

FOOD HYGIENE AND FOODBORNE DISEASES: A COMPREHENSIVE REVIEW

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Abstract

Food safety remains one of the most persistent public health challenges of the twenty-first century. Every year, hundreds of millions of people across the globe fall ill after consuming contaminated food, and a substantial proportion of these cases could be prevented through the consistent application of sound food hygiene practices. This review article examines the fundamental concepts of food hygiene, explores the major categories of foodborne diseases and their causative agents, and discusses the burden these illnesses place on individuals, healthcare systems, and economies. Particular attention is given to bacterial, viral, parasitic, and chemical hazards, the pathways through which food becomes contaminated, and the preventive frameworks — from personal hygiene and the "clean, separate, cook, chill" approach to Hazard Analysis and Critical Control Points (HACCP) — that are used to interrupt the contamination chain. The article concludes that while foodborne disease cannot be eliminated entirely, a combination of consumer education, robust regulation, and science-based management systems can reduce its incidence dramatically. Food hygiene, in short, is not merely a technical discipline; it is a shared responsibility that begins in the home kitchen and extends to the farthest reaches of the global food supply chain.

Keywords: food hygiene; foodborne disease; food safety; contamination; HACCP; foodborne pathogens

1. Introduction

Food is essential to life, yet the very act of eating carries risk when hygiene is neglected. Food hygiene refers to the set of conditions and measures necessary to ensure the safety and suitability of food at every stage of the food chain — from production and harvesting through processing, storage, distribution, preparation, and finally consumption. When these measures fail, the result is foodborne disease: illness

caused by consuming food or water contaminated with pathogenic microorganisms, their toxins, or harmful chemical substances.

The scale of the problem is striking. The World Health Organization estimates that unsafe food causes hundreds of millions of illnesses annually worldwide, with diarrheal diseases alone accounting for a large share of the global burden, and children under five years of age being disproportionately affected. Beyond human suffering, foodborne outbreaks generate enormous economic losses through medical costs, lost productivity, product recalls, and trade restrictions.

What makes foodborne disease especially frustrating from a public health perspective is that most cases are preventable. The hazards are well understood, the transmission routes have been mapped, and effective control measures — many of them remarkably simple, such as washing hands and cooking food thoroughly — have been known for decades. The gap lies in consistent implementation. This review therefore aims to synthesize current understanding of food hygiene principles, survey the landscape of foodborne diseases, and evaluate the strategies available for their prevention and control.

2. Understanding Food Hygiene

2.1 Definition and Scope

Food hygiene encompasses all practices that preserve the wholesomeness of food and prevent it from becoming a vehicle for disease. It is broader than cleanliness alone: while cleaning and sanitizing are central, food hygiene also includes temperature control, cross-contamination prevention, personal hygiene of food handlers, pest management, safe water supply, and the structural design of food premises. International guidance, notably the Codex Alimentarius General Principles of Food Hygiene, frames hygiene as a continuum that stretches across the entire food chain, often summarized as the principle "from farm to fork."

2.2 The Core Pillars of Food Hygiene

Although national regulations differ in detail, they converge on a common set of hygiene pillars. Table 1 summarizes the principal pillars and the risks each one addresses.

Hygiene Pillar	Key Practices	Risks Addressed
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Personal hygiene	Handwashing, clean clothing, exclusion of ill workers, no bare-hand contact with ready-to-eat food	Transfer of pathogens from handlers to food
Cleaning and sanitizing	Scheduled cleaning of surfaces, utensils and equipment; correct sanitizer concentration	Build-up of bacteria on food-contact surfaces
Temperature control	Cooking to safe internal temperatures; cold storage at or below 4 °C; rapid cooling of cooked food	Survival and multiplication of pathogens and toxin formation
Cross-contamination prevention	Separate raw and cooked foods; dedicated cutting boards and knives; correct storage order	Spread of pathogens from raw ingredients to ready-to-eat items
Safe water and raw materials	Potable water only; approved suppliers; inspection of incoming ingredients	Chemical and microbial contamination at source
Pest control	Sealing entry points, proper waste management, regular inspection	Pathogen carriage by insects and rodents

Table 1. Core pillars of food hygiene and the risks they mitigate.

2.3 Why Hygiene Failures Occur

In practice, contamination rarely results from a single dramatic failure. More often it accumulates through small lapses: a refrigerator door left open, a knife reused without washing, a worker who comes in despite feeling unwell. Behavioral studies of food handlers repeatedly show that knowledge of hygiene rules is often adequate while

compliance is not — a reminder that food safety is as much a matter of culture, training, and supervision as it is of regulation.

3. Foodborne Diseases: An Overview

3.1 Definition and Classification

Foodborne diseases are illnesses acquired through the ingestion of contaminated food or water. They fall into two broad clinical patterns: foodborne infection, in which live pathogens multiply in the body and cause illness (for example, salmonellosis), and foodborne intoxication, in which a toxin pre-formed in the food damages the host (for example, staphylococcal or botulinum poisoning). Some organisms, such as certain strains of *Escherichia coli*, can cause both, depending on the circumstances.

