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Epidemiology of *Salmonella Typhi* among Pregnant Women Attending Antenatal Care at General Hospital Keffi, Keffi Local Government Area of Nasarawa State, Nigeria

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Abstract

Typhoid fever is one of the major and common health problems worldwide. Caused by *Salmonella typhi*, it leads to morbidity and mortality in both mothers and fetuses in developing countries. This cross-sectional study examined *Salmonella* infection among pregnant women attending General Hospital Keffi, Nigeria. A serological analysis (Widal test) was carried out among one hundred (100) pregnant women. The results of this study show an overall prevalence of 31%. Participants in the age group 26-30 years had the highest prevalence of 9 (33.3%), followed by those aged 21-25 years with 15 (31.9%), then those under 20 years with 7 (31.8%), and the least among those over 31 years with 0 (0.0%). There was no statistical difference (P=0.72) between typhoid fever and age group. Women in their third trimester had the highest prevalence of 9 (62.1%), followed by the second trimester with 26 (54.1%), and the least was among those in their first trimester with 9 (60%). There was

no statistically significant difference (P=0.88). Those with secondary education had the highest prevalence of 15 (32.6%), followed by those with informal education at 4 (30.7%), those with primary education at 7 (30.4%), and the least among those with tertiary education. There was no statistically significant difference (P=0.99). Urban residents had a higher prevalence of 27 (35.0%) compared to rural residents at 4 (17.3%). There was no statistically significant difference (P=0.18). Housewives had the highest prevalence of 19 (37.2%), followed by civil servants at 5 (33.3%), and traders with the least at 10 (23.8%). There was no statistically significant difference (P=0.53). Regarding the source of drinking water, users of stream/river water had the highest prevalence of 5 (100%), followed by well users at 22 (86.6%), then sachet/table water users at 4 (18.1%), followed by borehole users at 7 (17.0%), and the least was among tap water users at 3 (60.0%). There was no significant difference (P=0.68). Users of pit toilets had a higher prevalence of 24 (72.7%) compared to users of water closets at 7 (9.0%). There was no statistically significant difference (P=0.79). This study concludes that there is a high prevalence of *Salmonella typhi* at 31%. It is important to emphasize public awareness and early and prompt diagnosis to curb the spread of the disease in Nasarawa State, particularly among pregnant women in Keffi.

Keywords: Typhoid fever, *Salmonella typhi*, pregnant women, prevalence, public health, diagnosis

Introduction

Typhoid fever (enteric fever), caused by *Salmonella typhi*, is an endemic disease in tropical and sub-tropical regions, becoming a major public health problem in developing countries. The estimated annual incidence is 540 cases per 100,000 people (WHO, 2008), with about 17 million cases worldwide (WHO, 2008). In tropical countries like Nigeria, typhoid fever constitutes serious sources of morbidity and mortality (Ibekwe *et al*., 2008). Pregnancy is a period of intense biological transformation, making both the mother and her newborn susceptible to various diseases. The outcomes of infections such as leishmaniasis, malaria, toxoplasmosis, listeriosis, and typhoid can be adversely affected during pregnancy (Pejcic-Karapetrovic

et al., 2007). *Salmonella* species infect various hosts, causing a range of diseases from acute self-limiting diarrhea to bacteremia and enteric fevers (Rishi *et al*., 2002). The incidence of typhoid in endemic areas is typically low in early childhood, peaks in school-aged children and young adults, and then falls in middle age (Hatta *et al*., 2009). High-risk populations for *Salmonella* infections include young children, the elderly, pregnant women, and individuals with compromised immune systems (Doffinger *et al*., 2005). Reports on typhoid fever during pregnancy are limited but indicate that it can lead to serious maternal infections with trans-placental spread to the fetus. Complications due to *Salmonella* infections in pregnancy include endomyometritis, salpingitis, chorioamnionitis, trans-placental infection of the fetus, septic abortion, neonatal septicemia, and meningitis, along with a few cases of life-threatening septicemia in mothers (Pejcic-Karapetrovic *et al*., 2007). Typhoid fever remains a disease of major importance and continues to pose health problems worldwide. It results from *Salmonella*-contaminated foods and drinks, affecting individuals of all ages and sexes, and poses high risks to pregnant women. Very few reports are available regarding typhoid fever in pregnancy and its effects on the physiology of pivotal organs (Geeta *et al*., 2012). There are over 2,600 serovars of *Salmonella* classified by surface antigens, including lipopolysaccharide (O) antigen and flagellar (H) antigen. Serovars of *S. enterica* are divided into two groups based on disease outcomes in humans: typhoidal and non-typhoidal salmonellosis (Sabbagh *et al*., 2010; Gal-Mor *et al*., 2014). Typhoidal *Salmonella* species, specifically *S. typhi* and *S. paratyphi*, cause life-threatening systemic infections. In contrast, non-typhoidal *Salmonella* typically results in self-limiting gastroenteritis in otherwise healthy individuals, including *S. enteritidis* and *S. typhimurium*.

