for consumers, industry, and policymakers that animal products carry inherent risks that are too dangerous to try to control exclusively in restaurant and home kitchens. Meat and poultry producers recognized that they needed to implement better pathogen controls throughout the food chain. Shortly thereafter, the government declared *E. coli* O157:H7 an adulterant in food and mandated the use of Hazard Analysis and Critical Control Point (HACCP) systems for all meat and poultry processors. Working together, the meat and poultry industry and the United States Department of Agriculture (USDA) have made great strides in decreasing the risk to consumers. But, still, the years since the Jack in the Box outbreak have seen many additional outbreaks and recalls linked to meat and poultry, and each is a reminder that a failure of controls at any point in the food chain can be potentially deadly for consumers.

This report identifies the meat and poultry products that pose the greatest risk of causing serious illnesses. CSPI's conclusions are based on 12 years of documented foodborne outbreaks from meat and poultry that occurred in the U.S. between 1998 and 2010 (3).

CSPI researchers identified meat and poultry categories based on the food terms used most frequently by state outbreak investigators in their reports to the Centers for Disease Control and Prevention (CDC). Meat from cows, chickens, pigs, and turkeys was included, and was categorized by common names and sometimes by cooking methods (*see* Appendix 1). Researchers excluded outbreaks where investigators mention multiple possible contaminated foods or ingredients, unless the investigator confirmed that a specific meat product was in fact the cause of the outbreak.

The meat and poultry products covered in this report were altogether responsible for 1,714 outbreaks, with over 33,000 illnesses. Those illnesses ranged from short-term gastrointestinal distress to severe cases requiring hospitalization. Some resulted in death.

To ensure a high degree of confidence in the findings, only those illnesses linked to outbreaks that were definitively attributed to a meat or poultry product were used for this report's analysis. Ultimately, the 33,372 illnesses used in this analysis represent only a small fraction of likely cases; however, they do represent the best data available.

The picture painted from reported outbreak data is, unfortunately, incomplete. While CDC estimates that 48 million Americans contract some form of foodborne illness each year, the vast majority of illnesses are not known and therefore not captured in outbreak data, either because they are "sporadic" (not linked to an outbreak) or because they are not diagnosed or reported to public health authorities (2).

Even outbreak-associated illnesses are rarely fully captured by public health officials or the CDC, for a number of reasons. The vast majority of foodborne illnesses, while unpleasant and often debilitating, do not require medical attention; without medical attention an illness is generally not reported to local public health officials or counted as part of an outbreak. Of the illnesses that are severe enough to require medical attention, many cases are (a) not fully diagnosed, (b) not reported to public health officials after diagnosis, or (c) are not fully investigated due to factors such as budget constraints at local health departments. Investigations, even when undertaken, may not be fruitful. Victims may have unknowingly thrown suspect foods away, leaving no sample behind for laboratory analysis, or may not recall enough of their eating history for investigators to pinpoint a cause. Sometimes the data collected and investigated by local health departments are not reported to CDC.

Importantly, outbreaks linked to meat and poultry have decreased over the period studied (7, 13). Since 1993, the meat and poultry industry, spurred by stricter regulatory oversight and litigation, has made changes in animal production, slaughter, and processing to reduce illnesses from *Salmonella*, *E. coli* O157:H7, and other well-known hazards—but every outbreak of preventable illness and deaths shows that more work is needed.

This report, by analyzing the meat and poultry products linked to outbreaks and by categorizing them according to severity (*see* Methodology, p. 19), should help stakeholders throughout the food chain take steps to minimize the risks inherent in these foods:

- For consumers, knowing which of their favorite foods carry the greatest risks can help them take precautionary steps, such as safer handling and more thorough cooking.
- For producers and processors, information on which animal products are causing illness may provide crucial information for designing pre-harvest,

Pathogens vary significantly, not just in the severity of resulting illness, but also in how they reach consumers. *Salmonella* and *E. coli* O15:H7, for example, originate in the environment of animal production—in growhouses, feedlots, slaughterhouses, and packing plants. These bacteria must be controlled at that point of origin, by the producers and processors of meat and poultry foods. Although these pathogens can generally be killed through thorough cooking, the amount needed to make a consumer sick is small, and the risk of cross-contamination during handling and cooking makes these pathogens very risky.

Other pathogens, such as *Clostridium* and *Staphylococcus*, may exist in meat and poultry, but cause illness primarily because of a handling error after cooking. When meat products are either inadequately cooked or properly cooked and then left at improper temperatures for too long after cooking, these bacterium can cause illness. To combat this risk, special care must be taken in the handling of meat and poultry foods even after they are cooked.

Some pathogens, such as Norovirus, are commonly passed from ill people to food during handling, in turn making other people sick when they eat that contaminated food. The large number of illnesses linked to Norovirus point to the need for extra attention to handwashing during food preparation, and to the importance of avoiding food handling when a food preparer is ill.

For more information on specific pathogens and symptoms of illness, see Appendix 2.

slaughter, and processing systems that keep pathogens off meats and out of retail and consumer kitchens.

- For retailers and other foodservice providers, such as restaurants, cafeterias, and grocery stores, identifying storage and cooking practices that are linked to repeated outbreaks can help inform critically important food-handling practices.

Each night around the country, millions of American families dine on burgers, steaks, chicken, and hot dogs. Each holiday, families gather around roasts, turkeys, and hams. Those meals, and all meals, should be as safe as possible.

Antibiotic-Resistance in Meat and Poultry

Each new outbreak serves as a public reminder that pathogens like *E. coli*, *Salmonella* and *Listeria* are hazards in food that continue to threaten the health of consumers. Compounding that risk, pathogens resistant to antibiotics have gained a foothold in the food supply (6). They have caused numerous outbreaks, indicating that animals dosed routinely with antibiotic drugs can become the carriers of pathogens that cause more severe foodborne illnesses and an increased risk of death (11). The challenge of recognizing and managing those risks remains a focus of the industry, the government, academics, and consumer advocates. For more on this critical food safety issue, see http://www.keepantibioticsworking.com.

FINDINGS

Meat and poultry products are popular in the American diet. The average consumer eats about 130 pounds of beef, pork, and poultry every year. Between 1998 and 2010, those foods were definitively linked to at least 1,714 outbreaks involving 33,372 illnesses. While those data represent only the tip of the iceberg, they provide the best information available to analyze and compare the risk from pathogens common in the meat supply.

Calculating the Severity Index

Not all cases of illness are equal, and that is reflected in CSPI's rankings. Most cases probably involved stomach cramps, nausea, vomiting and diarrhea; other cases may have resulted in hospitalization, kidney failure and even death. While each case is included in the analysis, the rankings go one step further. CSPI's rankings are based on an analysis of *severity*, a metric derived by determining the number of illnesses caused by each pathogen for each food group, and then applying the hospitalization rate due to that pathogen (15). For example, using the severity metric, each case of *Listeria monocytogenes*, with a 94 percent hospitalization rate, was counted as 0.94, and not simply as 1.0; a case of *Clostridium perfringens*, with a hospitalization rate of 0.6 percent, was counted as 0.006. The results show that Chicken and Ground Beef are most likely to cause severe illness requiring hospitalization, while Chicken Nuggets, Ham, and Sausage are least likely to cause such severe illnesses.

