Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

Salmonella Gastroenteritis in Older Infants: Epidemiology and Treatment, A Review

***Noor D. Hameed*[1] * and *Shahad B. Ismaeal*[2]**

[1]Department of Microbial Biotechnology, college of Biotechnology, Al-Nahrain University, Baghdad-Iraq
[2]Department of Molecular and Medical Biotechnology, College of biotechnology, Al-Nahrain University, Baghdad- Iraq

*Corresponding author: Noor.Dheyaa@nahrainuniv.edu.iq.

Received: 7/2/2026, Accepted: 12/5/2026, Published: 30/6/2026.

Abstract

Salmonella Gastroenteritis among infants, specifically because they are normally susceptible to invasive diseases, often comes from infections. Non-typhoidal Salmonella is a major public health challenge around the world, primarily from the intake of contaminated food or water and from poor hygiene practices. The goal of this study is to conduct a narrative literature review of non-typhoidal Salmonella gastroenteritis in infants and examine the current main themes in the literature (epidemiology, clinical presentation, risk factors, complications, and therapeutic management) to provide an appraisal. To accomplish this, a literature search was held in multiple electronic databases, including PubMed, Scopus, and Google Scholar, and continued until June 2025. Included in the long list of inclusion criteria was the study of clinical and/or epidemiological reasons for non-typhoidal Salmonella gastroenteritis, so the search was extensive. Although the majority of Salmonella infections are self-limiting, younger children have a greater risk of developing serious complications (bacteremia and sepsis). Clinical symptoms range from mild and self-limiting diarrhea to systemic invasive disease. The above-listed identified risk factors (i.e., formula feeding, lack of cleanliness/poor hygiene, and immature immunity) significantly contribute to the development and severity of the disease. Therefore, early diagnosis, proper risk stratification, and tailored management strategies for infants are all necessary to have desirable outcomes. As the emergence of antibiotic-resistance bacteria increases; therefore, proper use of antibiotics rationally and implementing public health measures to prevent infection should be reinforced.

Keywords: *Salmonella* infections, *Salmonella gastroenteritis*, infants, pediatric infections, antimicrobial resistance

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

Introduction

Salmonella spp. are bacteria that are motile, gram-negative, and and facultatively anaerobic (able to grow either in aerobic or anaerobic environments), and they belong to the family Enterobacteriaceae. There are many clinical manifestations associated with *Salmonella* spp., including enterocolitis, enteric fever, bacteremia, osteomyelitis, and abscess formation. Enterocolitis is the most common clinical manifestation of Salmonella infection; however, as diarrheal diseases are responsible for approximately 2.5 million deaths per year, this represents only one part of a very large, multifactorial global health issue and cannot be attributed solely to infections caused by *Salmonella* spp [1].

Salmonella's ability to invade the intestinal epithelial cells and persist in the cells of the host contributes to its pathogenicity and allows for the potential dissemination throughout the system. A Salmonella infection will, in most instances, resolve without any treatment; however, the severity of the disease will be impacted by both the virulence factors of the bacteria and host-related factors. Infants, especially those under three years of age, are a special population at a higher risk for developing severe infections from the immature state of their immune system, leading to an increased susceptibility to severe infections and bacteremia [2].

Salmonella spp. are The health-related characteristics of salmonella type 1 and type 2 infections fall into two distinct categories based on their terminology: “typhoidal” (systemic infections) and “non-typhoidal” (typically, gastroenteritis resulting from contaminated food). All strains of non-typhoidal salmonella viruses are classified as foodborne pathogens. If you have a healthy immune system, you will almost always recover on your own from an infection by one of the types of non-typhoidal salmonella, however, serious illnesses can occur among vulnerable individuals such as infants and those with weakened immune systems [3] (Figure 1).

Figure (1): *Salmonella typhi* diagram (Zhang *et al*., 2026)

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

Salmonella bongori and *Salmonella enterica* are the two species in the genus *Salmonella* according to the current categorization scheme. There are over 2500 types of *Salmonella enterica* (Figure 2) [5]. Humans are the primary hosts of typhoid *Salmonella serotypes*, such as *Salmonella typhi* or *Salmonella paratyphi*, which are generally spread by eating or drinking food or water contaminated with feces [6]. These serotypes induce clinical infections, which often manifest as very mild diarrhea. Food tainted with animals or human feces is typically the source of the non-typhoidal [7].