Enteric fever is a human-specific systemic illness caused by infection with *S. enterica* serovars—*typhi* and para*typhi* (A, B, C)—resulting in typhoid and paratyphoid fever, respectively. Humans are the only reservoir for these bacteria, with no animal or environmental sources. Transmission occurs via ingestion of food or water contaminated by the feces of an acutely infected, convalescent, or chronic asymptomatic carrier. The disease is more common in Africa and Southeast Asia than in other regions. Poverty and poor hygiene are known risk factors for transmission. Outbreaks of typhoid fever have been reported in Africa,

with case fatality rates of up to 53%. Typhoid fever contributes more to the global burden of enteric fever than paratyphoid fever (GBD, 2017; Lancet 2019). Both typhoid and paratyphoid fevers are clinically indistinguishable and share symptoms with other prevalent diseases in Africa, especially malaria. This reliance on clinical judgment, without laboratory confirmation, can lead to misdiagnosis and over-reporting of enteric fever. To avoid missing positive cases of typhoid fever, clinicians may treat febrile patients empirically to cover enteric fever and other common causes of fever, such as malaria (Nsutebu *et al*., 2003). Typhoid fever poses particular risks during pregnancy due to reduced peristaltic activity in the gastrointestinal and biliary tracts and increased prevalence of biliary sludge and concretions. Antibiotic resistance among *Salmonella* strains complicates the choice of antibiotics for initial treatment until cultures and sensitivities are available. The potential risks of some antimicrobial agents during pregnancy further complicate the selection of antibiotic therapy (Crump *et al*., 2004).

Typhoid fever during pregnancy poses significant risks, including uteroplacental infection, miscarriage, and vertical transmission, potentially leading to neonatal typhoid (Kim *et al*., 2017). It has been associated with complications such as premature birth and low birth weight, with studies indicating that spontaneous abortion or premature labor occurs in 60-80% of affected cases (Charles *et al*., 1951). The maternal mortality rate can reach about 15%, with a substantial proportion of fetuses and infants lost due to infection (Charles *et al*., 1951). In the Keffi community of North Central Nigeria, inadequate access to clean water has led residents to rely on untreated sources, heightening the risk of typhoid infection among pregnant women. Despite existing knowledge on enteric fever's epidemiology and management, data on its prevalence and impact in this region remain scarce (Kim *et al*., 2017). This study aims to investigate the current status and statistics of *Salmonella typhi* among pregnant women attending antenatal care at the General Hospital Keffi, providing essential insights into the public health burden of typhoid fever in Nigeria and contributing to broader understanding and efforts to combat this critical health issue. The aim of this study was to determine the occurrence of *Salmonella typhi* among pregnant women attending antenatal care at General Hospital Keffi, located in the Keffi local government area of Nasarawa State, Nigeria. To achieve this aim, the study had several objectives: first, to determine the prevalence of *Salmonella typhi* among the pregnant women; second, to identify risk factors associated with *Salmonella typhi* infection, including age, educational status, occupation, and source of drinking water; and

third, to assess the prevalence of *Salmonella typhi* infection in relation to the trimester of pregnancy among the women attending antenatal care at the hospital.

METHODOLOGY

Study Area

This study was conducted at General Hospital in the Keffi community of Keffi Local Government Area, Nasarawa State, Nigeria, which has a population of about 92,664 according to the 2006 census (NIPOST, 2009). It is located in Keffi, sitting along the Keffi-Akwanga expressway (Sadiq and Abga, 2012).

Study Population

The study population consisted of pregnant women accessing antenatal care at General Hospital Keffi, Nasarawa State.

