

# Foodborne Diseases

## A9

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# Objectives

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1. Describe the types and classification of foodborne disease.
2. Describe the types of contaminants in food and their modes of transmission.
3. Describe the national and global burden attributed to foodborne disease.
4. List factors associated with foodborne illness.
5. Understand the preventative measures needed for control of these diseases.
6. Describe the measures taken by the Saudi authorities to prevent foodborne disease.

## Types and classification of foodborne disease

**Foodborne disease** (also known as foodborne illness or food poisoning) is any illness that results from the consumption of contaminated food or drink.

Food poisoning is usually characterized by:

- History of ingestion of common food
- Attacks many individuals at the same time.
- Similar signs and symptoms in the majority of cases

The most common symptoms of foodborne diseases include: fever, nausea, vomiting, stomach cramps and diarrhea. However, symptoms may vary depending on the different causes of foodborne diseases.

Foodborne diseases can be classified into two broad categories:

### Foodborne intoxication

1. Naturally occurring toxins in foods
  2. Bacterial toxins
  3. Fungal toxins.
  4. Chemicals Poisoning
- **Toxic heavy metals** : Several metals, such as cadmium in shellfish, mercury in fish, and lead in canned food, contaminate food primarily through the industrial environment.
  - **Plants** : Plants are the foundation of the food chain, and they may easily absorb toxins from the soil, infecting not only fruits and vegetables but even seafood.
  - **Pesticides**: are used as plant protection agents, infiltrate the food chain, causing immunological suppression, decreased IQ, hormone disruption, cancer, and reproductive abnormalities in humans.

### Foodborne infections

1. **Bacterial diseases**: Salmonellosis, streptococcal infection and E.coli diarrhea
2. **Viral diseases**: viral hepatitis and gastroenteritis
3. **Parasites**: Ascariasis and amoebiasis

# Types of contaminants in food and their mood of transmission

<p><b>Biological contamination</b></p>	<p>It refers to food that has been contaminated with pathogens, which are divided into six microorganisms: Bacteria, Parasites, Viruses, Prions, Protozoa and Fungi These pathogens flourish on diets abundant in carbohydrates and protein, as well as those that are moist and neutral in acidity.</p>
<p><b>Physical contamination</b></p>	<p>It refers to food that has been contaminated during the manufacturing process with a foreign object. These objects can cause injuries such as broken teeth or choking, and can also carry harmful biological elements that can cause illness.</p> <p>Examples of physical food contaminants:</p> <ul style="list-style-type: none"> <li>• Hair</li> <li>• Plasters</li> <li>• A piece of jewelry</li> <li>• Shards of shattered glass</li> <li>• False nails or fingernails</li> <li>• Dirt</li> <li>• Stones, pips, bones, or shells</li> <li>• Pest-related debris</li> <li>• Insects or flies</li> </ul>
<p><b>Chemical contamination</b></p>	<p>Chemical contamination is the pollution of food by unwanted chemicals. Some of the most common causes include cleaning products or pesticides and herbicides from unwashed fruit and vegetables</p> <p>Common causes are classified into:</p> <ul style="list-style-type: none"> <li>• <b>Industrial chemicals:</b> Cleaning products such as detergents and sanitizers.</li> <li>• <b>Agricultural chemicals:</b> Herbicides, pesticides and fertilizers present on fruit and vegetables.</li> <li>• <b>Toxic metals:</b> Pots, pans, food containers or utensils made by non-food grade materials.</li> <li>• <b>Preservatives:</b> Ingredients added to food for longevity and flavor. Such as nitrates in meat.</li> <li>• <b>Naturally occurring toxin:</b> Chemical toxins produced or contained naturally within shellfish, seafood and plants.</li> </ul>
<p><b>Allergenic contamination</b></p>	<p>Food allergy happens when the body elicits a reaction to specific food if it recognizes the substance as a threat. When food that causes an allergic reaction contacts other food, this is known as allergenic contamination. And can be transmitted through:</p> <ul style="list-style-type: none"> <li>• <b>Equipment-to-food:</b> reusing a knife that has been used to cut bread to cut gluten-free bread.</li> <li>• <b>Food-to-food:</b> mixing allergenic foods like peanuts and chocolate can put children with allergies in life-threatening anaphylactic shock.</li> <li>• <b>People-to-food:</b> this is often due to negligence regarding hygiene regulations when a worker at a restaurant touches the food without washing their hands after touching other food.</li> </ul> <p>There are fourteen major allergens that can contaminate food:</p> <ul style="list-style-type: none"> <li>• Celery</li> <li>• Cereals containing gluten (such as oats and barley)</li> <li>• Crustaceans (such as crabs, prawns, and lobsters)</li> <li>• Fish</li> <li>• Eggs</li> <li>• Milk</li> <li>• Lupin</li> <li>• Mollusca (such as oysters and mussels)</li> <li>• Peanuts</li> <li>• Mustard</li> <li>• Soybeans</li> <li>• Sesame</li> <li>• Tree nuts (such as hazelnuts, almonds, Brazil nuts, walnuts, cashews, macadamia nuts pecans and pistachios)</li> <li>• Sulfites and sulfur dioxides (if the concentration exceeds ten parts per million)</li> </ul>

