

Prevalence of *Salmonella typhi* Infection among Food Handlers in Imo State University Owerri Nigeria and its Environs

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Abstract

Typhoid fever caused by *Salmonella enterica* serovar *Typhi* is an endemic acute febrile illness which causes a high disease mortality and morbidity rate in developing countries. The disease can be transmitted through contaminated food and water and has gained an endemic status as the bacterium can be carried and shed by some individuals who have recovered from the disease. This study investigates the carriership of the bacteria by food handlers who may shed the bacteria into street vended foods they serve, thus spreading the disease and correlating this data to sex, age and source of drinking water. 420 blood and stool samples were collected from volunteers working in the food retail sector (cafeterias) around Imo State University Owerri and its environs using stratified random sampling methods. Widal test (rapid slide agglutination) was utilized as a presumptive screening test with titer values of 1:80 and above considered as positive. Stool culture served as confirmatory assay and resultant bacterial colonies were subjected to a series of biochemical tests to confirm the presence of *S. typhi*. The overall prevalence rate recorded in this study is 66.2%, with females having a prevalence rate of 67.4% while males had a prevalence of 64.2%. Older adults in the age group of 41-55 had the highest prevalence of 82.9% followed by children within the ages of 8 to 18 (80%). With respect to the source of drinking water, the highest prevalence of *Salmonella* carriership was recorded for individuals consuming untreated water from boreholes and sachet water at 82.4% and 83.2% respectively while individuals that drank treated water recorded a percentage prevalence of *Salmonella* carriership of 29.8%. The results obtained from this study highlights the high carriership rate of *Salmonella* amongst food handlers and the possibility of these individuals introducing the bacteria into foods, posing a public health risk. It also identifies the consumption of untreated water as the possible source of infection of these individuals, thus indicating the need for public health interventions in the provision of portable water to reduce the morbidity and mortality rates of typhoid fever.

Keywords: Typhoid fever; *Salmonella*; Carrier; Food handlers

Introduction

Typhoid fever which is also known as enteric fever is an acute febrile illness that is caused by the bacteria *Salmonella enterica* serovar *typhi*. *Salmonella typhi* is a Gram-negative bacterium that infects the intestinal tract of man and can enter blood circulation too. The disease causes an estimated 16.6 million cases of the disease and 600,000 deaths annually worldwide [1]. The organism is usually transmitted through the consumption of food and water contaminated with feces from an infected individual. Humans are the only host of *S. typhi* and some individuals who have recovered from the disease continue to secrete the bacteria in their feces for a long period of time. This has enabled the disease to gain an endemic status especially in developing countries of the world. The chronic carriage of *Salmonella* usually seen in middle-aged and older people is of public health concern especially in individuals working in the food sector as exemplified in the case of "Typhoid Mary" in the early 18th century [2]. About 5% of individuals who are treated for typhoid fever still carry and continue to shed the bacteria after recovery [3].

Frequently, outbreaks of typhoid fever are reported from countries in Sub-Saharan Africa and South-east Asia [4,5]. In Nigeria, typhoid disease is very common, where it occurs all year round and the country is rated as an endemic zone for typhoid fever [6]. The risk

factors associated with the transmittance of the infection include the consumption of street vendor foods, drinking of untreated contaminated water, inadequate toilet facilities, poor personal hygiene, lack of proper education about the disease and eating vegetables or salads prepared with vegetables grown with human wastes as fertilizers, amongst others. The disease manifests typically as a prolonged fever with frontal lobe headache, weakness and considerable loss in appetite. Occasionally, there are incidences of abdominal ache, accompanied by intestinal perforation and neurological complications in severe cases [7]. Typically, symptoms subside after 7-21 days with antibiotic therapy and a mortality rate of about 1% to 5% is recorded in hospitalized patients [8]. Detection of *Salmonella* is by the classical method of stool culture and detection of circulating antibodies by the Widal test.

In light of its endemicity, high morbidity and mortality rates in Nigeria, it is of paramount importance to screen for *Salmonella typhi* within high population density areas to establish the disease burden and prevalence of carriership. This will guide public health intervention strategies to help in mitigating the impact and burden of the disease. Thus, the major aim of this study is to establish the prevalence of carriership of *Salmonella typhi* amongst food vendors operating around Imo State University Owerri, Nigeria who may be responsible for the spread of the pathogen through the food they serve and correlate this carriership with age, sex and source of drinking water.

Materials and Methods

Study area and population

The study was undertaken at Owerri, the Imo State capital of Nigeria, with samples collected from apparently healthy food handlers within Imo State University Owerri and its environs.

Ethical consideration

Ethical approval was obtained from the university medical center prior to commencement of this study and written consent was signed by each participant before sample collection.