Ethical Clearance

An introductory letter was obtained from the Department of Science Laboratory Technology at Nasarawa State University, Keffi. This letter was presented to the hospital management to seek permission before commencing the research. Consent was sought and obtained from participants before they were enrolled in this study. Approval for the study was also obtained from the hospital management, and ethical clearance was granted by the ethical committee of the Federal Medical Center, Keffi, Nasarawa State.

Inclusion and Exclusion Criteria

The inclusion criteria for this study specified that participants must be patients visiting the hospital at the time of data collection who exhibit clinical signs and symptoms of typhoid fever, for whom blood serological analysis was requested. Additionally, only pregnant patients were considered for inclusion, and informed consent had to be sought and obtained before participation in the study. The exclusion criteria included patients who were not pregnant, those who did not provide their consent, and all male patients in the hospital.

Sample Size Determination

The sample size (N) was estimated using the single population proportion formula described by Charan and Biswas (2013):

$N = \frac{Z^2 PQ}{d^2}$

Where:

N = Required sample size,

Z = Standard normal variate at 5% error (P < 0.05), with a 95% confidence interval of 1.96,

P = Proportion of the population with typhoid fever infection from a previous study,

Q = Proportion of the population without typhoid fever infection (1 – P), and

d = Absolute error margin of 0.05.

Calculating this, we have:

$N = \frac{Z^2 PQ}{d^2}$

N = 43.6487N

= 43.6487N

= 43.6487

N ≈ 43N

This was rounded up to N = 100. For the calculation, a 95% confidence interval, a P value of 0.1407 (i.e., a prevalence rate of 14.07% from a previous study by Udujih *et al.* (2020), and a margin of error (d) set at 0.05 were used to determine the minimum sample size required. Although the minimum sample size (N) calculated was 43, we decided to screen a total of 100 pregnant women to make our work robust.

Sample Collection and Processing

For sample collection, the upper part of each participant's arm was tied just above the elbow with a tourniquet to make the vein more prominent. The vein was then traced, and the overlying skin was disinfected using cotton wool soaked in methylated spirit. A sterile needle was inserted horizontally into the vein to collect blood; after this, the tourniquet was untied, and the needle was gently withdrawn. A dry sterile cotton wool was placed over the site to prevent continuous bleeding. The collected blood was dispensed gently into an ethylenediaminetetraacetic acid (EDTA) container and transported to the laboratory for processing.

Sera obtained from the blood samples, along with test reagents (previously stored in the refrigerator at 2-8°C), were removed from the refrigerator and left on the

workbench for an hour to reach room temperature. The Widal test was then conducted using each participant's serum. A drop of antigen from the Widal test kit was added to 0.05 ml of test serum on a rocking board. The contents of each circle were mixed separately and spread across the entire circles. The test board or slide was rocked gently for one minute to observe for agglutination. The titre was read before the one-minute duration, as directed by the manufacturer of the Widal kit. No agglutination within one minute is considered a negative test, indicating the absence of corresponding antibodies. Agglutination within one minute is a positive test, indicating the presence of corresponding antibodies. A titre greater than 1:80 is considered significant and usually suggestive of infection (Cruickshank, 2017).

Serological Analysis (Widal Test)

The Widal agglutination test, commonly used for diagnosing typhoid fever, was carried out according to the manufacturer's instructions using plasmatic reagents (Antec Laboratory Products, UK) containing S. *Typhi* O and H antigens, as well as S. Para*typhi* A, B, and C antigens. Positive and negative serum controls were included, and a titre greater than 1/160 indicated typhoid or paratyphoid fever.

Principle of the Widal Test

The Widal test is based on the principle that bacterial suspensions containing antigens will agglutinate upon exposure to antibodies against *Salmonella* organisms. Patients suffering from enteric fever will have antibodies in their sera that react and agglutinate with serial doubling dilutions of killed, colored *Salmonella* antigens in the agglutination test. Specifically, if homologous antibodies are present in the patient's serum, they will react with the respective antigens in the reagent, resulting in visible clumping on the test card and agglutination in the tube. The test employs "H" and "O" antigens of *Salmonella typhi* and the "H" antigen of S. Para*typhi*. The paratyphoid "O" antigens are not used due to cross-reactivity with the typhoid "O" antigen, owing to shared factor 12. The "O" antigen is a somatic antigen, while the "H" antigen is a flagellar antigen.