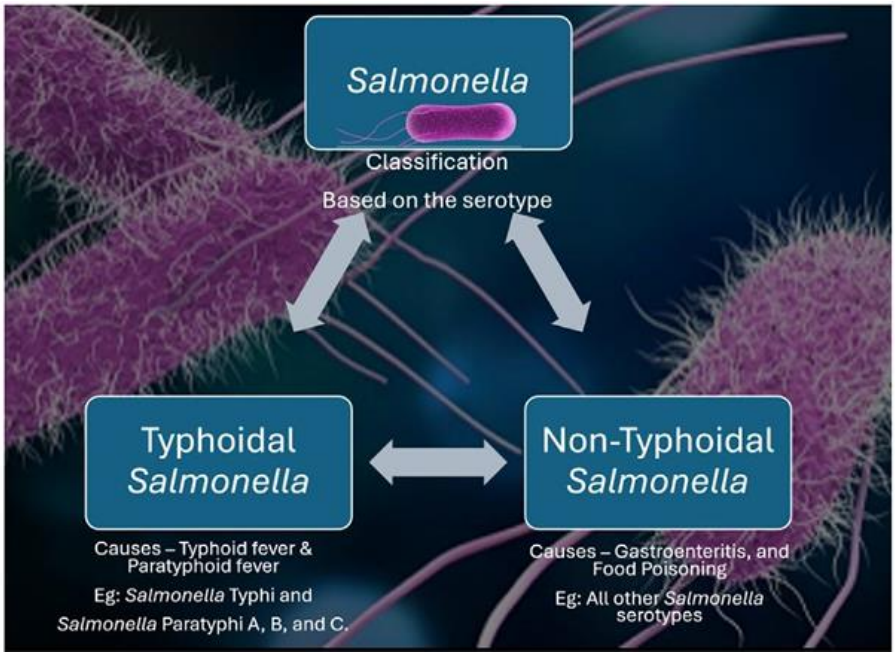

Figure 2: Classification of Salmonella infections into typhoidal and non-typhoidal groups based on serotype, showing their associated clinical manifestations (Ranjan *et al*., 2026)

Figure 2 illustrates the classification of *Salmonella* based on serotypes into two main groups: typhoidal and non-typhoidal *Salmonella*. Typhoidal strains, including *S. typhi* and *S. paratyphi*, are primarily associated with systemic infections such as typhoid and paratyphoid fever. In contrast, non-typhoidal *Salmonella* include a wide range of serotypes that are commonly associated with gastroenteritis and foodborne infections [9].

Additionally, non-typhoidal *Salmonella* can be contracted directly from people or animals through the fecal-oral pathway [10]. More cases of salmonellosis are observed in infants than in other age groups. Infants accounted for 9% to 10% of culture-confirmed cases reported between 2013 and 2015 [11]. The relative significance of the causes or factors that lead to invasive *Salmonella* infections in babies is not well understood, all newborns are susceptible to severe salmonellosis, although the risk varies depending on exposures and host variables [12]. This study aims to comprehensively evaluate the clinical features, risk factors, and management of *Salmonella* gastroenteritis in hospitalized infants, with particular emphasis on disease severity and antimicrobial resistance patterns.

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

Types and causative agents of salmonellosis

According to the Centers for Disease Control and Prevention (CDC), six subspecies of *S. enterica* are distinguished: enterica (I), salamae (II), arizona (IIIa), diarizonae (IIIb), houte-nae (IV), and indica (VI). However, there are no subspecies of *S. bongori* [13,14]. A variety of hosts, including people, animals, birds, and fish, can contract salmonellosis, Typhoidal and nontyphoidal *Salmonella* (NTS) are two categories into which can be classified according to their clinical symptoms [15]. *S. Typhi* and *S. Paratyphi* A cause enteric fever in humans [16]. Furthermore, nontyphoidal *Salmonella* usually causes gastroenteritis, and the frequency of invasive sickness is determined by host immunity [17]. Invasive NTS is more common in people with diseases like malaria [18].

Recent outbreaks of Salmonella

Recent outbreaks of *Salmonella* have been reported worldwide, underscoring its continued public health significance. In the United States, *Salmonella* infections are estimated to result in approximately 26,500 hospitalizations and 420 deaths annually [19]. In contrast, a specific outbreak linked to contaminated cantaloupes in November 2023 involved 302 reported cases, including 129 hospitalizations and six deaths, as documented by the CDC. These figures represent a single outbreak and should be clearly distinguished from the overall annual burden [20].

Similarly, outbreaks have been documented in other regions. In 2016, 230 cases were reported in South Australia, while 97 cases were identified in New South Wales in association with contaminated cantaloupes [21]. In the same year 907 people in the US were affected by an out-of-control spread of a disease across countless states. Also, there have been localized epidemics of those infected with Typhoid Fever that have occurred among particularly susceptible populations including more than 40 Iraqi and Syian migrants living within the confines of the Al-Hol Camp within 2018 and then 40 cases of people contracting the disease by way of contaminated water from Woraiyur, India [22,23].

These findings highlight the critical role of contaminated food and water, as well as population vulnerability, in the transmission of *Salmonella* infections. They further emphasize the importance of robust surveillance systems and effective food safety measures in preventing and controlling future outbreaks [24].

Management of *Salmonella* infections

Azithromycin is one of the antibiotics used in the treatment of *Salmonella* infections [25]. Typhoid fever has been treated for many years with ampicillin, trimethoprim–sulfamethoxazole, and chloramphenicol therapies. However, increasing numbers of patients have been found to have resistant organisms which makes it necessary to develop new therapy options. Fluoroquinolones are widely used in adults; however, their use in children is more restricted because of the risk of adverse side effects [26].

Resistance to fluoroquinolones has been linked to mutations in topoisomerase genes, including *gyrA*, *gyrB*, *parC*, and *parE*, as well as plasmid-mediated quinolone resistance (PMQR) mechanisms and efflux pumps [27]. Azithromycin has emerged as an alternative treatment due to its ability to accumulate intracellularly [28]. Several studies have shown that azithromycin concentrations can exceed the minimum

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

inhibitory concentration (MIC) of *S. Typhi* [29], and it has demonstrated efficacy in experimental models of *Salmonella* infection [30].

Owing to its long half-life, azithromycin can be administered once daily, which may improve patient adherence. Nevertheless, the selection of appropriate antibiotic therapy should be guided by clinical condition, patient age, and local antimicrobial resistance patterns [31].