## National and global burden attributed to foodborne disease

### Global

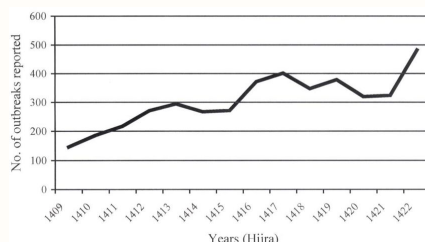
The World Health Organization attempted to estimate the worldwide burden of foodborne infections using data from 2007 to 2015, and some of their findings include:

1. Foodborne transmission of *Salmonella* spp. and *Brucella* spp. is more prevalent in developed countries than in developing countries.
2. In the case of *Campylobacter* spp., *Salmonella* spp., and Shiga-toxin producing *Escherichia coli*, foodborne transmission was the primary mode of transmission worldwide.
3. In the case of Hepatitis A, both foodborne and human-to-human transmission were considered equally important globally.
4. Foodborne transmission was the main cause of *Toxoplasma gondii* and *Ascaris* spp. worldwide, with soil also having a role in its spread.

### National

Burden of foodborne diseases and their outcomes in Saudi Arabia:

1. The most frequent foodborne disease reported by the Saudi Epidemiological Bulletin was salmonella which follows seasonal and regional variations and transmitted via three major food items; chicken, meat and rice. Also it's the most isolated microorganisms, whether in outbreaks from a public source or in household outbreaks, according to the 2018 Annual Report on Foodborne Disease Outbreaks.
2. In KSA, Staphylococci are also responsible for 41% of all bacterial food poisoning cases.
3. Most common settings in which foodborne illness incidents occur are restaurants and communal feasts, as well as institutional feeding (such as in school cafeterias, hospitals, nursing homes, prisons, and so on) where large quantities of food are prepared several hours before serving, according to ProMED-MENA editorials.



(Food poisoning accidents in the Kingdom of Saudi Arabia (1409-1422 Hijra) (Yagob, 2004))

## Factors associated with foodborne illness

The top 5 variables contributing to foodborne diseases have been determined by the Centers for Disease Control and Prevention (CDC) in the United States

<p><b>Poor Personal Hygiene</b></p>	<p>Food establishments must develop a culture of food safety since the leading cause of foodborne illnesses is poor personal hygiene. Various policies can be set to ensure personal hygiene such as employee illness policy, proper handwashing procedures, and a no bare-hand contact policy with ready-to-eat meals.</p>
<p><b>Improper Holding Temperatures</b></p>	<p>We should ensure to control and document food's time and temperature if it was between 41°F and 135°F at any period. Time and temperature control for safety (TCS) indicates that food should be date marked and stored no longer than 7 days keeping in mind that day one is the day of preparation or food package opening. When in doubt in regards to food's duration of storage, throw the meal out</p>
<p><b>Improper Cooking Temperatures</b></p>	<p>Metal stem thermometers should be conveniently stored and accessible for employees to monitor final cooking temperatures and to follow the minimum internal cooking temperature for food that the Food and Drug administration has specified in order to ensure pathogen counts are decreased to safe levels.</p>
<p><b>Food from Unsafe Sources</b></p>	<p>All foods served in restaurants and licensed establishments must come from sources that are approved and follow all applicable laws and regulations.</p>
<p><b>Contaminated utensils / Cross-Contamination</b></p>	<p>Various sources can be the origin of cross contamination including chemicals and uncooked food. To limit the spread of harmful microorganisms all equipments must be sanitized at least once every 4 hours. The sanitizer solutions used should be tested using test strips because sanitizers with low concentrations fail to remove microbes, whereas high concentrations will leave a toxic residue.</p>