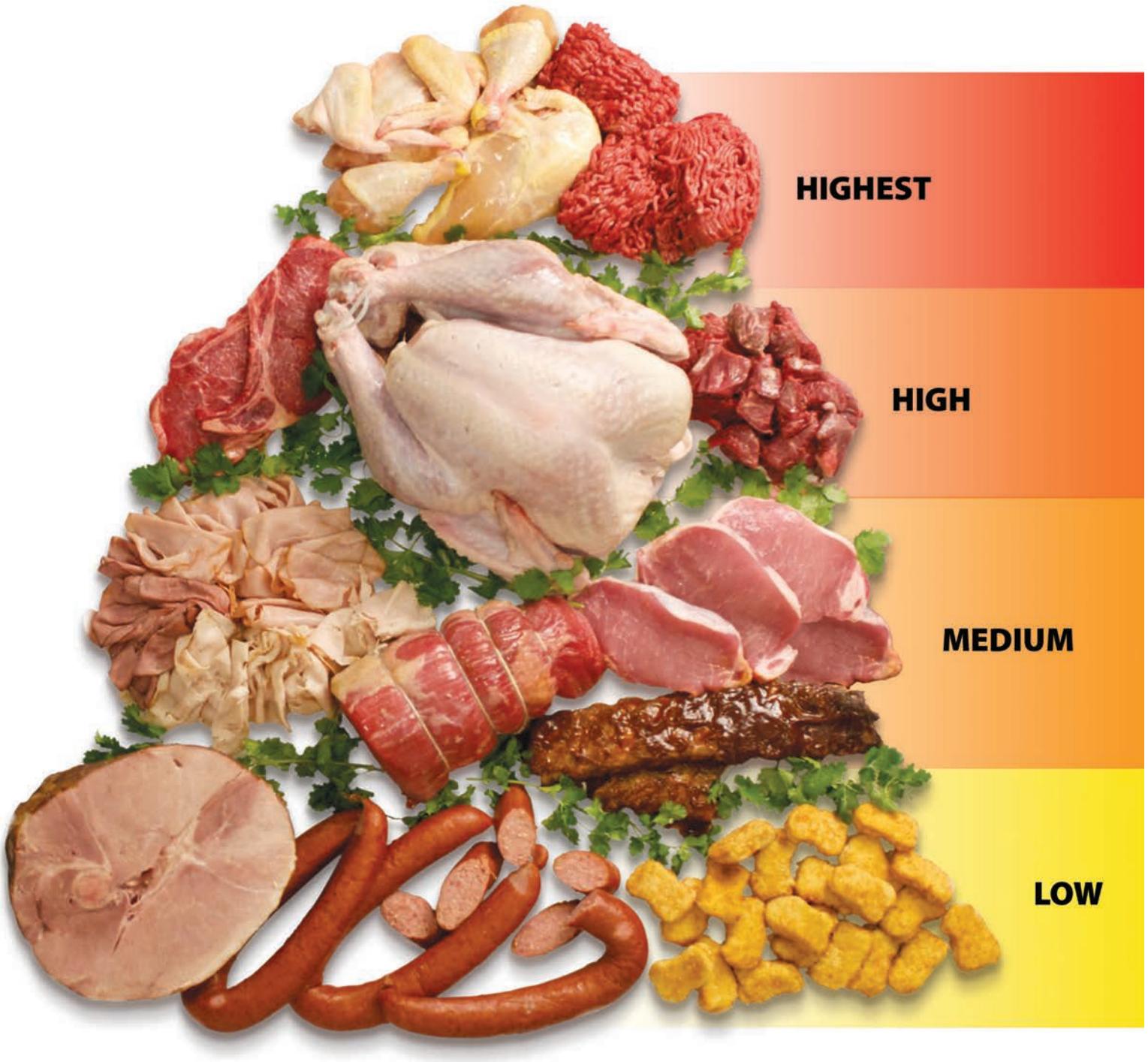
Table 1. Summary of Risks from Meat and Poultry Foods.

	Outbreaks	Cases Of Illness	Severity Index
HIGHEST			
Chicken	452	6,896	657
Ground Beef	336	3,801	869
HIGH			
Beef (Other)	99	2,414	398
Steak	82	1,935	509
Turkey	130	4,349	453
MEDIUM			
Barbecue	94	2,484	312
Deli Meat	59	1,515	258
Pork	129	2,262	248
Roast Beef	92	2,470	178
LOW			
Chicken Nuggets	37	203	18
Ham	49	1,094	57
Sausage	54	823	56

Foods are ordered alphabetically within risk categories.

Salmonella and *E. coli* O157:H7, two pathogens that contaminate meat and poultry during slaughter and processing, were together responsible for one-third of all illnesses. Reducing these hazards should be the focus of the meat and poultry industry and regulators. *Clostridium perfringens*, a little-publicized pathogen that grows on cooked foods left at improper temperatures for too long, was responsible for another one-third of illnesses linked to meat and poultry. That pathogen is commonly associated with food handling errors that occur after cooking, making it a key issue for the foodservice industry and consumers. Finally, nearly 20 percent of illnesses were from an unknown pathogen, due in part to incomplete data collection by public health departments. Increasing the percentage of outbreaks where pathogens and foods are identified is an issue that state health departments should address.

MEAT & POULTRY: A RISK PYRAMID



Chicken

Highest Risk

American consumers eat more chicken—almost 50 pounds per person every year—than all types of beef combined. But in the 12 years reviewed in this study, more outbreaks linked to chicken were reported to CDC than any other meat or poultry product. Chicken, with a severity index of 657, was responsible for 452 outbreaks over the course of the study, and sickened 6,896 consumers. Chicken products, as defined by outbreak data, can include various cuts of chicken (breast, leg, etc.), various cooking methods (roast, grilled, baked, etc.), and ground chicken, as well as others. Barbecue chicken is also included, since it is most often roasted or grilled and then barbecue sauce is added. Chicken nuggets are identified separately in outbreak reports to CDC and in this report.

The large number of outbreaks associated with *Salmonella* leads to a high number of hospitalizations for chicken, second only to the pathogens linked to ground beef. *Salmonella* and *Clostridium perfringens* are the most commonly reported causes of outbreaks due to chicken.

Campylobacter is another pathogen routinely found in poultry, but, outbreaks linked to *Campylobacter* are rarely captured in outbreak data (10). *Campylobacter* is easily transferred from raw poultry to other surfaces, making proper handling critically important.

While outbreaks linked to chicken are often small and rarely make national headlines, chicken recalls can be quite large. Overall, 127 million pounds of chicken and chicken products were recalled between 1999 and 2010 (19). Most of those recalled products were fully cooked ready-to-eat (RTE) foods and not fresh uncooked chicken.

How it happens: Chicken

The spread of *Salmonella* contamination in poultry occurs most often during slaughter and processing (18). Live birds can carry contamination from the farm into the slaughter plant on their feathers and in their intestines, and those bacteria can be transferred to the carcass during slaughter. For example, chicken carcasses are immersed in both hot and cold water at several points during processing, and that immersion allows contamination to spread between carcasses. Other parts of slaughter and processing can also be points where contamination spreads. Changes to USDA's poultry slaughter inspection practices, such as increasing line speeds and changing microbial testing requirements, could also impact the risk.