The risk of *Salmonella* infection

Salmonella infections may resolve spontaneously or progress to more severe conditions. In infants, improper storage of infant formula is considered a common source of infection [٣٢]. In addition, asymptomatic carriers play an important role in transmission, facilitating the spread of infection compared to other enteric pathogens [33].

Maternal asymptomatic carriage may contribute to transmission, particularly through improper food handling or preparation. Infection is commonly acquired through contaminated food, which may be transferred indirectly to infants via caregivers [1, 34].

Following ingestion, Salmonella invades the intestinal mucosa and may spread to mesenteric lymph nodes, leading to localized or systemic infection. Clinically, *S. gastroenteritis* typically presents with diarrhea, which is initially watery but may become bloody or mucus-containing in severe cases [35].

Host immunity plays a critical role in controlling infection. In immunocompetent individuals, immune responses limit pathogen spread and disease progression. However, infants and young children are more susceptible to severe outcomes due to their underdeveloped immune system [36]. Given its invasive potential, Salmonella infection should be considered in cases of gastroenteritis, particularly in high-risk groups. Notably, bacteremia may occur in approximately 30–50% of infected infants, even in the absence of diarrhea [37], (Figure 3).

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

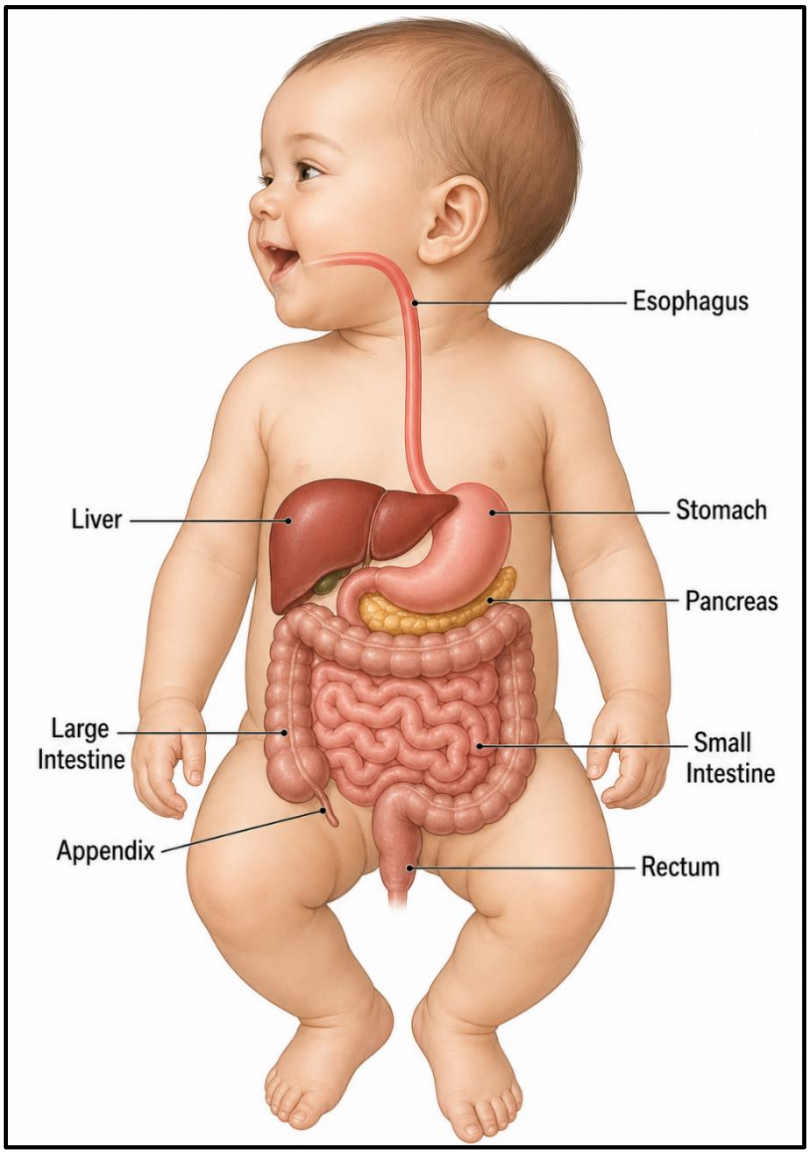

Figure 3: Anatomical representation of the infant digestive system (Russell and Rollins, 2026)

Salmonella gastroenteritis

Meningitis represents one of the most severe complications of *Salmonella* infection, underscoring the importance of careful clinical evaluation in neonates with suspected infection [39]. Infants younger than two months are at the highest risk of developing meningitis and Salmonella bacteremia. According to recommendations from the Centers for Disease Control and Prevention (CDC), neonates should receive prompt antibiotic therapy due to their increased susceptibility to invasive Salmonella infections, particularly in the presence of risk factors such as lack of breastfeeding or immunocompromised status [40].

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

Although acute *S. gastroenteritis* is typically self-limiting, antibiotic therapy is generally not recommended for otherwise healthy older infants, children, and adults [41]. However, treatment is indicated in infants younger than three months because of the elevated risk of severe complications, including meningitis and sepsis. For infants aged three to twelve months, antibiotic therapy may be considered on a case-by-case basis, as supporting evidence remains limited [42]. Parenteral antibiotics are recommended for patients who appear clinically ill or toxic, whereas oral therapy may be appropriate for clinically stable patients if blood cultures remain negative after 48 hours [7]. In immunocompetent children, the duration of antibiotic therapy typically ranges from 3 to 14 days, depending on clinical severity and response to treatment [43].