## Preventative measures for foodborne diseases

Food is a potential source of infection and is susceptible to contamination by microorganisms, at any point during its journey from the producer to the consumer. Food hygiene implies hygiene in the production, handling, distribution and serving of all types of food and it is the primary aim to prevent food poisoning and other food-borne illnesses.

Food hygiene can be grouped under the following headings:

<b>Fruits and vegetables</b>	<ul style="list-style-type: none"> <li>• People should be educated to wash the vegetables before eating them raw.</li> <li>• choose items that aren't damaged.</li> <li>• If you buy pre-cut fruits and vegetables choose items that are refrigerated</li> <li>• Separate fruits and vegetables from raw meat, and seafood in your grocery bags.</li> </ul>
<b>Milk hygiene</b>	<ul style="list-style-type: none"> <li>• Healthy and clean animal to produce safe and clean milk.</li> <li>• The place where the animal is housed and milked should be clean.</li> <li>• Milk handlers must be free from communicable diseases, and before milking they must wash their hands and arms.</li> <li>• Pasteurization may be defined as the heating of milk to such temperatures and for such periods of time as are required to destroy any pathogens that may be present while causing minimal changes in the composition, flavor and nutritive value.</li> </ul>
<b>Meat hygiene</b>	<ul style="list-style-type: none"> <li>• Clean slaughterhouse to prevent contamination of meat.</li> <li>• Animals for slaughter require an ante-mortem and post-mortem inspection.</li> </ul>
<b>Food handlers</b>	<p>Proper personal &amp; utensil hygiene are imperative to prevent contamination and for food sanitation.</p> <p>The first essential is to have a complete medical examination carried out of all food handlers at the time of employment.</p> <p>Education of food handlers in matters of personal hygiene, food handling, utensils, dish washing, and insect and rodent control is the best means of promoting food hygiene. Many of the food handlers have little educational background.</p> <p>Certain aspects of personal hygiene are therefore required to be continually impressed upon them:</p> <p><b>Hands :</b> The hands should be clean at all times. Hands should be scrubbed and washed with soap immediately after visiting the bathroom and as often as necessary at other times. Fingernails should be kept trimmed and free from dirt.</p> <p><b>Hair :</b> Head coverings should be provided, to prevent loose hair entering the food.</p> <p><b>Overalls :</b> Clean white overalls should be worn by all food handlers,</p> <p><b>Habits :</b> Coughing and sneezing in an area near food, licking the fingers before picking up food, smoking on food better to be avoided.</p>
<b>Health education</b>	<p>To decrease food poisoning risks, health education programs targeting the general community using television, radio, newspapers and other educational channels are very important, while for Hajjis posters and mobile health education teams can be a good source of information.</p>

## Preventative measures for foodborne diseases in Saudi

### Tasks and responsibilities of different governmental and non-governmental organizations involved in food safety

#### Governmental

<b>Ministry of Health (MOH)</b>	<ul style="list-style-type: none"> <li>• Cooperation with other governmental bodies.</li> <li>• Has issued 25 national standard guidelines related to health conditions of the food and other establishments like restaurants and cafeterias.</li> <li>• Reacting to food poisoning outbreaks.</li> <li>• Monitor the food suppliers in the hospitals of the ministry.</li> </ul>
<b>Environmental Health Administration (EHA)</b>	<ul style="list-style-type: none"> <li>• Regulate food poisoning outbreaks by training teams to investigate food poisoning outbreaks.</li> <li>• Educate society regarding issues of food safety</li> </ul>
<b>Ministry of Municipality and Rural Affairs</b>	<ul style="list-style-type: none"> <li>• Participates in reacting to outbreaks of food poisoning</li> </ul>
<b>Saudi Food and Drug Authority (SFDA)</b>	<ul style="list-style-type: none"> <li>• Ensure that imported as well as local food products conform to national and international standards</li> <li>• Approve and enforce rules and regulations, review procedures and rules related to food, chemical substances and drugs as major concern for public health</li> <li>• Educate consumers by regulating awareness campaigns</li> </ul>

#### Non-governmental

<b>Consumer Protection Association</b>	<ul style="list-style-type: none"> <li>• Educating consumers about the methods of consumption.</li> <li>• Receiving consumer complaints about services.</li> </ul>
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#### - Why was there a need for establishing one association for food safety?