Top Pathogens

Clostridium perfringens	2,137 Illnesses
Salmonella	1,727 Illnesses
Norovirus	380 Illnesses

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Ground Beef

Highest Risk

How it happens: Ground Beef

Cattle naturally carry *E. coli* O157:H7 in their intestinal tract, and the bacteria can be transferred to the animal carcass during slaughter. For example, if inner organs are not handled and extracted carefully, their contents—including bacteria—can be transferred to the carcass. The hide is another source of contamination: if the hide is improperly removed during slaughter, microscopic organisms can become airborne and settle onto the exposed carcass (12). When small pieces of meat (called "trimmings") from multiple carcasses are combined into ground beef, a single source of contamination can be spread throughout the resulting product.

Ground beef—with a severity index of 869—racked up 336 outbreaks in twelve years, making it the second most common source of meat or poultry outbreaks reported to CDC. Over 3,800 people were sickened in those outbreaks. *E. coli* O157:H7, a pathogen with a high rate of hospitalizations (46.2%), was responsible for over 100 of the outbreaks. Beyond the factors captured in this report, in recent years, ground beef has also been implicated in a number of outbreaks linked to antibiotic-resistant *Salmonella* strains (6). Pathogenic *E. coli* and *Salmonella* strains, both antibiotic-susceptible and resistant, can cause severe illnesses leading to hospitalization, long-term health problems, or death, putting ground beef into the highest risk category.

Nearly 90 percent of all ground beef recalls were due to contamination of the products with *E. coli* O157:H7, *Salmonella,* and *Listeria monocytogenes*. There were over 140 separate ground beef recalls between 1999 and 2010, resulting in a total of 70 million pounds of ground beef recalled (19).

Top Pathogens

E. coli O157:H7	1,489 Illnesses
Clostridium perfringens	622 Illnesses
Salmonella	428 Illnesses

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Steak, Beef (Other)

High Risk

How it happens: Steak

From a food safety perspective, steak may be similar in risk to ground beef if it has been tenderized using needles or blades that pierce the meat and push surface pathogens to the otherwise sterile interior. The resulting "mechanically tenderized" product *looks* like an intact steak, but cooking it to rare or medium rare may not be sufficient to kill dangerous pathogens inside. Products that have been tenderized mechanically do not carry a special label alerting retailers, restaurants, or consumers of the difference, so they may not be properly cooked. USDA is considering regulatory action to require labeling of these products. Because they are not identified, it is not known what portion of Steak outbreaks in the data are attributable to mechanically tenderized steaks.

An enduring American symbol of a gourmet meal, steak remains a popular entree for consumers. Made from the choicest cuts of beef, it can go by many names including filet, prime, sirloin, and T-bone. Generally steaks are cooked over high heat for short periods—as compared to roast beef or barbecue beef, which are cooked at lower temperatures for a longer time. This cooking style sears off pathogens from the surface of the meat.

Steak, with a severity index of 509, showed up as a distinct meat category in outbreaks reported to CDC over 12 years. Eighty-two (82) outbreaks were linked to steak, resulting in nearly 2,000 illnesses. Almost half of these illnesses were caused by *E. coli* O157:H7. Infections from *E. coli* can result in hospitalization, death, or long-term health problems, putting steak into the high-risk category for meats. Steak outbreaks were also linked to *Clostridium perfringens*, a bacterium commonly associated with improper temperature controls after cooking.

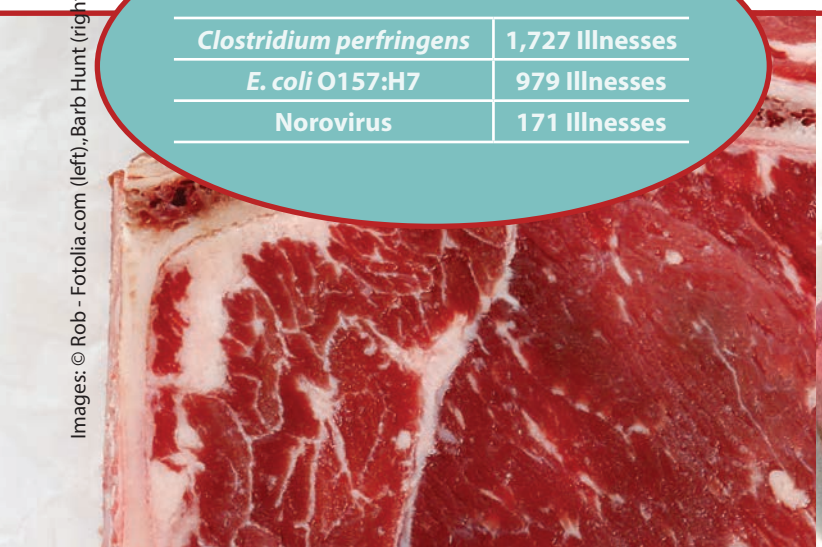
Beef products that are not described in the outbreak data as steak, ground, or roast beef are categorized for this report as Beef (Other), and have a severity index of 398. The handling of these types of beef, and the way they become contaminated, is very similar to the way steak is handled and becomes contaminated, even though the ultimate cooking methods vary. These foods, which include items such as beef jerky, beef stroganoff, and chipped beef, were responsible for 99 outbreaks and at least 2,414 individual illnesses in the period studied. Illnesses categorized as Beef (Other) were most often linked to *Clostridium perfringens*, suggesting that foods were improperly handled after cooking. *Salmonella* was responsible for nearly 500 illnesses.

Top Pathogens—Steak

Clostridium perfringens	1,727 Illnesses
E. coli O157:H7	979 Illnesses
Norovirus	171 Illnesses

Top Pathogens— Beef *(Other)*

Clostridium perfringens	655 Illnesses
Salmonella	495 Illnesses
E. coli O157:H7	458 Illnesses



Turkey

High Risk

Despite its enduring popularity, a severity index of 453 places turkey in the High Risk category. Over 12 years, 130 outbreaks linked to turkey were reported to CDC, resulting in 4,349 documented illnesses—more illnesses than any other meat or poultry product besides chicken. As with chicken, those illnesses were most often associated with *Clostridium perfringens* and *Salmonella*. Another important pathogen, *Campylobacter*, is frequently found on poultry carcasses, but rarely shows up in outbreak reporting (10). It is reasonable to assume that this omission represents a significant number of uncounted consumer illnesses linked to both turkey and chicken.

Clostridium perfringens, the most prevalent cause of turkey outbreaks, thrives on cooked foods left at room temperature for too long. Holiday meals, where foods and leftovers are improperly handled, are ripe for these problems; thus, November and December are the months with the highest number of turkey-associated *Clostridium perfringens* illnesses (1). The unique handling challenges of turkeys also pose food safety risks; consumers are not accustomed to handling a whole raw turkey, and simple handling errors can easily cross-contaminate kitchens and side dishes.

Ground turkey, a lower-fat protein source than ground beef, shares many of the risks of other ground meats: a single piece of contaminated meat can be mixed and ground with many others and spread contamination throughout multiple servings. Outbreak data is not yet sufficiently granular to know what percentage of turkey outbreaks are from intact versus ground product.