Oral antibiotics for *Salmonella*

According to these recommendations, the patient's recurrent episodes of high fever necessitated the initiation of antibiotic therapy [44]. Fluoroquinolones exhibit strong antibacterial activity against Gram-negative enteric pathogens and are considered the standard treatment for adults and adolescents with *S. gastroenteritis* [45]. In pediatric patients, the use of fluoroquinolones is generally restricted rather than contraindicated, due to concerns regarding potential adverse effects, including cartilage toxicity observed in animal studies. However, short-term use may be considered in selected cases where the benefits outweigh the risks [46]. Alternative oral antibiotics include trimethoprim–sulfamethoxazole (TMP–SMX), cefixime, and azithromycin. In children with acute invasive diarrhea, ceftriaxone has been shown to be as effective as oral ciprofloxacin [47]. Therefore, ceftriaxone is often preferred in young infants to minimize the potential risk of joint toxicity associated with fluoroquinolones. In this case, a 4-month-old infant was treated with parenteral ceftriaxone for three days [48], followed by oral azithromycin for an additional five days in accordance with current clinical recommendations [49].

The causes of *Salmonella gastroenteritis*

Salmonella gastroenteritis in infants is most commonly associated with exposure to contaminated food, According to CDC (Centers for Disease Control and Prevention) or through bad care for baby formula. At this level of the population, it is also possible to transfer indirectly through caregivers, especially in poor hygiene environments where fecal-oral transmission is facilitated. Infants under one year of age are particularly at risk because of weak immune systems, reduced gastric acid production and immature intestinal flora, all of which create conditions conducive for the establishment of Enteric Pathogens. Additionally, feeding such as usage of baby formulas rather than breastfeeding is a significant risk factor for transferring Salmonella as opposed to breastfed only babies[50,51].

The pertinent clinical signs of fever and bloody diarrhea in this situation strongly indicated that a bacterial gastroenteritis had occurred, which warranted urgent clinical assessment. Infants are at greater risk for developing a systemic infection (through blood stream) versus older children/adults based on these signs [52]. While the majority of gastroenteritis cases are self-resolving, *Salmonella* infection should be high on a clinician's differential diagnosis list in infants who Present with an acute episode of diarrhea that is associated with systemic signs such as fever or evidence of sepsis. The definitive diagnosis and management of these patients requires a stool culture and microbiological analysis to establish a final diagnosis [53].

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

The clinical spectrum of *Salmonella* infection in infants ranges from mild, self-limiting diarrhea to severe invasive disease. This variability underscores the importance of early recognition, targeted diagnostic workup, and risk-based therapeutic decision-making in this vulnerable population [54].

Methods of diagnosing *Salmonella gastroenteritis*

This study was designed as a narrative review to summarize and critically analyze the available literature on *S. gastroenteritis* in infants, with a particular focus on epidemiology, clinical features, risk factors, and therapeutic management. A comprehensive literature search was conducted using electronic databases, including PubMed, Scopus, and Google Scholar. Relevant articles published up to 2025 were considered. The search strategy included the following keywords: "*Salmonella gastroenteritis*", "*Salmonella* infections", "infants", and "pediatric infections", using different combinations to ensure comprehensive coverage of the topic.

Research conducted on Salmonella infections in infants and children showed that data collected from studies published in multiple languages were systematically included and descriptively represented as potential risks due to study population differences. Data and analyses have demonstrated the need to promote early diagnosis and effective antibiotic therapy in pediatric populations because of the increased morbidity associated with Salmonella infections. Literature and data demonstrate that many infants and children with Salmonella infections will be hospitalized and treated for an extensive time due to complications[٥٥]. The majority of children with Salmonella infections also develop complications from those infections. It has also been documented that children under the age of newborns are most frequently hospitalized and treated for Salmonella infections due to the extended length of time required for illness. It has been demonstrated that children who receive antibiotic therapy as prescribed will have a lower risk of developing complications when compared to those who do not receive antibiotics. There is a need to create a protocol for the appropriate management of children with Salmonella infections and to evaluate treatment outcomes, including complications from Salmonella infections[٥٦].

Conclusions

Salmonella gastroenteritis remains a significant cause of morbidity in infants, particularly those under one year of age, owing to immune immaturity and increased susceptibility to invasive complications such as bacteremia and meningitis. Although most non-typhoidal *Salmonella* infections Infants' clinical course may be unpredictable despite their typically self-limiting nature; thus, it may be possible for infants to exhibit rapid progression to severe illness. Therefore, clinicians must make decisions about how best to care for these infants using a variety of criteria (e.g., patient age, severity of illness) without relying solely upon the fact that the infant will eventually recover from the infection without treatment and antibiotics will eventually be effective. As discussed here, there is a need for individualized approaches toward treating infants since no one method works for all infants. The increased incidence of resistant Salmonella in the USA and worldwide is becoming a significant public health problem, and prudent use of antibiotics and continued epidemiological surveillance are essential components to reducing overall cases of Salmonella infection.