Data collection

A semi-structured questionnaire was utilized in obtaining information from participants in this study about their age, sex, and source of drinking water.

Using standard phlebotomy procedures, 5 ml of venous blood was collected by venous-puncture from the veins of respondents. This was transferred to Ethylene Diamine Tetra-Acetic Acid (EDTA) containers and gently mixed. Sera obtained after centrifugation of the blood sample was used in rapid screening slide agglutination (Widal test) using a Widal test kit (ANTEC febrile antigen) according to the protocol outlined by the manufacturers to serologically measure significant serum agglutins titer against typhoid/paratyphoid antigens. The test is repeated for each participant after four weeks. A sample is considered as positive when the titer value of 1:80 and above is obtained in both screening assay for the same patient, thus demonstrating an increase in antibody titer levels indicating the presence of the bacteria.

Stool sample collection and culture

Freshly passed early morning stool was collected in sterile wide mouth sample containers labeled with the respondents' details and analyzed within one hour of collection. For the analysis of the stool samples, a loopful of stool sample was aseptically inoculated into Selenite F broth in McCartney bottles. This was incubated at 37°C for 24 hours for the selective enrichment of *Salmonella spp.* After overnight incubation, the inoculum was transferred using an inoculating loop from the Selenite F broth onto Salmonella/Shigella Agar and disseminated on the media via the streaking method. This was incubated at 37°C for 24 hours. After overnight incubation, resulting colonies were observed and sub-cultured to obtain pure cultures.

Identification of isolates

Isolates from stool culture were identified based on their cultural characteristics, Gram stain reaction, cell morphology and biochemical tests [6].

Statistical analysis

Results obtained were subjected to statistical analysis using mean +SD.

Results

Table 1 shows the overall prevalence of *Salmonella* carriers among food handlers in Imo State University Owerri and its environs. A total of 420 samples were analyzed, (210 each for Widal and stool analysis). A total of 140 samples (66.7%) were positive in the stool culture while 138 (65.7%) were positive in the Widal test assay. A total of 278 samples were positive, representing an overall prevalence rate of 66.2% *Salmonella* carriership.

Test conducted	Number examined	Number positive	Percentage prevalence
Stool culture	210	140	66.7%
Widal test	210	138	65.7%
Total	420	278	66.2%

Table 1: Overall prevalence of *Salmonella* carriers.

Table 2 shows the age-related prevalence of *Salmonella* carriers among food handlers in Imo State University Owerri and its environs. The respondents were categorized into four age groups (8-18 years, 19-29 years, 30-40 years and 41-55 years). The highest prevalence of *Salmonella* carriership was recorded by the 41-55 age grades with a percentage of 82.9%, closely followed by the 8-18 age grades at 80%. Overall, the least prevalence was recorded by young adults between the ages of 30-40 at 40%.

Age grade	Test conducted	Number examined	Number positive	Percentage prevalence
8-18	Stool analysis	70	56	80%
	Widal test	105	78	74.3%
19-29	Stool analysis	63	35	55.6%
	Widal test	30	15	50%
30-40	Stool analysis	42	20	47.6%
	Widal test	30	12	40%
41-55	Stool analysis	35	29	82.9%
	Widal test	45	33	73.3%

Table 2: Age-related prevalence of *Salmonella* carrier.

Table 3 shows the gender-related prevalence of *Salmonella* carriers among food handlers in Imo State University Owerri and its environs. A total of 258 females were tested with both assay methods with 174 samples giving positive results representing a 67.4% prevalence rate while 162 males were tested with 104 positives (64.2% prevalence). Thus, this result shows that the prevalence of *Salmonella* carriership was similar irrespective of sex.

Sex	Test conducted	Number examined	Number positive	Percentage prevalence
Female	Stool analysis	126	84	66.7%
	Widal test	132	90	68.2%
Total		258	174	67.4%

Male	Stool analysis	84	56	66.7%
	Widal test	78	48	61.5%
Total		162	104	64.2%

Table 3: Gender-related prevalence of *Salmonella* carriers.

Table 4 shows the prevalence of *Salmonella* carriers among food handlers in Imo State University Owerri and its environs in relation to their source of drinking water. Three drinking water sources were identified; borehole, sachet water, and treated water. Individuals drinking borehole and sachet water recorded the highest prevalence of *Salmonella* carriership at 82.4% and 83.2% respectively while individuals that drank treated water recorded a percentage prevalence of *Salmonella* carriership of 29.8%.