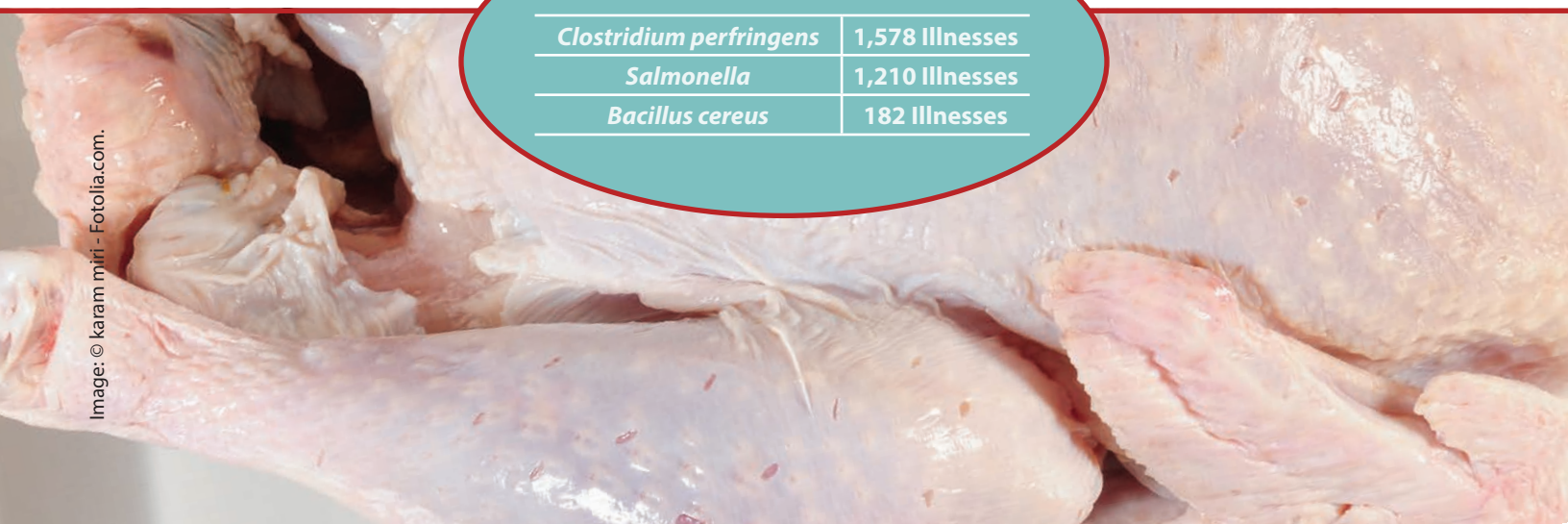
Overall, 33 million pounds of turkey meat were recalled from 1999 to 2010 (19).

The Relationship Between Recalls & Outbreaks

Recalls are designed to get contaminated foods out of commerce, whether they are still in stores, restaurants, schools, or in consumer homes. Sometimes food is recalled without being linked to an outbreak, such as when certain pathogens (like some types of *E. coli*) are detected through regulatory or industry testing. Other times, foods are recalled after they have caused illness—even if the pathogens responsible for the illness wouldn't have triggered a recall. The recall totals included in this report are Class 1 recalls for pathogens only (excluding allergens, etc.) between 1999 and 2010, and may or may not have been outbreak-associated.

Top Pathogens

Clostridium perfringens	1,578 Illnesses
Salmonella	1,210 Illnesses
Bacillus cereus	182 Illnesses



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Barbecue (BBQ) Beef or Pork

Medium Risk

The cooking method—low, indirect heat—and after-cooking handling techniques of barbecue make both the taste and the risk of illness unique. A severity index of 312 places Barbecue between Medium and High Risk; because it is a cooking method and not a type of meat, Barbecue was included here as a Medium Risk food. Food preparers should be aware of the risks associated with this cooking method. Nearly 2,500 people got sick from BBQ beef or pork, most often from pathogens such as *Staphylococcus aureus* and *Clostridium perfringens*. This does not include those who may have gotten sick from BBQ chicken, since generally that food is prepared like traditional chicken (grilled, baked, etc.), rather than slow-cooked, with the addition of a BBQ sauce or rub to make it "barbecue."

Nearly 40 percent of these outbreak-associated illnesses occurred in a restaurant, which underscores the importance of keeping prepared foods piping hot and chilling them rapidly for storage (1). When restaurants cook large quantities of food and leave it at room temperature, bacteria like *Staphylococcus aureus* and *Clostridium perfringens* grow rapidly and form spores that cause illness.

Top Pathogens

Salmonella	804 Illnesses
Staphylococcus	716 Illnesses
Clostridium perfringens	434 Illnesses

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Deli Meat

Medium Risk

Deli sliced meat, though popular and convenient, made 1,515 people sick in 59 outbreaks over the course of the 12-years studied, with a severity index of 258. For this report, deli meat includes meat sliced at the deli counter, such as roast beef, ham, and turkey, as well as pre-packaged sliced deli meat. Sliced salami, pepperoni, and similar meats used for sandwiches were also included.

Deli meats are a primary cause of *Listeria monocytogenes* infections, one of the deadliest foodborne pathogens. *Listeria* differs from many other pathogens in that it multiplies at refrigerated temperatures, adding to its risk. This resilient pathogen can also survive on surfaces like plastic and metal, which means that the deli slicer itself can serve as a serious point of cross-contamination regardless of the type of meat (beef, pork, or poultry). *Listeria* carries a higher risk of death than either *E. coli* O157:H7 or *Salmonella*—it kills 20 percent of people whom it sickens (5).

While most consumers could eat contaminated deli meat and not become ill, elderly or immune-compromised consumers face life-threatening illness. For those at-risk consumers, *Listeria* has a hospitalization rate of over 90 percent, the highest rate among foodborne pathogens. Pregnant women are another high-risk group. While symptoms are mild for the mother, the pathogen can be transmitted to the fetus, causing miscarriage or stillbirth (5).

Norovirus was also associated with outbreaks in this category. That pathogen is commonly called "winter vomiting disease" as frequent projectile vomiting is its most dominant symptom. Norovirus caused nearly one-third of the illnesses from contaminated deli meat.

Listeria at Retail

USDA has a "zero tolerance" for *Listeria* on its products—requiring producers to take specific actions to ensure that products do not carry measurable levels of the pathogen—but FDA, the agency that regulates the cheeses and non-meat deli products (such as deli salads) found at retail, is considering allowing some products to carry more of the organisms (8). That means that deli meat products could be exposed to cross-contamination wherever meat and non-meat foods are stored together, such as in deli cases and refrigerators.