Despite advances in clinical management, significant gaps persist in the current literature. There is a lack of well-defined, age-specific treatment guidelines for infants, particularly those between three and twelve months of age. Furthermore, limited data are available regarding the long-term outcomes of invasive *Salmonella* infections Early life has been restricted from being able to base their decisions upon evidence due to a lack of evidence based decision-making in early life. Future research must focus on developing optimized and age specific treatment protocols and early diagnostic methods; also, there is a need for broad assessment of antimicrobial resistance trends in the child population. Additionally, strengthening public health interventions, such as food safety policies, safe and hygienic practices, and developing public health surveillance systems with the support of the World Health Organization (WHO)/Centers for Disease Control (CDC), are crucial to decreasing the incidence of Salmonella infections in infants.

Acknowledgments

We gratefully acknowledge the staff members of College of Biotechnology for its support.

Author's Contribution Statement

All authors participated in the collection of literature reviews, wrote the draft of the review article, and revised it

References

1. Bula-Rudas, F. J., Rathore, M. H., and Maraqa, N. F. (2015). Salmonella infections in childhood. *Advances in Pediatrics*, **62**(1), 29–58. https://doi.org/10.1016/j.yapd.2015.04.005
2. Lamichhane, B., Mawad, A. M. M., Saleh, M., Kelley, W. G, Harrington, P. J., Lovestad, C. W., Amezcua, J., Sarhan, M. M., El Zowalaty, M. E., Ramadan, H., Morgan, M., Helmy, Y. A. (2024). Salmonellosis: An Overview of Epidemiology, Pathogenesis, and Innovative Approaches to Mitigate Antimicrobial Resistant Infections. *Antibiotics*, **13**(1): 76. doi: https://doi.org/10.3390/antibiotics13010076
3. Onwuezobe, I. A., Oshun, P. O., and Odigwe, C. C. (2012). Antimicrobials for treating symptomatic non-typhoidal Salmonella infection. Cochrane Database of Systematic Reviews, **11**, CD001167. https://doi.org/10.1002/14651858.CD001167.pub2
4. Zhang, K., Chen Q., Chen, J., Jiang, R., Zhang, C., Tang, D., Chen, Y. and Qiu, Z. (2026). Contactless gas-sensitive photoelectrochemical biosensor for determination of *Salmonella typhimurium* based on SnO_2/CeO_2 heterojunction. *Analytica Chimica Acta*, **1406**, 345466. https://doi.org/10.1016/j.aca.2026.345466
5. Wen, S. C. H., Best, E., and Nourse, C. (2017). Non-typhoidal *Salmonella* infections in children: Review of literature and recommendations for management. *Journal of Paediatrics and Child Health*, **53**(10), 936–941. https://doi.org/10.1111/jpc.13585
6. Eugene, L., Janco, J., and Piglansky, L. (2000). Oral ciprofloxacin versus intramuscular ceftriaxone as empiric treatment of acute invasive diarrhea in children. *Pediatric Infectious Disease Journal*, **19**(11), 1060–1067. https://doi.org/10.1097/00006454-200011000-00006

7. Muthumbi, E. (2024). Understanding the carriage and transmission of non-typhoidal *Salmonella* infections in Kenya. Doctoral dissertation, London School of Hygiene and Tropical Medicine.
8. Ranjan, A., Chandna, M., Stevens, N. J., Kandil, J., Dinh, B., Kuhn, M., Mian, N., Tran, B., Hamid, A., Kim, P. and Desin, T. S. (2026). *Salmonella* infections: Global trends and emerging challenges. *Microorganisms*, **14**(4), 816. https://doi.org/10.3390/microorganisms14040816
9. Faris, H., Mahdi, M. A., and Al-Shaikhli, N. H. (2026). Virulence factors and pathogenic mechanisms of *Salmonella enterica* serovar Typhi: A narrative review. *Journal of Medical and Oral Biosciences*, **3**(1), 01–20. https://doi.org/10.58564/jmob.122
10. John, C., and Christenson, M. D. (2013). *Salmonella* infections. *Pediatrics in Review*, **34**(9), 375–383. https://doi.org/10.1542/pir.34-9-375
11. Mkangara, M. (2023). Prevention and control of human Salmonella enterica infections: An implication in food safety. *International Journal of Food Science*, **2023**, 8899596. https://doi.org/10.1155/2023/8899596
12. Alakomi, H. L., and Saarela, M. (2009). Salmonella importance and current status of detection and surveillance methods. *Quality Assurance and Safety of Crops and Foods*, **1**(3), 142–152. https://doi.org/10.1111/j.1757-837X.2009.00032.x
13. Aguirre, D. B., Carter, J., and Niemira, B. A. (2025). An investigation about the historic global foodborne outbreaks of Salmonella spp. in eggs: From hatcheries to tables. *Journal of Food Science*, **24**(3), e70202. https://doi.org/10.1111/1541-4337.70202
14. Popa, G. L., and Papa, M. I. (2021). Salmonella spp. infection: A continuous threat worldwide. *GERMS*, **11**(1), 88–96. https://doi.org/10.18683/germs.2021.1244
15. Boakye Okyere, P., Twumasi-Ankrah, S., Newton, S., Nkansah Darko, S., Owusu Ansah, M., Darko, E., Agyapong, F., Jin Jeon, H., Adu-Sarkodie, Y., Marks, F. and Owusu-Dabo, E. (2025) Risk factors for typhoid fever: Systematic review. *JMIR Public Health and Surveillance*, **11**, e67544. https://doi.org/10.2196/67544
16. Fasih, F., Fatima, A., Baig, S., Naseem, S., Tauheed, M. M. and Gohar, H. (2023). Antimicrobial susceptibility of bacteraemic isolates of Salmonella enterica serovar Typhi and Paratyphi infection in Pakistan from 2017–2020. *Journal of Pakistan Medical Association*, **73**(3), 505–510. https://doi.org/10.47391/jpma.6083
17. Fatima, M., Kumar, S., Hussain, M., Memon, N. M., Vighio, A., Syed, M. A., Chaudhry, A., Hussain, Z., Baig, Z. I., Baig, M. A., Asghar, R. J., Ikram, A. and Khader, Y. (2021). Morbidity and mortality associated with typhoid fever among hospitalized patients in Hyderabad district, Pakistan, 2017–2018: Retrospective record review. *JMIR Public Health and Surveillance*, **7**(5), e27268. https://doi.org/10.2196/27268
18. Girgis, N. I., Butler T., Frenck, R. W., Sultan, Y., Brown, F. M., Tribble, D. and Khakhria, R. (1999). Azithromycin versus ciprofloxacin for treatment of uncomplicated typhoid fever in a randomized trial in Egypt that included patients with multidrug resistance. Antimicrobial *Agents and Chemotherapy*, **43**(6), 1441–1444. https://doi.org/10.1128/aac.43.6.1441
19. Sjölund-Karlsson, M., Howie, R. L., Crump, J. A., and Whichard, J. M. (2014). Fluoroquinolone susceptibility testing of Salmonella enterica: Detection of acquired resistance and selection of zone