Due to the involvement of multiple authorities, ineffective management and lack of coordination has occurred between organizations, along with limited communication and overlapping duties. All resulting in low engagement with citizens and food businesses.



# Foodborne chemical contaminants

## Minamata Mercury poisoning in Japan

A significant methyl mercury (MeHg) poisoning of individuals living around Minamata Bay, a small inlet on Kyushu island, Japan, in the early 1950s initially aroused awareness of the terrible neurological disorder that resulted. The predominant route of exposure to MeHg in this incidence was through the ingestion of high-concentration MeHg-contaminated fish and shellfish. It was thought that a huge petrochemical plant was involved. Chisso Corporation was in charge of the operation. Chisso denied the charges and continued to produce without modifying their processes.

The amount of mercury spilled in Minamata Bay is estimated to be over 27 tons. Poisoned mothers had poisoned children. The following are some of their abnormalities:

1. Gnarled limbs
2. Mental retardation
3. Deafness
4. Blindness

There are two types of Methyl mercury poisoning around Minamata Bay each with certain manifestations in adults:

Acute poisoning	Chronic poisoning
Impairment of the 5 senses. Motor ataxia. Speech disorder. Somatosensory disorder Mental disorder.	Despite the fact that poisoned patients' exposure appeared to have ended more than 30 years ago, they reported paresthesia in the distal part of their extremities and around their lips.

## Arsenic

**Arsenic** is a naturally occurring element in the earth's crust that can be found in the air, water (groundwater), and soil. It can cause chemical contamination because it is highly poisonous in its inorganic form .

**Individuals get exposed to elevated levels of inorganic arsenic during :**

1. Consuming tainted water
2. Use of contaminated water in food preparation and cooking, as well as agricultural irrigation
3. Tobacco smoking
4. Industrial processes

**Effects on health :**

Inorganic arsenic is a well-known carcinogen and is the most common chemical contaminant related to drinking water around the world.

Acute consequences	Chronic consequences
<ol style="list-style-type: none"> <li>1. Vomiting</li> <li>2. Diarrhea and abdominal pain</li> <li>3. tingling and numbness in the extremities</li> <li>4. In severe circumstances, muscle cramps might lead to death.</li> </ol>	<ol style="list-style-type: none"> <li>1. Pigmentation of the skin</li> <li>2. Skin lesions</li> <li>3. skin cancer</li> <li>4. bladder and lung cancer</li> <li>5. Increase the likelihood of developing a non-communicable disease, such as diabetes (CVD , DM)</li> </ol>