Top Pathogens

Norovirus	478 Illnesses
Shigella	353 Illnesses
Listeria	103 Illnesses

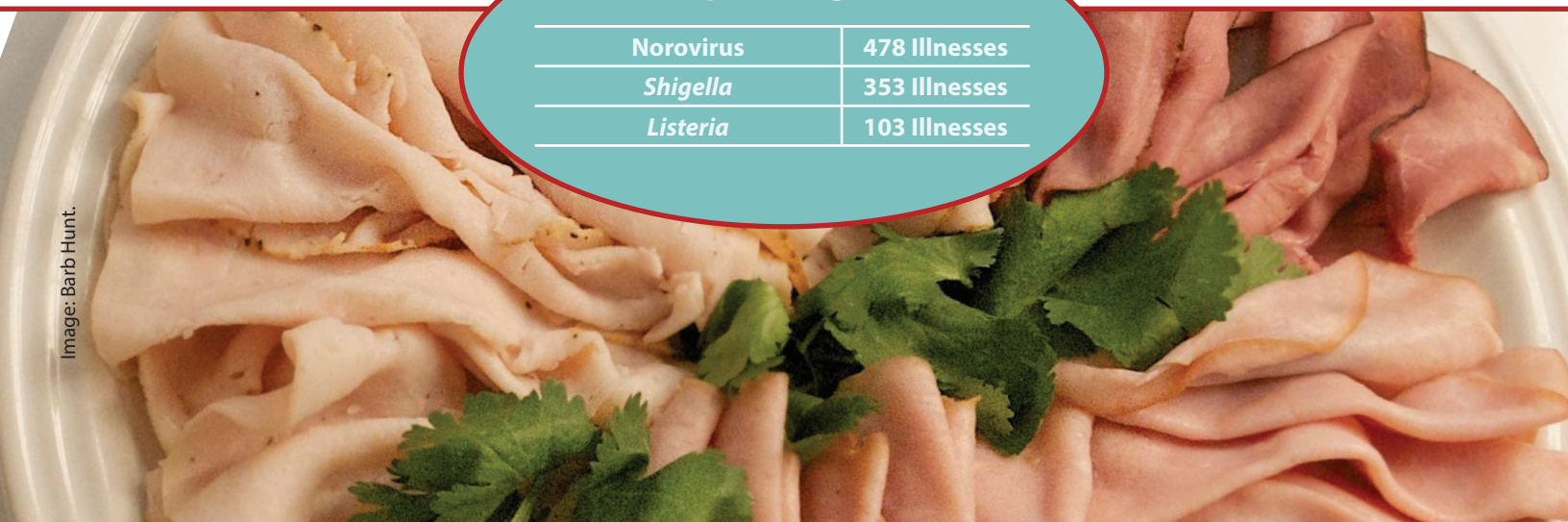

Image: Barb Hunt.

Pork

Medium Risk

The average American eats more than 30 pounds of pork per year, making it the third most consumed meat or poultry item in the U.S. after beef and chicken. But for over 2,000 people who were sickened by eating pork (other than ham, sausage, and BBQ) from 1998 to 2010, pork is no picnic. With a severity index of 248, most pork illnesses are linked to *Salmonella.* Consumers also got sick from *Clostridium perfringens* and *Staphylococcus aureus*.

Salmonella, a pathogen common to almost all the meats in this study, was responsible for almost 630 of the illnesses linked to pork. *Clostridium perfringens* and *Staphylococcus aureus* are pathogens associated with time and temperature handling errors. That is, proper cooking may destroy most of the bacteria, but if enough spores remain, they can rebound to dangerous levels if the food is not properly cooled. Pork outbreaks most frequently occurred in consumers' homes (40 percent of outbreaks) and in restaurants (24 percent of outbreaks) (1).

A lesser-known foodborne pathogen, *Yersinia enterocolitica,* was also responsible for 72 cases of illness. It can cause fever, abdominal pain and diarrhea, lasting one to three weeks.

Top Pathogens

Salmonella	630 Illnesses
Clostridium perfringens	376 Illnesses
Staphylococcus	241 Illnesses

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Roast Beef

Medium Risk

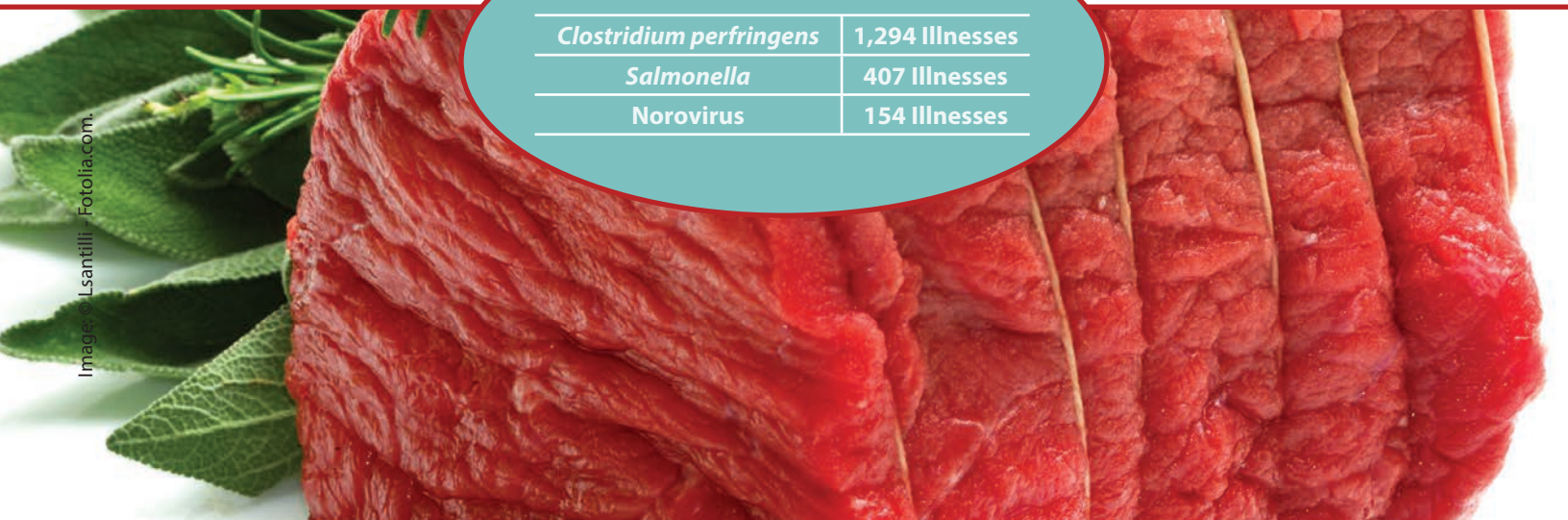
For a family meal, many Americans choose traditional roast beef, brisket, or pot roast. These cuts of meat are more than two inches thick, and are roasted in an oven in a shallow pan, boiled on a stove, or cooked on a closed grill. Some types of roast meats (such as rib roast and tenderloin) are more tender and thus considered higher quality, while others (such as pot roast and brisket) are less tender and require longer cooking times. Unfortunately, with a severity index of 178, roast beef is not without risk; the 2,470 people who got sick from eating roast beef from 1998 to 2010 got more than just a hearty meal.

Nearly 1,300 of those consumers were sickened by *Clostridium perfringens*, which generally indicates that the meat was cooked and then held for too long at room temperature before being served or stored as leftovers. *Clostridium perfringens* illnesses typically appear 8-12 hours after eating, with symptoms including watery diarrhea and stomach cramps. While the illness usually passes within a day, in older adults the symptoms can be more serious and may require medical treatment to avoid dehydration and other complications.

Another 400 consumers who ate roast beef got sick from *Salmonella*, one of the more common foodborne pathogens. Salmonellosis can range from mild to deadly. Unlike illnesses from *Clostridium perfringens*, an illness from *Salmonella* in roast beef suggests that the beef was not fully cooked or was cross-contaminated after cooking.

Top Pathogens

Clostridium perfringens	1,294 Illnesses
Salmonella	407 Illnesses
Norovirus	154 Illnesses



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Sausage

Low Risk

Typically made from ground lean meat and fat (from either a single species or multiple meats) stuffed into a casing, sausage ranks among the lowest-risk products in this study, racking up only 833 illnesses with a severity index of 56 in 12 years. For this report, Sausage products include hot dogs, bratwurst, sausage links, etc., but not deli-case salami (*see* Deli Meat).