By causative agent, foodborne diseases are conventionally grouped into four categories:

Bacterial diseases form the largest and best-studied group. *Salmonella*, *Campylobacter*, pathogenic *E. coli*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Clostridium perfringens*, and *Clostridium botulinum* are among the most important agents. Bacterial disease typically follows consumption of undercooked meat, poultry, eggs, unpasteurized dairy products, or food that has been held at unsafe temperatures.

Viral diseases are frequently underdiagnosed because they seldom trigger the dramatic outbreaks associated with bacteria, yet viruses such as norovirus and hepatitis A are estimated to cause a very large share of foodborne illness globally. Infected food handlers are a major transmission route, which underlines why personal hygiene and exclusion of symptomatic workers are so critical.

Parasitic diseases include infections with protozoa such as *Giardia*, *Cryptosporidium*, and *Toxoplasma gondii*, as well as helminths such as *Trichinella spiralis* and tapeworms. These agents are often linked to contaminated water, undercooked meat, or unwashed produce grown in contaminated soil.

Chemical and toxin hazards round out the picture. These include heavy metals (lead, mercury, cadmium), pesticide residues, mycotoxins such as aflatoxins produced by molds on grains and nuts, marine biotoxins in seafood, and adulterants. Although less common than microbial illness, chemical hazards can cause chronic disease, including cancer, after long-term exposure.



Figure 1. Artistic rendering of Salmonella bacteria, one of the leading bacterial causes of foodborne illness worldwide.

3.2 Major Foodborne Pathogens and Their Sources

Table 2 profiles some of the most significant foodborne pathogens, their typical food vehicles, and characteristic illness features.

Pathogen	Common Food Sources	Typical Incubation	Characteristic Illness
Salmonella spp.	Poultry, eggs, raw milk, contaminated produce	6–72 hours	Diarrhea, fever, abdominal cramps; can invade bloodstream
Campylobacter jejuni	Undercooked poultry, unpasteurized milk	2–5 days	Bloody diarrhea, fever; linked to Guillain-Barré syndrome
Pathogenic E. coli (e.g., O157:H7)	Undercooked beef, contaminated leafy greens, raw milk	1–10 days	Severe cramps, bloody diarrhea; risk of hemolytic uremic syndrome

Listeria monocytogenes	Ready-to-eat meats, soft cheeses, smoked seafood	3–70 days	Mild flu-like illness in healthy people; severe in pregnancy and elderly
Norovirus	Contaminated shellfish, ready-to-eat food handled by infected persons	12–48 hours	Sudden vomiting and diarrhea; highly contagious
Hepatitis A virus	Contaminated water, produce, shellfish; infected handlers	15–50 days	Jaundice, fatigue, nausea; prolonged illness
Staphylococcus aureus	Cream-filled pastries, salads, cooked meats handled improperly	1–6 hours	Rapid-onset vomiting and nausea; usually self-limiting
Clostridium botulinum	Improperly canned foods, garlic-in-oil, fermented fish	12–36 hours	Descending paralysis; a medical emergency

Table 2. Selected major foodborne pathogens, their typical vehicles, and clinical features.

3.3 The Global Burden of Foodborne Disease

Quantifying the burden of foodborne disease is difficult because surveillance systems vary enormously between countries and many cases are never reported. Nevertheless, WHO's landmark 2015 estimates, updated since, indicated that contaminated food causes roughly 600 million illnesses and hundreds of thousands of deaths each year worldwide. Diarrheal pathogens account for the majority of this burden. Children under five bear a disproportionate share of deaths, and the highest per-capita burden falls on

low- and middle-income countries in Africa and Southeast Asia, where unsafe water, limited refrigeration, and weak regulatory capacity intersect.

Even in high-income countries with mature surveillance, the numbers are sobering. In the United States, the Centers for Disease Control and Prevention estimates that foodborne pathogens cause tens of millions of illnesses annually. The true figures everywhere are almost certainly higher than reported figures, because mild cases go unreported and laboratory confirmation is required for most surveillance systems. Nor can the burden be measured in health statistics alone: foodborne outbreaks erode consumer confidence, trigger costly recalls, and can destroy businesses and livelihoods overnight.

4. How Food Becomes Contaminated

Food contamination can occur at any point in the food chain, and understanding the pathways is essential to interrupting them. Hazards arrive through three principal routes.

First, primary contamination occurs at the source — in the field or on the farm. Pathogens in irrigation water or manure used as fertilizer can settle on fresh produce; animals can carry *Salmonella* or *Campylobacter* without appearing sick; and seafood can accumulate marine toxins from the waters in which it grows. Second, secondary contamination takes place during processing, transport, storage, or preparation. This is where cross-contamination between raw and ready-to-eat foods, lapses in refrigeration, and transmission from infected handlers typically occur. Third, contamination can arise from the environment itself: unclean utensils, pest droppings, or chemical residues from cleaning agents used improperly.

