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# **SALMONELLA**

**A DANGEROUS FOODBORNE PATHOGEN**

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Edited by Barakat S M Mahmoud

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# **SALMONELLA – A DANGEROUS FOODBORNE PATHOGEN**

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## **Salmonella – A Dangerous Foodborne Pathogen**

Edited by Barakat S. M. Mahmoud

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## Preface

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Salmonella is a gram-negative microorganism, widely dispersed in nature and often found in the intestinal tract of animals and humans. More than 2,500 serotypes of Salmonella exist, but only some of these serotypes have been frequently associated with food-borne illnesses. The pathogenic *Salmonella* is a life-threatening bacterium, and it is a leading cause of food-borne bacterial illnesses in humans. After *Campylobacter*, Salmonella is the second most predominant bacterial cause of food-borne gastroenteritis worldwide. Salmonella pathogens may primarily spread through the feces of wildlife and domestic animals, contaminated water, poor fertilization methods, and other agricultural practices. Salmonella serotypes can grow and survive in many different foods. The behavior of Salmonella in foods is governed by a variety of environmental and ecological factors. These include water activity, pH, chemical composition, the presence of natural or added antimicrobial agents, and storage temperature and processing factors, such as the application of heat and physical manipulation.

Food-borne infections from Salmonella are obtained through ingesting contaminated food or water. Poultry, eggs, beef, and milk products are the main vehicles in the salmonellosis outbreak, and secondary sources are foods, such as fruits, vegetables, and seafood. Since 1962, registered cases of human salmonellosis caused by contaminated food have been steadily increasing. Salmonellosis, or Salmonella infection, caused by nontyphoid strains is the most common food-borne disease reported from population-based, active laboratory surveillance in the United States. However, since the 1980s, food-borne salmonellosis from Salmonella serotypes Typhimurium and Enteritidis has increased. The Centers for Disease Control and Prevention (CDC) revealed that the incidence of Salmonella infections in 2010 was significantly higher than during the period 2006–2008.

Often, most people who suffer from Salmonella infections may have temporary gastroenteritis, which usually does not require treatment. However, when infection becomes invasive, antimicrobial treatment is mandatory. Symptoms generally occur 8 to 72 hours after ingestion of the pathogen and can last 3 to 5 days. Children, the elderly, and immunocompromised individuals are the most susceptible to salmonellosis infections. The annual economic cost due to food-borne Salmonella infections in the United States alone is estimated at \$2.4 billion, with an estimated 1.4

million cases of salmonellosis and more than 500 deaths annually. Many milder cases are not reported, making the estimated number of salmonellosis cases in the United States thirty times the number of reported cases.

The chapters contained in this book describe a range of different topics, such as the role of foods in Salmonella infections, food-borne outbreaks caused by Salmonella, biofilm formation by Salmonella (Salmonella grows predominantly as biofilm in most of its natural habitats). Additional topics include antimicrobial drug resistance of Salmonella isolates (the multidrug resistance of Salmonella, which reduces the therapeutic options in cases of invasive infections and could potentially be associated with an increased burden of illness), methods for controlling Salmonella in food, and Salmonella isolation and identification methods to ensure the safety of food. Contributing to this book are internationally renowned scientists who have provided a diverse and global perspective of the issues of concern with the Salmonella pathogen. This book serves as an excellent resource for those interested in Salmonella. In fact, this book is intended to be primarily a reference book. However, it also summarizes the current state of knowledge regarding Salmonella, and it contains ideas for future research. The editor is indebted to the participating authors for their state-of-the-art contributions in providing authoritative views resulting from their research on this dangerous Salmonella pathogen.

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# The Burden of Salmonellosis in the United States

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## 1. Introduction

Salmonellosis or *Salmonella* infection caused by nontyphoid strains is the most common foodborne disease reported from population-based, active laboratory surveillance in the United States (U.S.) (Figure 1). The overall incidence of laboratory confirmed *Salmonella*

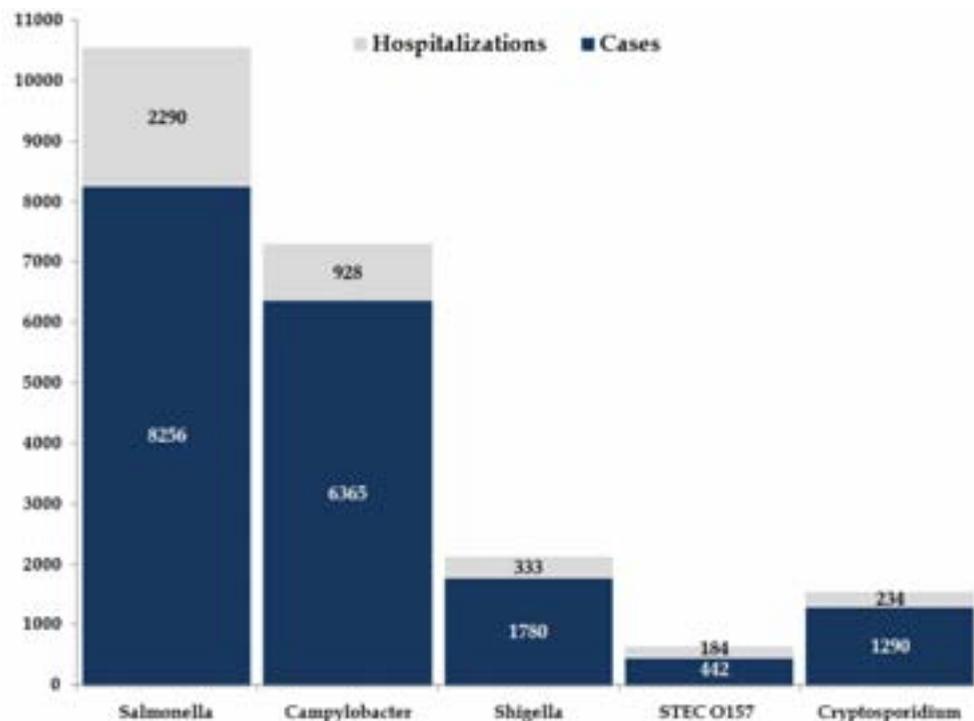


Fig. 1. Total number of laboratory-confirmed bacterial and parasitic infection cases and hospitalizations by pathogen in the United States (CDC, 2011).