Almost 229 people contracted Norovirus from eating sausage during the period studied. Since Norovirus requires a human host to multiply, those illnesses suggest that a food-handling error and improper hand-washing were likely responsible. Generally, illnesses from Norovirus include gastrointestinal symptoms, such as diarrhea, stomach cramps, and violent nausea. For at-risk consumers, including young children, those symptoms can cause dehydration and more serious illness.

Consumers were also sickened by *Staphylococcus aureus* and *Clostridium perfringens*-contaminated sausage products, pointing to another food-handling error. These bacteria form spores that can survive cooking. After foods are cooked, if left at room temperature for an extended period of time, those spores germinate into bacteria that can cause illness.

Top Pathogens

Norovirus	229 Illnesses
Staphylococcus	161 Illnesses
Clostridium perfringens	159 Illnesses

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Ham

Low Risk

Ham can be fresh, cured, or cured-and-smoked. Ham is the cured leg of pork, while fresh ham is the uncured leg of pork (16). Altogether these types of ham (excluding deli sliced ham, *see* Deli Meat) made 1,094 people sick in 49 outbreaks over the 12-year period studied here. Ham's severity index is 57.

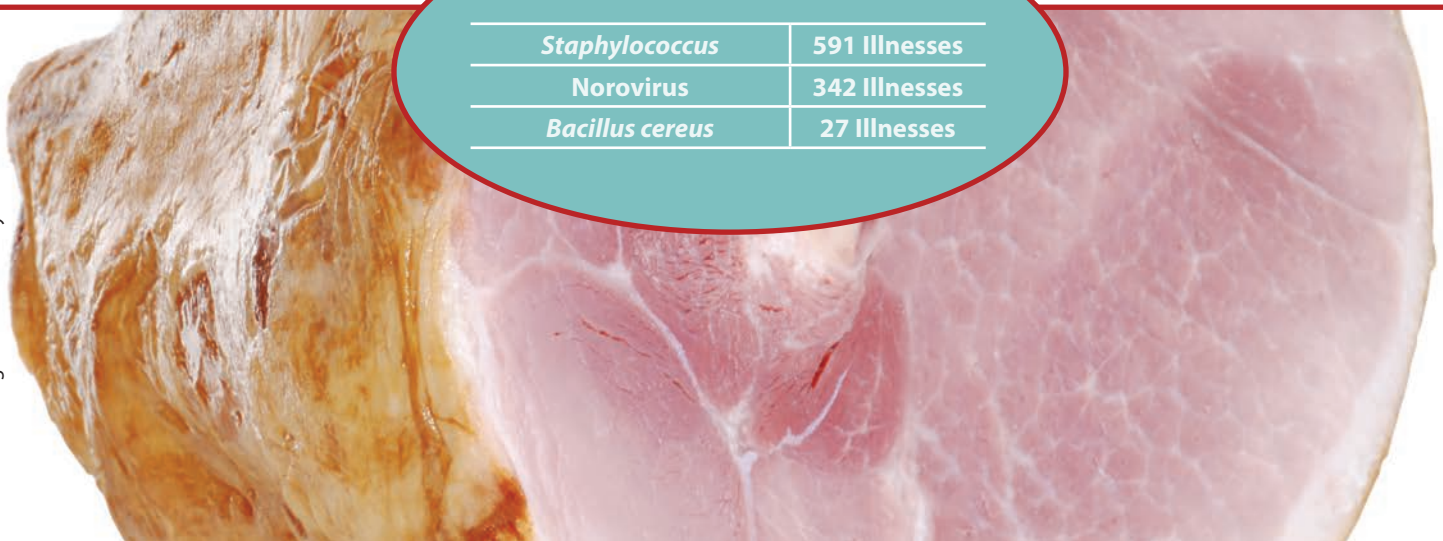
The most common cause of ham outbreaks is *Staphylococcus aureus*, which caused 22 of the 49 outbreaks linked to ham reported to CDC. If pre-cooked ham is inadequately reheated, *Staphylococcus aureus* bacteria produce toxins that can cause sometimes rapid-onset and violent gastrointestinal reactions. While the illness can resolve rapidly, patients may suffer through diarrhea, vomiting, and stomach cramps. For more vulnerable consumers (young children, older adults, and immune-compromised people), the illness may become severe, causing dehydration, and require hospitalization and intravenous treatment.

Norovirus—typically associated with inadequate hand-washing during food preparation—was also responsible for 13 outbreaks in ham. Although *Trichinella spiralis*, a parasite found in hogs, is historically associated with ham, CSPI found no confirmed outbreaks of *Trichinella* in the years studied.

Nearly 60 thousand pounds of ham were recalled between 1999 and 2010 (19).

Top Pathogens

Staphylococcus	591 Illnesses
Norovirus	342 Illnesses
Bacillus cereus	27 Illnesses



Chicken Nuggets

Low Risk

A favorite of children—though perhaps not of nutritionists—Chicken Nuggets are the lowest-risk category of meat and poultry covered in this study. The term "Chicken Nuggets" refers to chicken tenders, fingers, and similarly processed chicken products, though not to chicken sausage (*see* Sausage). Because they are so highly processed, and often pre-cooked, Chicken Nuggets have a lower risk than other meats, with a severity index of 18.

These products were linked to 37 outbreaks with 203 illnesses in the 12 years studied, indicating how rare illnesses from nuggets are. Over 80 of those illnesses were from Norovirus, a fairly common pathogen linked to improper hand-washing. Another 42 of those illnesses were linked to *Salmonella*, which indicates that the foods were likely contaminated by something else during food preparation. Frozen chicken nuggets that were not first thoroughly cooked have also been linked to illness, where subsequent frying did not adequately cook the interior raw chicken.

Top Pathogens

Norovirus	83 Illnesses
Salmonella	42 Illnesses
Staphylococcus	13 Illnesses

Methodology

For this report, CSPI used information from 1,714 foodborne-illness outbreaks to determine which meat and poultry categories were most frequently linked to outbreaks and illnesses and associated with pathogens that cause severe illness requiring hospitalization. The purpose of this analysis was to better inform consumers and policymakers of the consumption risks posed by these foods.

Outbreaks reported by the states and compiled by CDC provide the most complete information on the risks posed by various food products. A fully-investigated outbreak provides information on the food source(s), the pathogen, and the numbers of consumers affected. For the majority of outbreaks reported to CDC, however, one or more of these essential elements is missing.

The first step in the analysis was to gather outbreaks from available sources. CSPI maintains a database of fully-investigated foodborne-illness outbreaks, compiled from CDC's annual outbreak listings (1, 3). Outbreaks in CSPI's database must meet the CDC's definition of an outbreak (two or more people have consumed the same food and contracted the same illness) and have an identified food and pathogen.

For this report, CSPI researchers analyzed foodborne-illness outbreaks occurring between 1998 and 2010 that were definitively linked to USDA-regulated meat and poultry products. CSPI researchers excluded outbreaks where investigators mentioned multi-ingredient, non-meat foods in addition to meat, unless the investigator confirmed that a specific meat or poultry product was in fact the cause of the outbreak. The number of outbreaks from the CSPI database that met those criteria was 1,150.