Interpretation of Results

Agglutination indicates a positive test result. If a positive reaction is observed with 20 µl of the test sample, it suggests the presence of clinically significant levels of the corresponding antibody in the patient's serum. Conversely, no agglutination is

a negative test result, indicating the absence of clinically significant levels of the corresponding antibody in the patient's serum.

Statistical Analysis

The data obtained from the laboratory analyses were analyzed using SPSS version 10.0. Descriptive statistics were presented in tables, figures, and charts. Chi-square tests were used to compare two or more variables, with a p-value of ≤0.05 considered statistically significant (Pallant, 2007).

RESULTS

The overall prevalence of typhoid fever among pregnant women attending General Hospital Keffi, Nasarawa State, in this study was 31% (Figure 1). In relation to socio-demographics, the highest prevalence was among the age group 26-30 years with a prevalence of 27 (33.3%), followed by 21-25 years with 31.9%, then <20 years with 31.8%, and the least was among the age group >31 years with 0 (0.0%). The prevalence of typhoid fever among pregnant women attending antenatal care at General Hospital Keffi varied significantly across different demographics and factors. In terms of age, Table 1 shows a prevalence rate of 31.8% for women under 20 and 31.9% for those aged 21-25, while older women (26-30) had a slightly higher prevalence of 33.3%.Also, there were no positive cases among women over 30. When examining pregnancy stage (Table 2), the first trimester exhibited the highest prevalence at 60%, followed closely by the third trimester at 62.1%, and the second trimester at 54.1%, though the differences were not statistically significant (P=0.885827). Education level (Table 3) revealed similar rates across groups, with the highest prevalence found among secondary education holders (32.6%), while the overall educational impact was not significant (P=0.991683).

Location played a role as well; Table 4 indicates a higher prevalence in urban areas (35.0%) compared to rural settings (17.3%), but again, this difference was not statistically significant (P=0.181602). Occupational data (Table 5) highlighted that housewives had the highest prevalence at 37.2%, although the P-value of 0.532156 suggests no significant occupational influence. Water quality emerged as a significant factor, as shown in Table 6, with well water users demonstrating a striking prevalence of 86.6% and river/stream users at 100%, while sachet/table water users had only 18.1%. The type of toilet facility also influenced prevalence (Table 7), with pit latrines showing a significant 72.7% compared to 8.95% for water systems (P=0.791856). Finally, eating in restaurants had a dramatic impact,

where 90.9% of those who dined out tested positive, compared to 23.5% who did not (Table 8). These statistics underscore the multifaceted nature of typhoid fever prevalence among pregnant women, highlighting the importance of sanitation, water quality, and dietary habits.