## Foodborne Organisms Contaminant

	Botulism	E.coli O157:H7
<b>Definition</b>	<p>a rare but serious illness caused by a toxin that attacks the body's nerves</p> <p><b>Produced by:</b> Clostridium botulinum</p> <p><b>Toxin:</b> Type F been associated with botulism.</p>	<p>E. coli O157:H7 was first identified as a possible human pathogen in 1975 in a California patient with bloody diarrhea and was first associated with a foodborne (ground beef) outbreak of disease in 1982. This serotype (defined by its O and H surface antigens) and some non-O157 serotypes of E. Escherichia coli O157:H7 is a Shiga toxin (Stx)-producing E. coli (STEC) strains cause diarrhea, hemorrhagic colitis.</p>
<b>Signs &amp; symptoms</b>	<p><b>1. Neurological symptoms:</b></p> <ul style="list-style-type: none"> <li>- Muscle weakness</li> <li>- Ptosis</li> <li>- Slurred speech</li> <li>- Difficulty swallowing</li> <li>- Difficulty breathing</li> </ul> <p><b>2. Gastrointestinal symptoms:</b></p> <ul style="list-style-type: none"> <li>- Nausea</li> <li>- Vomiting</li> <li>- Stomach pain</li> <li>- Diarrhea</li> </ul> <p><b>3. Infant botulism symptoms:</b></p> <ul style="list-style-type: none"> <li>- Constipation</li> <li>- Poor feeding</li> <li>- Weak cry</li> <li>- Floppy movement</li> </ul>	<p>1. Infection with E. coli O157:H7 can be <b>asymptomatic</b></p> <p><b>2. Or may manifest as:</b></p> <ul style="list-style-type: none"> <li>- non-bloody diarrhea</li> <li>- hemorrhagic colitis</li> <li>- hemolytic uremic syndrome (HUS)</li> <li>- thrombocytopenia purpura</li> <li>- death</li> </ul>
<b>Transmission</b>	<p><b>1. Foodborne botulism</b></p> <p>The Clostridium botulinum toxin has been found in a variety of foods, including:</p> <ul style="list-style-type: none"> <li>- Homemade canned, preserved or fermented food.</li> <li>- Low-acid preserved vegetables, such as green beans, spinach, mushrooms, and beets.</li> <li>- Fish.</li> <li>- Meat products, such as ham and sausage which are a common source.</li> </ul> <p><b>2. Infant botulism</b></p> <ul style="list-style-type: none"> <li>- Infant botulism is caused by a toxin (a poison) from Clostridium botulinum bacteria, which live in soil and dust.</li> <li>- The bacteria can get on surfaces like carpets and floors and also can contaminate honey. That's why babies younger than 1 year old should never be given honey.</li> <li>- These bacteria are harmless to older kids and adults. That's because their mature digestive systems can move the toxins through the body before they cause harm.</li> </ul>	<p><b>1. Consumption of contaminated food</b> such as raw or undercooked ground meat products and raw milk.</p> <p><b>2. Cross-contamination</b> during food preparation with beef and other meat products or contaminated surfaces and kitchen utensils will also lead to infection.</p> <p><b>3. Faecal contamination</b> of water and other foods.</p> <p><b>4. Person-to-person contact</b> is an important mode of transmission through the oral-faecal route even if they were asymptomatic carriers.</p>
<b>Epidemiology</b>	<p>Georgia has the highest nationally reported rate of foodborne botulism in the world.</p>	<p>Disease caused by E. coli O157:H7 has been reported from more than 30 countries on six continents. E. coli O157:H7 has been found in cattle of several countries including the USA, Canada, Germany, Spain, England, and Scotland. Outbreaks have also occurred in these countries, as well as in Japan.</p>