CSPI also analyzed outbreaks identified by CDC during the same time period that were definitively linked to USDA-regulated meat and poultry products but where states had not identified the pathogen. Those outbreaks provided additional valuable information on the frequency and size of the outbreaks and helped to create a clearer picture of the risks posed by meat and poultry products. The number of such outbreaks was 564.

The second step in the analysis was to define the food categories and sort the outbreaks. Meat and poultry products were sorted into consumer-identifiable categories based on the descriptions of the foods as reported by investigators (e.g., "Beef," "Beef, Other," "Beef, Steak") and, where necessary, segregated by cooking and handling methods, as well as other qualities inherent to the food (*see* Table 1). The descriptive food terms used by investigators were often helpful in developing the categories. For example, "Barbecue" was identified in 94 outbreaks, about the same number as roast beef (92 outbreaks), but investigators did not always specify whether it was beef or pork. Both barbecue beef and pork products are prepared using the same (indirect heat, slow) cooking method, so grouping them together is logical. Barbecue chicken, however, was grouped with Chicken, and not with Barbecue, because it is usually grilled or roasted with a barbecue sauce applied to the surface of the meat before, during or after cooking.

Where foods were not adequately identified as a single meat or poultry source that could be categorized, they were grouped together in categories called "Other Meats" (goat, buffalo, etc.), and "Multiple Meats" (events where multiple meats were identified, e.g., a cookout serving both beef hamburgers and pork hot dogs). Overall, 14 categories emerged. For the sake of clarity, the two non-specific categories (Other Meats and Multiple Meats, with fewer than 100 outbreaks total) were not included in the final ranking.

Once the 12 categories were defined and the outbreaks sorted, CSPI devised a system to rank their risks (*see* Table 2). To determine the severity of the risk of foodborne illness posed by each of the food groups, researchers examined the pathogens responsible for the illnesses attributed to each food group. Each outbreak-associated case was multiplied by the hospitalization rate associated with the causative pathogen, as identified by CDC (3). For example, a case of *Listeria monocytogenes,* with a 94 percent hospitalization rate, was 0.94, and a case of *Clostridium perfringens*, with a hospitalization rate of 0.6 percent, was 0.006.

Outbreaks of unknown etiology were assigned the median hospitalization rate (6.4%) for all illnesses analyzed for this report. The hospitalization rates of each food/pathogen pair were added to create a severity metric for each food group.

Over the years this study covers, outbreak reporting has become more complete, even capturing in some cases the numbers of deaths or hospitalizations linked to a specific outbreak. But for the majority of outbreaks, such data does not exist, so CSPI used CDC's estimations of rates of hospitalizations (15).

CSPI chose the hospitalization rate as the key metric for severity, as opposed to the death rate, the simple illness counts, or other metrics for several reasons:

- Use of the death rate was not used due to its lack of granularity: most foodborne illnesses, though debilitating in the short term, are not life-threatening, and only a few pathogens have a death rate greater than 0.1percent.
- Simple illness counts (raw numbers of illnesses per food item) were not used because they do not reflect the wide range of severity of illnesses, such as *E. coli* 0157:H7, hospitalization rate 46.3 percent, and *Bacillus cereus*, hospitalization rate 0.4 percent.
- Quality-Adjusted Life Years (QALYs), Disability-Adjusted Life Years (DALYs), and other burden of illness metrics that take into account long-term impacts, early death, pain, and loss of mobility, were not used because they extend beyond the scope of this report.

This report characterizes the risks posed by meat and poultry products to consumers. The data reported here represent acute illnesses. The use of hospitalization rates as a proxy for severity captures the risk to consumers of experiencing a severe life-threatening illness. Using this approach, the food categories divided into a spectrum of risks that are scientifically meaningful and easy to understand. The final rankings of the dozen categories of meat and poultry categories indicate the Highest, High, Medium, and Low risk of severe illness, relative to one another.

Table 2. The final categories of analysis: Barbecue, Beef (Other), Chicken, Chicken Nuggets, Deli Meat, Ground Beef, Ham, Pork, Roast Beef, Sausage, Steak, and Turkey.

To illustrate the method:

Turkey was responsible for 130 outbreaks and 4,349 illnesses. Illnesses were caused by eight identified pathogens: *Bacillus cereus* (182 illnesses); *Campylobacter* (38 illnesses); *Clostridium perfringens* (1,578 illnesses); *Listeria monocytogenes* (28 illnesses); Norovirus (170 illnesses); *Salmonella* (1,210 illnesses); *Staphylococcus aureus* (120 illnesses); *E. coli* O157:H7 (6 illnesses); and Unknown pathogens (1,054 illnesses).

To tally a severity metric for turkey, each illness was weighted by the pathogen's hospitalization rate:

Pathogen	Hospitalization Rate*	Illnesses	Severity Equation	Severity
Bacillus cereus	0.4%	182	(182)(0.004)=	0.7
Campylobacter	17.1%	38	(38)(0.171)=	6.5
Clostridium perfringens	0.6%	1,578	(1,578)(0.006)=	9.5
E. coli O157:H7	46.2%	6	(6)(0.462)=	2.8
Listeria monocytogenes	94.0%	28	(28)(0.94)=	26.3
Norovirus	1.5%	170	(170)(0.015)=	2.6
Salmonella	27.2%	1,210	(1,210)(0.272)=	329.1
Staphylococcus aureus	6.4%	120	(120)(0.064)=	7.7
Unknown	6.4%	1,054	(1,054)(0.064)=	67.5
Total Severity Index for Turkey				**452.7**

This type of weighting allows us to compare the harm caused by different pathogens. For example, an illness from E. coli *O157:H7 (Hospitalization Rate: 46.2%; 6 illnesses) is far more likely to result in a severe illness than one from* Bacillus cereus *(Hospitalization Rate: 0.4%; 182 illnesses). Thus, CSPI's analysis compares the overall severity of illnesses linked to 12 types of meat and poultry products based on the likelihood that people required hospitalization during the course of their illness.*

*Hospitalization Rates are based on laboratory-confirmed cases for all pathogens except Norovirus. For Norovirus, the hospitalization rate is based on diagnosed outbreak-associated cases reported to CDC (15). Illnesses due to unknown pathogens were assigned the median hospitalization rate (6.4%) for all illnesses identified in this study, not just those applicable to turkey.

Endnotes

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Appendix 1. Categorization of Meat and Poultry Foods

Beef	Roast Beef	Roasts, brisket, carne asada, corned beef, beef ribs, excluding sliced sandwich-style roast beef (see Deli Meat).
	Steak	All steak meats, including filet, prime, sirloin, tri-tips, veal, and other cuts.
	Ground Beef	Any ground beef product.
	Beef (Other)	Any beef product not covered by the other categories, such as jerky, or when the beef product is not specified, e.g. "Beef Tacos."
Pork	Ham	All ham products, except deli-sliced ham (see Deli Meat).
	Pork	All non-ham pork products, such as pork chops and pork loin, excluding pork sausage and pork BBQ (see Sausage, Barbecue).
Poultry	Turkey	Any turkey product, excluding deli-sliced turkey (see Deli Meat).
	Chicken	Any chicken product, such as breast, wings, and whole broilers, excluding chicken sausage (see Sausage) or highly processed chicken products (see Chicken Nuggets).
	Chicken Nuggets	Highly processed chicken products, such as frozen and fast-food chicken nuggets, chicken fingers, etc., excluding chicken sausage (see Sausage).
Other	Barbecue (BBQ)	Any beef or pork BBQ, but not chicken BBQ (see Chicken).
	Sausage	Any sausage, bratwurst, hot dog, or salami-style sausage, excluding sliced sandwich-style salami (see Deli Meat).
	Deli Meat	Any meat sliced and/or served at a deli.