diameter breakpoints for levofloxacin and ofloxacin. *Journal of Clinical Microbiology*, **52**(3), 877–884. https://doi.org/10.1128/jcm.02679-13

20. Parry, C. M., Vu Thieu, N. T., Dolecek, C., Karkey, A., Gupta, R., Turner, P., Dance, D., Maude, R. R., Ha, V., Tran, C. N., Le, P. T., Van Be, B. P., Thi Phi, L. T., Ngoc, R. N., Ghose, A., Dongol, S., Campbell, J. I., Thanh, D. P., Thanh, T. H., Moore, C. E., Sona, S., Gaind, R., Deb, M., Anh, H. V., Van, S. N., Tinh, H. T., Day, N. P. J., Dondorp, A., Thwaites, G., Faiz, M. A., Phetsouvanh, R., Newton, P., Basnyat, B., Farrar, J. J. and Baker, S. (2015). Clinically and microbiologically derived azithromycin susceptibility breakpoints for Salmonella enterica serovars Typhi and Paratyphi A. *Antimicrobial Agents and Chemotherapy*, **59**(5), 2756–2764. https://doi.org/10.1128/aac.04729-14
21. Wang, J. Li, Y., Xu, X., Liang, B., Wu, F., Xiaoxia, Y., Ma, Q., Yang, C., Hu, X., Liu, H., Li, H., Sheng, C., Xie, J., Du, X., Hao. R., Qiu, S. and Song, H. (2017). Antimicrobial Resistance of Salmonella enterica Serovar Typhimurium in Shanghai, China. *Frontiers in Microbiology*, **8**, 510. https://doi.org/10.3389/fmicb.2017.00510
22. Heidary, M., Samangani, A. E., Kargari, A., Nejad, A. K., Yashmi, I., Motahar, M., Taki, E. and Khoshnood, S. (2022). Mechanism of action, resistance, synergism, and clinical implication of azithromycin. *Journal of Clinical Laboratory Analysis*, **36**(6), e24427. https://doi.org/10.1002/jcla.24427
23. Kosek, M., Bern, C., and Guerrant, R. L. (2003). The global burden of diarrhoeal disease. *Bulletin of the World Health Organization*, **81**, 197–204.
24. Türkmenoğlu, Y. Köşeli, E., Göksoy, E. Ö., Jorayev, M. and Arıca, V. (2015). A case of gluteal abscess due to Salmonella typhimurium. *Journal of Pediatric Research*, **2**(3), 167–169. https://doi.org/10.4274/jpr.28291
25. Chiu, C. H., Su, L. H., and Chu, C. (2004). Salmonella enterica serotype Choleraesuis: Epidemiology, pathogenesis, clinical disease, and treatment. *Clinical Microbiology Reviews*, **17**(2), 311–322. https://doi.org/10.1128/cmr.17.2.311-322.2004
26. Acheson, D., and Hohmann, E. L. (2001). Nontyphoidal salmonellosis. *Clinical Infectious Diseases*, **32**(2), 263–269. https://doi.org/10.1086/318457
27. Alara, J. A., and Alara, O. R. (2024). Global increase of multidrug resistance: A major challenge in clinical diagnosis. *Infectious Disorders Drug Targets*, **24**(3), 26–42. https://doi.org/10.2174/1871526523666230725103902
28. Hung, Y. T., Lay, C.J., Wang, C. L. and Koo, M. (2017). Characteristics of nontyphoidal Salmonella gastroenteritis in Taiwanese children: A 9-year period retrospective medical record review. *Journal of Infection and Public Health*, **10**(5), 518–521. https://doi.org/10.1016/j.jiph.2016.09.018
29. Arıkan, K. Ö., and Güven, G. B. (2021). Salmonella infections in children: Clinical features and antibiotic resistance trends. *Forbes Medical Journal*, **2**(2), 87–91.
30. Hurtado, A., Ocejo, M. and Oporto, B. (2017). Salmonella spp. and Listeria monocytogenes shedding in domestic ruminants and characterization of potentially pathogenic strains. *Veterinary Microbiology*, **210**, 71–76. https://doi.org/10.1016/j.vetmic.2017.09.003