Drinking water source	Test conducted	Number examined	Number positive	Percentage prevalence
Borehole	Stool analysis	98	77	78.6%
	Widal test	90	78	86.7%
Total		188	155	82.4%
Sachet Water	Stool analysis	56	42	75%
	Widal test	45	42	93.3%
Total		101	84	83.2%
Treated Water	Stool analysis	56	21	37.5%
	Widal test	75	18	24%
Total		131	39	29.8%

Table 4: Prevalence of *Salmonella* carriers with respect to source of drinking water.

Discussion

The results of *Salmonella* carriership outlined in this study using stool analysis and Widal test shows a high prevalence rate in the population of food handlers and this is of public health concern. Out of 420 samples analyzed, 140 (66.7%) was positive for stool culture while 138 (65.7%) was positive for the Widal test, with an overall prevalence rate recorded as 66.2%. This result agrees with the findings of Abioye et al. [9] who recorded a prevalence rate of 69.44% for Widal test and 62.70% for stool culture and an overall prevalence rate of 62.70%. It is noteworthy that the results obtained from both the stool culture and Widal tests were very similar. This highlights the usefulness of the Widal test as a rapid screening assay for the detection of Typhoid fever [10]. The overall prevalence rate of 66.2% recorded in this study is very high and necessitates urgent public health intervention in the food retail sector of Imo state as these food handlers may shed the *Salmonella* bacteria into food and encourage the endemicity of the disease. As recorded by other authors, the burden of typhoid fever in Nigeria is high, with Eze et al. [11] reporting prevalence of 92% in Enugu while Okonko et al. [12] and Adogo et al. [13] reported a prevalence of 92.50% and 67.8% in Ogun State and Niger state, Nigeria respectively in separate studies.

In this study, older adults within the age range of 41-55 recorded the highest prevalence of infection (82.9% and 73.3%) for stool analysis

and Widal test. Similarly, children within the ages of 8-18 had a high prevalence of 80% and 74.3% for both assays. The lowest prevalence rate was recorded for the age range of 30-40 at 47.6% and 40% for both assays. This result is in agreement with the assertion of WHO [14] which indicates that there is a high occurrence of the disease in children between 5-19 years. This high burden of *Salmonella* carriership amongst children and young adults is of great concern as children have lower hygiene practices and there is the tendency to transfer the pathogen via the fecal-oral route while playing. A similar result was obtained from a study conducted in Karu Local Government Area of Nasarawa State Nigeria which recorded high prevalence rates of 80.95% amongst children 1-15 years of age and a similarly lower rate of 53.97% amongst young adults aged 31-45 years [9].

The study indicates a higher prevalence rate amongst females than males. Females recorded prevalence rates of 67.4% compared to the 64.2% recorded by males which are in tandem with the findings of Ezeigbo et al. [15] in Aba, Abia State, and Abioye et al. [9] in Karu, Nasarawa State. However, other studies conducted by Okonko et al. [12] in Abeokuta, Ogun State and Isa et al., [16] in Biu, Borno State reported a higher prevalence rate in males. This difference recorded in the gender-related prevalence of *Salmonella* carriership in different locations in the country is expected as various indices including cultural practices, climate, and immunological competences can affect gender-related statuses of disease conditions as pointed out by Zailani et al. [17].

Results obtained in this study show a clear relationship between the source of drinking water and *Salmonella* carriership. Three sources of drinking water were identified by individuals involved in this study. Those individuals that consumed untreated borehole and sachet water which usually undergoes minimal or no treatment recorded the highest *Salmonella* carriership of 82.4% and 83.2% respectively, while individuals that consumed water which has received some form of treatment had the lowest prevalence of 29.8%. This result is in agreement with the findings of Ogah et al. [18] who recorded a higher prevalence rate for food handlers drinking public tap water in Lagos State Nigeria. It is understood that one of the major determinants in the endemicity of typhoid fever is the portability of drinking water amongst the populace [19]. Thus, the result obtained in this study corresponds to the recommendations of the World Health Organization [19] which advocated proper treatment of drinking water to reduce the spread and carriership of *Salmonella* bacteria.

Conclusion

The prevalence of *Salmonella typhi* amongst food handlers in Imo State University Owerri and its environs is very high at 66.2%. This high prevalence rate is of a public health concern as food handlers serve as an important source for the dissemination of the disease. The study shows no discernable difference in the disease burden with respect to sex but highlighted a slightly higher burden in the older age group of 41-55 and children within the ages of 8-18. Of paramount significance is the fact that there is a clear relationship between the source of drinking water and infection with *Salmonella typhi*. Evidently, individuals that consumed untreated borehole water and sachet water suffered a higher disease burden than those that drank treated water. Thus, public health intervention strategies should focus on improving the quality of potable water available for individuals and other environmental sanitation efforts. These measures significantly will stem the rate of infection of food handlers and coincidentally

reduce the transmission of the disease to individuals who consume street vended foods.

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