Appendix 2. Overview of Pathogens

Pathogen	Hospitalization Rate (%)	Disease Details
Listeria monocytogenes	94.0	*Listeria* infects a comparably small number of people, but is nonetheless a leading cause of death from foodborne illness. Listeriosis can take two forms: the first type of infection causes mild to severe gastroenteritis, with vomiting, cramps, and nausea; these symptoms often go away on their own. The other form of infection causes sepsis; this is a serious life-threatening infection. Pregnant women are especially susceptible to illness from *Listeria*: although infection is often mild for the mother, it frequently causes death or miscarriage of the fetus. *Listeria* infections are most commonly associated with unpasteurized dairy (milk and cheese); smoked seafood; meats, including deli; and raw produce.
E. coli O157:H7	46.2	While many types of *E. coli* bacteria are harmless, some can cause severe illness, such as the shiga-toxin producing enterohemorrhagic *E. coli* (STEC), the most common of which in this study are *E. coli* O157:H7. Symptoms of infection range from bloody diarrhea and gastroenteritis, to life-threatening infections that can cause acute kidney failure. *E. coli* O157:H7 is most frequently associated with ground beef, unpasteurized milk, unpasteurized fruit juice, leafy greens, and sprouts.
Yersinia enterocolitica	34.4	*Yersinia* can cause disease in anyone, but most frequently does so in small children. Symptoms appear 1-2 weeks after exposure, and are usually mild but include fever, diarrhea, stomach pain and sometimes vomiting. Severe cases producing arthritis-like pain and affecting the heart can also occur. *Yersinia* is most frequently associated with pork (especially chitterlings), unpasteurized milk, and oysters. It is important to practice good hand washing when handling these foods, as *Yersinia* can survive on hands and contaminate cooked foods.
Hepatitis A	31.5	Hepatitis A is a vaccine-preventable virus that causes inflammation of the liver. Symptoms include fever, low appetite, nausea, vomiting, diarrhea, muscle aches, and temporary jaundice due to reduced liver function; symptoms are usually mild, begin 2-4 weeks after exposure, and resolve within a few weeks. Some cases can last up to 6 months and may cause severe liver damage which requires immediate medical attention. The Hepatitis A virus is spread by contamination of food and water by an infected host. It is most frequently an issue in developing countries with poor sanitation, and most often associated with fresh produce, shellfish, and other foods washed in contaminated water.
Salmonella spp., nontyphoidal	27.2	Nontyphoidal *Salmonella* species (spp.) cause gastrointestinal illness, the symptoms of which are nausea, vomiting, diarrhea, cramps and fever. Symptoms last a few days, and usually resolve without treatment; severe cases are possible, however, which result in severe gastroenteritis and possibly death. *Salmonella* spp. are traditionally associated with animal products, such as meat, poultry, eggs, dairy, fish, and shrimp, but can also be found in spices, produce, and peanut butter.
Trichinella spp.	24.3	*Trichinella* spp. are parasites that infect the muscles. Symptoms include fever, myalgia, malaise and edema; anti-parasitic medication can cure the infection, but muscle pain and damage may persist. *Trichinella* spp. are historically associated with undercooked pork, but most developed countries have removed or largely reduced this risk; in the United States, the largest risk of trichinosis comes from predatory game meat–wild pig, bear, cougar and walrus meat.
Shigella spp.	20.2	*Shigella* spp. are spread through poor sanitation–either through contaminated drinking water, recreation water, or through inadequate hygiene practices during food preparation. Illness is often mild and flu-like, and usually resolves within a week. Severe illness is possible, however, and includes voluminous diarrhea; this is a serious issue, and requires immediate medical attention. *Shigella* spp. infections are most frequently associated with produce or other foods washed with contaminated water, or food prepared by an infected food handler, such as ground meats and deli items.

Campylobacter spp.	17.1	*Campylobacter* spp. infections are frequently non-severe and self-limiting; because of this, *Campylobacter* is among the most underreported pathogens. Symptoms include diarrhea, vomiting and cramping, and last 2-10 days. Severe illness is possible, most frequently in the elderly and immune compromised. Infection in pregnant women can, cause stillbirth or miscarriage. *Campylobacter* spp. infections are typically associated with raw poultry, unpasteurized milk and cheeses, and contaminated water and those foods washed in contaminated water.
Staphylococcus aureus	6.4	*Staphylococcus aureus*, or "staph," is found in much of the environment, but can cause foodborne illness under certain conditions. Staph bacteria produce toxins, which can contaminate foods; usually, cooking does not destroy the toxin, but can destroy the bacteria. If ingested, these toxins may cause nausea, cramps, vomiting, and diarrhea. In severe cases, dehydration and changes in blood pressure and heart rate are possible. Symptoms are intense, but usually resolve within 1-7 hours. Outbreaks can occur in any food; the bacteria thrives on food left at improper temperatures, especially on foods which are not kept cool enough during prolonged preparation stages, such as deli or butcher counter meats.
Norovirus	1.5	Norovirus causes violent vomiting, watery diarrhea, and cramps. Symptoms usually subside within 1-2 days, but medical attention may be needed in severe cases. Norovirus is a human-associated virus that can be transmitted person-to-person, through contaminated water, or when a sick food handler prepares food – the primary source of foodborne Norovirus illnesses. Any food can become contaminated with Norovirus, and most contamination occurs in foodservice settings–the more a food is handled, the greater the chance that it can be handled by someone sick.
E. coli, non-STEC	0.8	Non-STEC *E. coli* spp. are those species of *E. coli* which do not produce shiga-toxin, but can still cause illness. These species of *E. coli* are spread much the same way STECs are, and produce symptoms such as diarrhea, nausea and stomach cramping. *E. coli* spp. are frequently associated with ground meats and produce.
Clostridium perfringens	0.6	*Clostridium perfringens* can contaminate foods which are left at improper temperatures for extended periods of time. Once eaten, the bacteria begin to produce a toxin while in the small intestine. Usually, this toxin produces mild illness, watery diarrhea and stomach cramps; this resolves within 24 hours, although illnesses may become more severe in some people. *Clostridium* may also cause "enteritis necroticans," a life-threatening form of intestine damage; symptoms include severe abdominal pain, and immediate medical attention is necessary. *Clostridium perfringens* can be found on any food–live bacteria produce spores on raw foods which can survive cooking; if cooked foods are left at improper temperatures for too long these spores can germinate into bacteria which can cause foodborne illness. Illness is most often associated with turkey and other foods eaten commonly as leftovers.
Bacillus cereus	0.4	*B. cereus* usually causes mild, brief illness. The most frequent type of illness caused by *B. cereus* involves the bacteria producing a toxin while in the small intestine—symptoms include diarrhea and cramping; this is usually mild and resolves quickly. Another, more severe, form of illness occurs when *B. cereus* bacteria produce toxin while on foods, usually starchy foods like rice. In this case, symptoms include nausea and vomiting, but this also resolves quickly. *B. cereus* is similar to *C. perfringens*—they are both primarily a problem of foods left at improper temperatures for too long, usually leftovers.

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