# References

1. Park, K. (2011) *Park's textbook of preventive and social medicine*. Bhanot.
2. *Food safety and the types of food contamination* (no date) *Canadian Institute of Food Safety*. Available at: <https://www.foodsafety.ca/blog/food-safety-and-types-food-contamination> (Accessed: April 2, 2022).
3. *What are the different types of food contamination?* (no date) *Australian Institute of Food Safety*. Available at: <https://www.foodsafety.com.au/faq/what-are-the-different-types-of-food-contamination> (Accessed: April 2, 2022).
4. *Understanding chemical contamination of food* (no date) *Canadian Institute of Food Safety*. Available at: <https://www.foodsafety.ca/blog/understanding-chemical-contamination-food> (Accessed: April 2, 2022).
5. Collier, E. (2019) *What are the 4 types of food contamination?, The Hub | High Speed Training*. High Speed Training. Available at: <https://www.highspeedtraining.co.uk/hub/four-types-contamination/> (Accessed: April 2, 2022).
6. Training Express (2021) *Types of food contamination: Learn how food contamination occurs, Training Express*. Available at: <https://www.trainingexpress.org.uk/types-of-food-contamination/> (Accessed: April 2, 2022).
7. Davidson, K. et al. (2020) *What is cross contamination? Plus, how to avoid it, Healthline*. Available at: <https://www.healthline.com/nutrition/what-is-cross-contamination> (Accessed: April 2, 2022).
8. World Health Organization(WHO) (2016) *WHO estimates of the global burden of foodborne diseases: Foodborne disease burden epidemiology reference group 2007-2015*. Genève, Switzerland: World Health Organization.
9. Aljoudi, A. S., Al-Mazam, A. and Choudhry, A. J. (2010) "Outbreak of food borne Salmonella among guests of a wedding ceremony: The role of cultural factors," *Journal of family & community medicine*, 17(1), pp. 29–34. doi: 10.4103/1319-1683.68786.
10. Todd, E. C. D. (2017) "Foodborne disease and food control in the Gulf States," *Food control*, 73, pp. 341–366. doi: 10.1016/j.foodcont.2016.08.024.
11. Al-Mazrou, Y. Y. (2004) "Food poisoning in Saudi Arabia. Potential for prevention?," *Saudi medical journal*, 25(1), pp. 11–14.
12. *Top 5 Foodborne Illness Risk Factors* (no date) *Tazewellhealth.org*. Available at: <https://www.tazewellhealth.org/DocumentCenter/View/173/2018-Top-5-FBI-Risk-Factors-PDF> (Accessed: April 2, 2022).
13. Saad, A., Alsubaie, R. and Berekaa, M. M. (no date) *Food safety in Saudi Arabia: A public health priority, Amhsr.org*. Available at: <https://www.amhsr.org/articles/food-safety-in-saudi-arabia-a-public-health-priority.pdf> (Accessed: April 2, 2022).
14. جمعية حماية المستهلك (no date) *Org.sa*. Available at: <https://cpa.org.sa/function-of-the-association> (Accessed: April 2, 2022).
15. *Arsenic* (no date) *Who.int*. Available at: <https://www.who.int/news-room/fact-sheets/detail/arsenic> (Accessed: April 15, 2022).
16. Rahal, E. A. et al. (2012) "Escherichia coli O157:H7-Clinical aspects and novel treatment approaches," *Frontiers in cellular and infection microbiology*, 2, p. 138. doi: 10.3389/fcimb.2012.00138.
17. Ekino, S., Susa, M., Ninomiya, T., Imamura, K. and Kitamura, T., 2022. *Minamata disease revisited: An update on the acute and chronic manifestations of methyl mercury poisoning*.
18. Harada, M., 2022. *Minamata Disease: Methylmercury Poisoning in Japan Caused by Environmental Pollution*.
19. Erbguth, F.J. (2004). Historical notes on botulism, Clostridium botulinum, botulinum toxin, and the idea of the therapeutic use of the toxin. *Movement Disorders*, 19(S8), pp.S2–S6. <https://pubmed.ncbi.nlm.nih.gov/15027048/>
20. Kidshealth.org. (2015). Infant Botulism (for Parents) - KidsHealth. [online] Available at: <https://kidshealth.org/en/parents/botulism.html>.
21. cdc.gov. (2019). Symptoms. [online] Available at: <https://www.cdc.gov/botulism/symptoms.html>.
22. World Health Organization (2018). Botulism. [online] Who.int. Available at: <https://www.who.int/news-room/fact-sheets/detail/botulism>.
23. Varma, J.K., Katsitadze, G., Moiscrafshvili, M., Zardiashvili, T., Chokheli, M., Tarkhashvili, N., Jhorjholiani, E., Chubinidze, M., Kukhalashvili, T., Khmaladze, I., Chakvetadze, N., Imnadze, P. and Sobel, J. (2004). Foodborne Botulism in the Republic of Georgia. *Emerging Infectious Diseases*, 10(9), pp.1601–1605. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3320295/>
24. Doyle, M. E. et al. (no date) Human illness caused by E. coli O157:H7 from food and non-food sources, Wisc.edu. Available at: [https://fri.wisc.edu/files/Briefs\\_File/FRIBrief\\_EcoliO157H7humanillness.pdf](https://fri.wisc.edu/files/Briefs_File/FRIBrief_EcoliO157H7humanillness.pdf) (Accessed: April 15, 2022).
25. Rahal, E. A. et al. (2012) "Escherichia coli O157:H7-Clinical aspects and novel treatment approaches," *Frontiers in cellular and infection microbiology*, 2, p. 138. doi: 10.3389/fcimb.2012.00138.
26. cdc.gov. (2018). E.coli. [online] Available at: <https://www.who.int/news-room/fact-sheets/detail/e-coli>