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Prevalence of *Salmonella typhi* Infection in Karu Local Government Area of Nasarawa State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors JOKA and BS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors JOKA and BS managed the analyses of the study. Author LYA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of this study is to determine the prevalence of *Salmonella typhi* infection in Karu Local Government Area of Nasarawa State, Nigeria.
Place of Study: Karu Local Government Area, Nasarawa State; Department of Biological Sciences, Bingham University, Karu.
Materials and Methods: Two hundred and fifty two blood and stool samples were collected from volunteers including children and adults, using stratified random sampling method. Widal test served as a presumptive screening test while the stool culture served as the confirmatory test. A sample was considered positive with the titer value of 1:80 and above. Biochemical tests were carried out on each isolate to further confirm the presence of *S. typhi*.
Results: Out of the 252 samples screened, 158 were found to be positive for *S. typhi* with a prevalence of 62.70%. The gender distribution of the disease revealed a higher prevalence of 71.43% in females than 53.97% in males. Also the age distribution of the disease revealed the highest prevalence of 80.95% in the age group of 1-15 years and the least prevalence of 40.30% was recorded within the age group of 46-60 years. The distribution of the infection was statistically significant ($p > 0.05$) to age. The infection was highest in Mararaba with a prevalence of (77.38%)

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and the least prevalence of 48.81% was recorded in Karu.
Conclusion: The prevalence of *Salmonella typhi* infection in Karu local government of Nasarawa State of Nigeria is high. This situation calls for urgent control measures on the part of individuals and the government by provision of provision of basic life utilities such as portable water.

Keywords: Salmonella typhi; stool culture; Widal test; antibiotics.

1. INTRODUCTION

Each year, typhoid and paratyphoid fever, respectively, cause an estimated 26 million and 5 million illnesses globally [1]. Developed countries have uncommon occurrence of typhoid fever where most cases are either acquired abroad or imported by emigrants with an estimated annual incidence of 540 per 100,000 or about 17 million cases worldwide. A study conducted by Crump and his colleagues estimated approximately 22 million cases of typhoid each year with at least 200 000 deaths [2]. Outbreaks of typhoid fever are frequently reported from sub-Saharan Africa and countries in South-east Asia [3,4].

Other regions of Asia and Africa, Latin America, the Caribbean, and Oceania have a medium incidence of 10 to 100 cases per 100,000 person years. These estimates, though, are limited by lack of consistent reporting from all areas of the world and are based on extrapolation of data across regions and age groups. More recent population-based studies from Latin America, in particular, are lacking, and surveillance suggests that rates have declined substantially over the past 30 years. Furthermore, subsequent data from Africa have revealed substantial heterogeneity between countries, with some Southern and Northern African countries having very low rates (<5 cases per 100,000 person years) while several countries in Eastern and West Africa have rates >100 per 100,000 [5].

Salmonella enteric serovar typhi (*Salmonella typhi*) and *Salmonella enterica* serovars Paratyphi (Salmonella Paratyphi) A, B, and C are Gram-negative bacteria which can invade the bloodstream and cause typhoid and paratyphoid fever respectively (also jointly known as 'enteric fever') [6].Typhoid fever, is a symptomatic bacterial infection which affects only humans [7].

Risk factors for the disease include eating food prepared outside the home, such as ice creams or flavoured ice drinks from street vendors, drinking contaminated water and eating vegetables and salads that have been grown with human waste as fertilizer [8]. A close contact or relative with recent typhoid fever, poor housing with inadequate food and personal hygiene and recent consumption of antimicrobials are further risk factors [9,10,11].

Symptoms of the resulting disease typically include prolonged fever, frontal headache, malaise and marked loss of appetite, sometimes accompanied by abdominal pains, nausea, and (in severe cases) intestinal perforation and neurological complications [12]. Symptoms typically subside in 7–21 days, but mortality is estimated to occur in 1–5% of hospitalized patients [13-15]. In a small percentage of cases, the bacteria may also colonize the gall bladder, leading to a chronic carrier state [12].

Systemic complications ranging from intestinal perforation to neurologic manifestations have been well documented [16,17]. Typhoid and paratyphoid fever are clinically indistinguishable [18,19], and bacterial culture remains the gold standard for diagnosis [20]. Antimicrobial therapy has reduced typhoid case-fatality rates from 15%–20% to <1% [20]. However, antibiotic resistance is a challenge for effective treatment of typhoid and is likely to become increasingly problematic with the spread of multi-drug resistant strains [21].

It is very relevant to screen for *Salmonella typhi* in view of the high morbidity and mortality rates that characterize the disease, especially in the developing countries like Nigeria. The current magnitude of the disease in the country is not known as there has been no surveillance study carried out nationally or at State or Local Government level. In particular, there has been no report on the prevalence study of *S. typhi* in Karu Local Government. This study will, therefore, generate a base line data for the Primary Health Care programme in the Local and State Governments. It will also create awareness concerning the disease, and measures to control the silent killer disease would be sought.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Karu Local Government Area of Nasarawa state. It has an area of 2,640 km².Karu local government has its headquarters in New Karu town. From west to east, the urban area includes towns like Kurunduma, Nyanya, Mararaba, New Karu, Ado, Masaka and Gidan Zakara. Three sites were selected; Mararaba, Masaka, and New Karu.