A useful way to visualize the risk is the contamination chain shown in everyday kitchens: raw chicken juices drip onto a salad in the refrigerator; a knife used to cut raw meat is wiped, not washed, before slicing bread; cooked rice is left out overnight and reheated briefly. Each link is a small failure of hygiene, and each is preventable.



Figure 2. Washing fresh produce under running water — a basic but powerful food hygiene practice.

5. Prevention and Control Strategies

5.1 The Consumer Level: Clean, Separate, Cook, Chill

At the household level, food safety guidance worldwide converges on four simple verbs. Clean means washing hands with soap before and during food preparation, washing produce under running water, and keeping utensils and surfaces sanitized. Separate means keeping raw meat, poultry, seafood, and eggs away from ready-to-eat foods, using separate cutting boards and plates. Cook means heating food to temperatures sufficient to kill pathogens — for poultry, that means an internal temperature of about 74 °C, verified with a food thermometer rather than guesswork. Chill means refrigerating perishables promptly, keeping the refrigerator at or below about 4 °C, and never leaving perishable food in the "danger zone" (roughly 4–60 °C) for extended periods.

These rules sound elementary, and they are — but outbreak investigations repeatedly trace major events back to their neglect. In this domain, simplicity is a strength: advice that people actually follow saves more lives than sophisticated protocols that remain on paper.



Figure 3. Handwashing remains the single most effective barrier against the spread of foodborne pathogens.

5.2 The Industry Level: HACCP and Food Safety Management

For food businesses, prevention is formalized through structured management systems, the most influential of which is the Hazard Analysis and Critical Control Points (HACCP) system. Developed originally for astronaut food in the 1960s and now embedded in Codex Alimentarius guidance, HACCP requires a food operation to identify hazards, determine where in the process each hazard can be controlled (the critical control points), set limits, monitor compliance, and correct deviations. Applied correctly, HACCP shifts food safety from reactive inspection of finished products to proactive control of the process itself.

HACCP is typically complemented by prerequisite programs: supplier approval schemes, sanitation standard operating procedures, pest control contracts, employee training, and traceability systems that allow contaminated products to be traced forward to retailers and backward to their source within hours. In many jurisdictions, third-party certification against standards such as ISO 22000 or the Global Food Safety Initiative benchmarked schemes provides additional assurance to buyers and regulators.

5.3 The Regulatory and Public Health Level

Governments contribute through food safety legislation, licensing and inspection of food premises, laboratory surveillance, outbreak investigation, and public education

campaigns. Effective systems combine risk-based inspection (focusing enforcement effort where hazard is greatest) with rapid communication to the public when hazards are identified — for instance, through recall notices and alerts. International cooperation matters too, because the modern food trade means a contaminated ingredient produced in one country can cause illness in dozens of others within days.

6. Contemporary Challenges in Food Hygiene

Several trends are reshaping the food safety landscape. The globalization of the food supply has lengthened supply chains and multiplied the number of handoffs at which contamination can occur, while also complicating traceability. Changing dietary patterns — greater consumption of fresh and minimally processed produce, which is often eaten raw — have increased exposure to hazards that cooking would otherwise eliminate. Climate change influences the picture in subtle ways, from the expansion of pathogen habitats to the greater frequency of extreme weather events that overwhelm sanitation infrastructure.

Antimicrobial resistance adds a further dimension: some foodborne bacteria are increasingly resistant to the antibiotics used to treat severe infections, meaning that a preventable kitchen lapse can evolve into an untreatable illness. Finally, the rise of e-commerce and informal food vending — street food, home-based producers selling through social media — creates large sectors that traditional inspection models struggle to reach. Addressing these challenges will require not only better technology but also sustained investment in training, infrastructure, and consumer education, particularly in the regions carrying the heaviest burden.

7. Conclusion

Foodborne disease is as old as eating itself, but it is not an inevitability. The evidence reviewed here points to a consistent conclusion: the hazards are known, the transmission pathways are understood, and the control measures are effective — where they are applied. Food hygiene operates at three interlocking levels: the habits of individual consumers and food handlers, the management systems of food businesses, and the regulatory frameworks of states and international bodies. Weakness at any one level undermines the others.

The practical implications are clear. Consumers should internalize the simple disciplines of cleaning, separating, cooking, and chilling. Food businesses should treat HACCP not as paperwork but as a living system embedded in daily operations. Policymakers should invest in surveillance, in risk-based inspection, and above all in the regions where the burden is greatest. Most fundamentally, food safety must be

recognized as a shared responsibility — one that begins at the farm, passes through every kitchen and factory, and ends at the dinner table. With that shared commitment, the heavy and largely preventable toll of foodborne disease can be dramatically reduced.

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