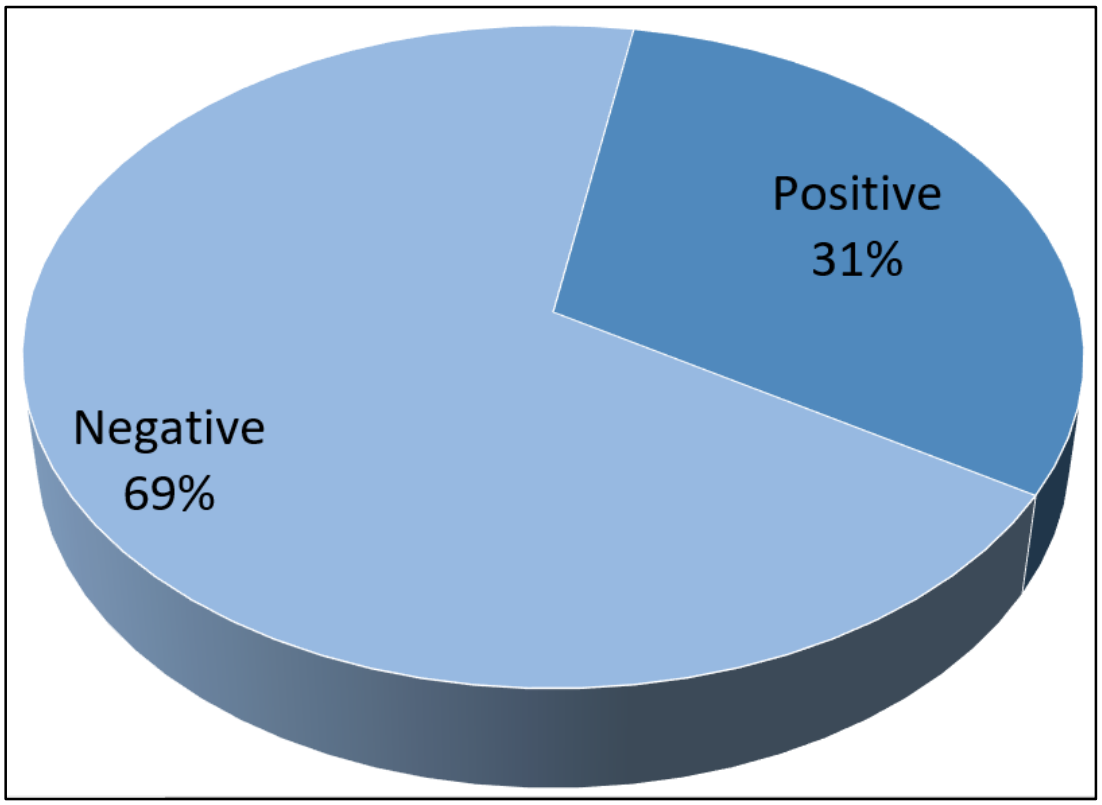


Figure 1: Prevalence of typhoid fever among pregnant women attending General Hospital Keffi, Nasarawa State.

Table 1: Prevalence of Typhoid Fever among Pregnant Women Attending Antenatal Care in General Hospital Keffi In Relation To Their Age.

Age (years)	No. Screened	No. Positive	Prevalence (%)	P- Value
<20	22	7	31.8	
21-25	47	15	31.9	0.727979
26-30	27	9	33.3	
30	4	0	0	
Total	**100**	**31**	**97**	

Table 2 Prevalence of Typhoid Fever among Pregnant Women Attending Antenatal Care in General Hospital Keffi in Relation To Their Pregnancy Stage

Trimester	No. Screened	No. Positive	Prevalence (%)
First	12	9	60
Second	48	26	54.1
Third	37	23	62.1
Total	**100**	**58**	**176.2**

P=0.885827

Table 3 Prevalence of Typhoid Fever among Pregnant Women Attending Antenatal Care at General Hospital Keffi in relation to their level of education

Educational Status	No Screened	No Positive	Prevalence (%)	P-value
Non Formal	13	4	30.7	0.991683
Primary	23	7	30.4	
Secondary	46	15	32.6	
Tertiary	18	5	27.7	
Total	**100**	**31**	**121.4**	

Table 4: Prevalence of Typhoid Fever among Pregnant Women Attending Antenatal Care at General Hospital Keffi in Relation To Their Location

Location	No Screened	No Positive	Prevalence (%)	P value
Rural	23	4	17.3	0.181602
Urban	77	27	35.0	
Total	**100**	**31**	**52.3**	

Table 5: Prevalence Of Typhoid Fever Among Pregnant Women Attending Antenatal Care at General Hospital Keffi in Relation to their Occupation

Occupation	No Screened	No Positive	Prevalence (%)	P-value
Trader	42	10	23.8	
House wife	43	16	37.2	0.532156
Civil servant	15	5	33.3	
Total	**42**	**10**	**23.8**	

Table 6: Prevalence Of Typhoid Fever Among Pregnant Women Attending Antenatal Care At General Hospital Keffi, In Relation To Type Of Drinking Water

Type of Drinking Water	No Screened	No Positive	Prevalence (%)	P value
Sachet/Table	22	4	18.1	
Tap	5	3	60	
Borehole	41	7	17.0	0.689724
Well	26	22	86.6	
River/Streams	6	5	100	
Total	**100**	**41**	**281.7**	

Table 7 Prevalence of Typhoid Fever Among Pregnant Women Attending Antenatal **Care At** General Hospital Keffi , In Relation To Their Type of Toilet

Type of Toilet	No Screened	No Positive	Prevalence (%)	P-value
Water System	67	7	8.95	0.791856
Pit	33	24	72.7	
Total	**100**	**31**	**81.65**	

Table 8 Prevalence of Typhoid Fever Among Pregnant Women Attending Antenatal Care At General Hospital Keffi, In Relation To Eating In Restaurant