31. Medugu, N., Michelow, I. C., Poole, C. and Obaro, S. K. (2026). Azithromycin mass drug administration: Balancing survival benefits and risks in children. *The Lancet Infectious Diseases*, **26**(1), e62–e74. https://doi.org/10.1016/s1473-3099(25)00363-9
32. Milazzo, A., Giles, L. C., Zhang, Y., Koehler, A. P., Hiller, J. E. and Bi, P. (2016). The effect of temperature on different Salmonella serotypes during warm seasons in a Mediterranean climate city, Adelaide, Australia. *Epidemiology and Infection*, **144**(6), 1231–1240. https://doi.org/10.1017/S0950268815002587
33. Chi, H., Sun, W., Chan, W. T., Lee, H. C. and Fang, S. B. (2001). Pediatric Salmonella enterocolitis in a teaching hospital: A four-year analysis. *Acta Paediatrica Taiwanica*, **42**(5), 297–300.
34. Erdem, B., Hascelik, G., Gedikocğlu, S. and Gür, D. (2004). Salmonella enterica serotypes and Salmonella infections: A multicenter study covering ten provinces in Turkey. *Mikrobiyoloji Bulteni*, **38**(3), 173–186.
35. Kasumba, I. N., Pulford, C. V., Perez-Sepulveda, B. M., Sen, S., Sayed, N., Permala-Booth, J., Livio, S., Heavens, D., Low, R., Hall, N., Roose, A., Powell, H., Farag, T., Panchalingham, S., Berkeley, L., Nasrin, D., Blackwelder, W. C., Wu, Y., Tamboura, B., Sanogo, D., Onwuchekwa, U., Sow, S. O., Ochieng, J. B., Omore, R., Oundo, J. O., Breiman, R. F., Mintz, E. D., O'Reilly, C. E., Antonio, M., Saha, D., Hossain, M. J., Mandomando, I., Bassat, Q., Alonso, P. L., Ramamurthy, T., Sur, D., Qureshi, S., Zaidi, A. K. M., Hossain, A., Faruque, A. S. G., Nataro, J. P., Kotloff, K. L., Levine, M. M., Hinton, J. C. D. and Tennant, S. M. (2021). Characteristics of Salmonella Recovered From Stools of Children Enrolled in the Global Enteric Multicenter Study. *Clinical Infectious Diseases*, **73**(4), 631–641. https://doi.org/10.1093/cid/ciab051
36. Kirk, M. D., Angulo, F. J., Havelaar, A. H. and Black, R. E. (2016). Diarrhoeal disease in children due to contaminated food. *Bulletin of the World Health Organization*, **95**(3), 233–234. https://doi.org/10.2471/BLT.16.173229
37. Worsena, C. R., Miller, A. S., and King, M. A. (2019). Salmonella infections. *Pediatrics in Review*, **40**(10), 543–545. https://doi.org/10.1542/pir.2017-0198
38. Russell, K. W., and Rollins, M. D. (2026). Alimentary tract duplications. *In Holcomb and Ashcraft's Pediatric Surgery* (pp. 576–587). https://doi.org/10.1016/B978-0-443-12431-0.00037-1
39. Gülmez, D. Gür, D., Hasçelik, G., Güleşen, R. and Levent, B. (2012). Experiences of a University Hospital Participating in the National Enteric Pathogens Surveillance Network (UEPLA): Four-year data of Salmonella, Shigella and Campylobacter. *Turkish Microbiology Society Journal*, **42**(3), 85–92.
40. Holmes, C. N., and Chiller, T. M. (2004). National antibiotic resistance monitoring system for enteric bacteria. *Emerging Infectious Diseases*, **10**(11), 2061. https://doi.org/10.3201/eid1011.040665
41. Ren, L., Yang, M., Geng, L., Chen, P., Chen, H., Gong, S. and Li, D. Y. (2018). Nontyphoidal Salmonella gastroenteritis in a tertiary children's hospital in southern China: Characteristics and dietary considerations. *Gastroenterology Research and Practice*, **2018**, 3097468. https://doi.org/10.1155/2018/3097468

Iraqi journal of Bioscience and Biomedical
Published Online First: 30 / June /2026.
p-ISSN: 3007-5491 / e-ISSN:3007-5505