infection was 17.6 cases per 100,000 persons in 2010. This was more than twice the U.S. Healthy People 2010 objective of 6.8 cases per 100,000 persons (Figure 2) (Matyas et al., 2010). Moreover, a recent report released by the Centers for Disease Control and Prevention (CDC) revealed that the incidence of *Salmonella* infections in 2010 was significantly higher than during 2006-2008 representing an increase of about 10% (95% Confidence Interval (CI), 4-17%). However, other foodborne infections, such as *Campylobacter*, *Listeria*, *Shigella*, STEC O157, *Vibrio*, and *Yersinia*, have all actually decreased during this same period (CDC, 2011). The disease burden of salmonellosis has remained substantial in the United States in spite of ongoing public health and regulatory efforts to prevent and control this infectious disease.

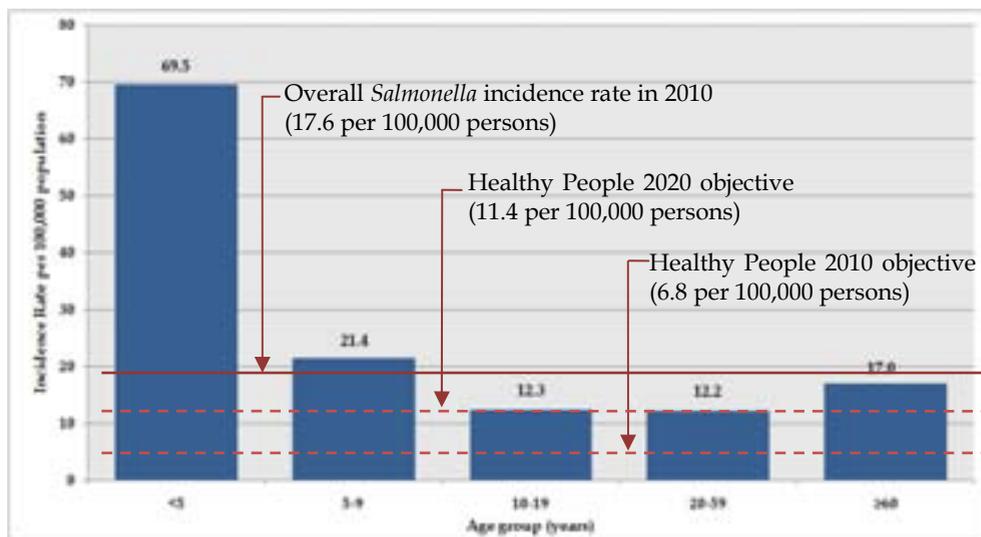


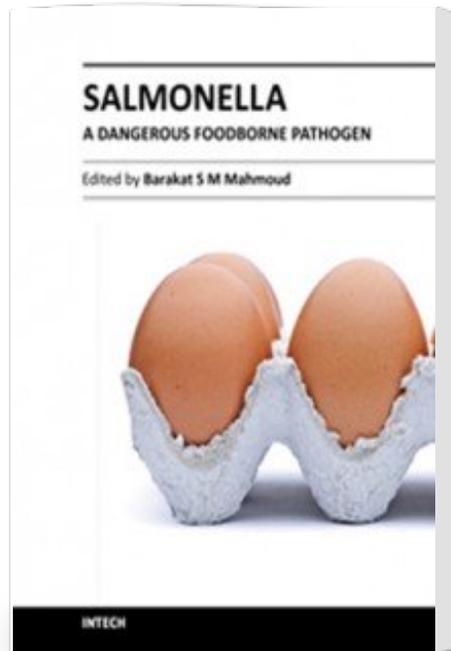
Fig. 2. Laboratory-confirmed *Salmonella* incidence rate per 100,000 population, by age group, as compared to the overall incidence rate and the national health objectives (Healthy People) for 2010 and 2020, United States, 2010 (CDC, 2011).

The present chapter discusses the trends in morbidity, mortality, and years of potential life lost attributed to human salmonellosis in the United States. In addition, this chapter provides a snapshot of U.S. public health measures and control policies that are currently in place to protect the public against *Salmonella* infection.

## 2. The burden of salmonellosis in the United States

Salmonellosis causes more disease burden than any other foodborne pathogen. An estimated 93.8 million cases (90% CI, 61.8-131.6 million) of gastroenteritis caused by *Salmonella* species occur globally each year and of these, nearly 80.3 million cases are foodborne (Majowicz et al., 2010). In the United States, an estimated 1 million incident cases of human salmonellosis occur annually (Scallan et al., 2011); however, only a small portion of these cases are recognized clinically (see section 2.2). In industrialized countries as few as 1% of clinical cases are actually reported (Heymann, 2008). Collectively, *Salmonella* infections in the United States account for roughly 19,336 hospitalizations, 17,000 quality adjusted life

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