Eating in Restaurant	No Screened	No Positive	Prevalence (%)	P-value
Yes	11	10	90.9	0.885827
No	8	21	23.5	
Total	**100**	**31**	**114.3**	

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The findings show that the age distribution of typhoid fever prevalence among pregnant women reveals minimal differences across age groups. The highest rate occurred in women aged 26-30 (33.3%) and those aged 21-25 (31.9%), while those under 20 years had a prevalence of 31.8%. In contrast, older women (above 30) recorded no positive cases. This suggests that age may not affect typhoid

susceptibility. Johnson *et al*. (2020) found that age differences were not related to typhoid prevalence, attributing the lack of association to sanitation and water quality. Further studies, like Olaripekun *et al*. (2019), reported slightly higher prevalence among younger adults (20-30). In Table 2, typhoid prevalence varied with pregnancy stage, reaching 62.1% in the third trimester. This aligns with Akinbo *et al*. (2018), who reported that immune modulation during pregnancy might elevate infection risk in later stages. Usman *et al*. (2021) found that women in later pregnancy stages were more susceptible due to immune adjustment prioritizing fetal tolerance. In educational level, the rates were close: non-formal education had 30.7%, primary education 30.4%, secondary education 32.6%, and tertiary education 27.7%. This lack of variation contrasts with Musa and Adams (2019), who observed higher prevalence among those with lower education. In General Hospital Keffi, this could stem from shared exposure to environmental factors. Regarding location, typhoid fever rates varied between rural (17.3%) and urban settings (35.0%) (Table 4), aligning with Kazi *et al*. (2017), who reported higher prevalence in urban areas due to crowding and sanitation challenges. Higher urban prevalence reflects reliance on public food sources and crowded living conditions. In occupation, housewives had the highest prevalence of 37.2%, followed by civil servants (33.3%) and traders (23.8%). This correlates with Gambo *et al*. (2021), who found non-working women were more susceptible due to limited access to potable water and sanitation. For drinking water, the highest prevalence was among those relying on river/stream water (100%) and wells (86.6%), while sachet or table water users had a lower prevalence of 15.1%. This supports Chukwu *et al*. (2019), emphasizing untreated water sources as primary typhoid transmission routes. The type of toilet facility also influenced typhoid rates, with pit latrine users showing a prevalence of 72.7% compared to 5.95% among water system users. This correlates with Okechakwu *et al*. (2018), who found areas relying on pit latrines had higher typhoid cases due to contamination risks. Lastly, eating in restaurants was associated with a high prevalence rate of 90.9% compared to those who did not eat in restaurants (23.5%). Onyeka *et al*. (2020) found that restaurant dining increases exposure to typhoid due to lapses in hygiene and food safety practices.

Conclusions

In conclusion, this study successfully determined the prevalence of *Salmonella typhi* among pregnant women attending General Hospital Keffi, revealing a

prevalence of 31%. The analysis highlighted several risk factors associated with the infection, including age, educational status, occupation, and source of drinking water. The age distribution indicated that younger women, particularly those aged 26-30 and 21-25, showed the highest prevalence rates, indicating that factors beyond age may play a role in susceptibility. Educational status appeared to have little variation in prevalence rates, with close figures across all educational backgrounds, indicating shared exposure to similar environmental factors. The occupation of the women also influenced prevalence, with housewives showing the highest rates, likely due to greater exposure to home-based water sources or inadequate sanitation practices. Furthermore, the type of drinking water emerged as a key factor, with those relying on river and stream water exhibiting a prevalence of 100%, underscoring the risks associated with untreated water sources. The analysis of pregnancy stages revealed a peak prevalence of 62.1% in the third trimester, aligning with findings in other studies regarding immune modulation during pregnancy.

Recommendation

To prevent and treat typhoid fever among pregnant women in society, improved living conditions and the introduction of antibiotics have led to a drastic reduction of morbidity and mortality in industrialized countries. However, in developing areas of Africa, the Americas, South-East Asia, and the Western Pacific regions, the disease continues to be a public health problem. Typhoid fever can be treated with antibiotics, and while resistance to antibiotics has emerged, including fluoroquinolones, newer antibiotics such as cephalosporins and azithromycin are used in affected regions. Although resistance to azithromycin has been reported sporadically, it is not common as of yet. Importantly, even when symptoms resolve, individuals may still carry typhoid bacteria, allowing them to spread it to others through their feces.

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