42. Canton, R., Akóva, M., Carmeli, Y., Giske, C. G., Glupczynski, Y., Gniadkowski, M., Livermore, D. M., Miriagou, V., Naas, T., Rossolini, G. M., Samuelsen, Ø., Seifert, H., Woodford, N. and Nordmann, P. (2012). Rapid evolution and spread of carbapenemases among Enterobacteriaceae in Europe. *Clinical Microbiology and Infection*, **18**(5), 413–431. https://doi.org/10.1111/j.1469-0691.2012.03821.x
43. Giani, T., Pini, B., Arena, F. and Conte, V. (2013). Epidemic diffusion of KPC carbapenemase-producing Klebsiella pneumoniae in Italy. *Euro Surveillance*, **18**(22), 20489. https://doi.org/10.2807/ese.18.22.20489-en
44. Glasner, C., Albiger, B., Buist, G., Andrasević, A. T., Canton, R., Carmeli, Y., Friedrich, A. W., Giske, C. G., Glupczynski, Y., Gniadkowski, M., Livermore, D. M., Nordmann, P., Poirel, L., Rossolini, G. M., Seifert, H., Vatopoulos, A., Walsh, T., Woodford, N., Donker, T., Monnet, D. L. and Grundmann, H. (2013). Carbapenemase-producing Enterobacteriaceae in Europe: a survey among national experts from 39 countries, February 2013. *Euro Surveillance*, **18**(28), 20525. https://doi.org/10.2807/1560-7917.es2013.18.28.20525
45. Borer A., Saidel-Odes, L., Riesenberg, K., Eskira, S., Peled, N., Nativ, R., Schlaeffer, F. and Sherf, M. (2009). Attributable mortality rate for carbapenem-resistant Klebsiella pneumoniae bacteremia. *Infection Control and Hospital Epidemiology*, **30**(10), 972–976. https://doi.org/10.1086/605922
46. Sivanandy, P., Yuk, L. S., Yi, C. S., Kaur, I., Soong Ern, F. H. and Manirajan, P. (2025). A systematic review of recent outbreaks and the efficacy and safety of drugs approved for the treatment of Salmonella infections. *IJID Regions*, **14**, 100516. https://doi.org/10.1016/j.ijregi.2024.100516
47. Marquez, P., Terashita, D., Dassey, D. and Mascola, L. (2013). Population-based incidence of carbapenem-resistant Klebsiella pneumoniae along the continuum of care, Los Angeles County. *Infection Control and Hospital Epidemiology*, **34**(2), 144–150. https://doi.org/10.1086/669087
48. Lin, M. Y., Lyles-Banks, R. D., Lolans, K., Hines, D. W., Spear, J. B., Petrak, R., Trick, W. E., Weinstein, R. A. and Hayden, M. K. (2013). The importance of long-term acute care hospitals in the regional epidemiology of Klebsiella pneumoniae carbapenemase-producing Enterobacteriaceae. *Clinical Infectious Diseases*, **57**(9), 1246–1252. https://doi.org/10.1093/cid/cit500
49. Guevara-Ramírez, J. F., Rodríguez-Gutiérrez, A. F., Sánchez-Escobar, I. S., Bolaños-Rodríguez, S. D., Adames-Restrepo, V., Ruiz-Galvis, S. A., Sánchez-Sánchez, V., Cruz-Torres, N. A D. L., Hernández-Rincón, E. H. and Barbosa, S. D. (2025). Antibiotic therapy in dysentery of infectious etiology in early childhood: A systematic scoping review. *Boletín Médico del Hospital Infantil de México*, **82**(1), 15–27. https://doi.org/10.24875/bmhim.24000085
50. Perlman, J. (2024). The Febrile Infant: Updates in Evaluation and Management. *Pediatr Ann*, **53**(9):e314-e319. https://doi.org/10.3928/19382359-20240703-04
51. Magiorakos, A. P., Burns, K., Baño, J. R., Borg, M., Daikos, G., Dumpis, U., Lucet, J. C., Moro, M. L., Tacconelli, E., Simonsen, G. S., Szilágyi, E., Voss, A. and Weber, J. T. (2017). Infection prevention and control measures and tools for the prevention of entry of carbapenem-resistant Enterobacteriaceae into healthcare settings: guidance from the European Centre for Disease

Prevention and Control. *Antimicrobial Resistance and Infection Control*, **6**, 113. https://doi.org/10.1186/s13756-017-0259-z

52. Durante-Mangoni, E., Andini, R., and Zampino, R. (2019). Management of carbapenem-resistant Enterobacteriaceae infections. *Clinical Microbiology and Infection*, **25**(8), 943–950. https://doi.org/10.1016/j.cmi.2019.04.013
53. Tomczyk, S., Zanichelli, V., Grayson, M. L., Twyman, A., Abbas, M., Pires, D., Allegranzi B. and Harbarth S. (2019). Control of Carbapenem-resistant Enterobacteriaceae, Acinetobacter baumannii, and Pseudomonas aeruginosa in Healthcare Facilities: A Systematic Review and Reanalysis of Quasi-experimental Studies. *Clinical Infectious Diseases*, **68**(5), 873–884. https://doi.org/10.1093/cid/ciy752
54. Terracciano, F., Lillo, C., and Siakavellas, S. I. (2026). Role of IUS in the differential diagnosis with other colitis. *Bowel Ultrasound Compared with Endoscopy*. 73–87. https://doi.org/10.1007/978-3-032-11418-1_7
55. Politi, L., Sideroglou, T., Triantafyllou, E., Mandilara, G., Chrysostomou, A., Mellou, K., Georgakopoulou, T. and Akinosoglou, K. (2026). Salmonellosis Among Children Aged 0–14 Years in Greece over the Period 2005–2024: Descriptive Analysis of Surveillance Data from the Mandatory Notification System. *Microorganisms*, **14**(4), 743. https://doi.org/10.3390/microorganisms14040743
56. Guarino, A., Vecchio, A. L., Dias, J. A., Berkley, J. A., Boey, C., Bruzzese, D., Cohen, M. B., Cruchet, S., Liguoro, I., Salazar-Lindo, E., Sandhu, B., Sherman, P. M. and Shimizu, T. (2018). Universal recommendations for the management of acute diarrhea in nonmalnourished children. *Journal of pediatric gastroenterology and nutrition*, **67**(5), 586-593. https://doi.org/10.1097/MPG.0000000000002053