2.2 Study Population

Stratified random sampling technique was used to collect two hundred and fifty two (252) stool and urine samples from adults and children who reported in the Health centers for medical care.

2.3 Ethical Consideration

Ethical approval to carry out this study was obtained from the Local Government Headquarters, after which a written consent was obtained from each participant before sample collection.

2.4 Blood Collection and Widal Test

The upper part of the arm was tied, a little above the elbow with a tourniquet to make the vein more prominent. The vein was then traced and the overlaying skin was disinfected with methylated spirit. A sterile needle was inserted into the vein horizontally to collect blood, after which the tourniquet was untied and the needle withdrawn gently. A dry sterile cotton wool was placed over the area to avoid continuous flow of blood. The blood was dispensed gently into an Ethylene diaminetetraaceticacid (EDTA) container and was transferred within two hours of collection to the laboratory in a sterile transparent polythene bag for processing.

Sera obtained from the blood samples and the test reagents (previously stored in the refrigerator at 2-8℃) were brought out of the refrigerator and left on the work bench for an hour to attain room temperature; after which the Widal test was carried out by Rapid Screening slide agglutination test, using Spinreact (Spain). The titre was read before one minute duration as directed by the manufacturer of the Widal kit.

2.5 Stool Sample Collection and Culture

Stool samples were collected into sterile plastic container and the patients were instructed on how to collect the early morning stool, which is more concentrated. The stool samples were equally transferred to the laboratory in sterile transparent polythene bags within two hours of collection for culturing.

A pinch from each stool sample was aseptically cultured on Salmonella/Shigella agar (ZSA Chemical, Germany) using streak method, and incubated at 37℃ in a preset incubator (Cole Medical England) for 24 hours. After incubation, bacterial growth was observed. Any plate with positive/significant growth was sub cultured to obtain pure culture. The isolates were identified based on their cultural characteristics, Gram reaction, cell morphology, motility test and biochemical tests [22].

3. RESULTS

Using stool culture technique all positive plates yielded pinkish mucoid colonies with black centers on Salmonella/Shigella Agar. The colonies were large with smooth/entire margin and convex in elevation. The biochemical tests revealed the isolates to be catalase positive, oxidase negative, urease negative and motility positive. The Gram reaction and microscopy showed the isolates to be Gram negative rods with polar flagellation.

Two hundred and fifty two (252) samples of the people of Karu local government were tested during this study. Of these a total of 158 samples were found to be positive for *S. typhi* with a general prevalence of 62.70% (Table 1).

Table 2 shows a comparison between the two methods used to determine the prevalence of *S. typhi infection* in the studied Local Government, while Table 3 indicates the prevalence of the infection in the three sites sampled in the Local Government. Mararaba had the highest prevalence of 77.38%, followed by 61.90% in Masaka, and Karu with 48.81% had the least prevalence of the disease. The distribution of the infection was statistically significant ($p > 0.05$) to the sample Sites.

Table 4 indicates the prevalence of *S. typhi* infection with respect to gender in the study sites, the result shows that the prevalence of *S. typhi* infection was higher in females in which 90 out of 126 were positive giving a prevalence of 71.43%, than in males where 68 out of 126 were positive with a prevalence of 53.97%. This result

shows that the distribution of the infection is Gender related ($p > 0.05$).

Table 5 shows the prevalence of *S. typhi* infection with respect to age in the study sites in general; the results shows that *S. typhi* infection was highest in the age group of 1-15 years where 51 out of 63 were positive with a prevalence of 80.95% and the least was found in the age bracket 46-60 years where 29 out of 63 were positive with a prevalence of 40.03%. The distribution of the infection was statistically significant ($p > 0.05$) to age.

The Socioeconomic Status distribution of the infection revealed the highest prevalence of 39.68% among the Low Class of the studied population. This was followed by 20.63% prevalence in the Middle Class, while the lowest prevalence of 2.38% was recorded in the High Class group (Table 6).

4. DISCUSSION

This study evaluated the results obtained using Widal test and stool culture method. Out of 252 samples analyzed, 175 (69.44%) was positive for Widal test while 158 (62.70%) was positive for stool culture. The results agree with the findings of Ezeigbo et al. [23] who recorded 24.5% and 9.3% positive results for Widal test and blood culture respectively. Also, positive results obtained using Widal test gave 95% negative results with blood culture [24]. The higher positive rate of Widal test may be due to prior antibiotic therapy by some participants that

Table 1. The overall prevalence of typhoid fever in karu LGA

Infection screened for	Number of people examined	Number of people infected	Number of uninfected people	Prevalence (%)
Typhoid fever	252	158	94	62.70

Table 2. Widal test compared with culture technique

Method used	Number positive (%)	Number negative (%)	Number screened (%)
Widal Test	175(69.44)	77 (30.56)	252 (50.0)
Stool Culture	158 (62.70)	94 (37.30)	252 (50.0)
TOTAL	333	171	504

Table 3. Prevalence of *S. typhi* infection with respect to sites of study

Sites	Number positive (%)	Number negative (%)	Number examined (%)
Mararaba	65(77.38)	19 (22.62)	84 (33.33)
Masaka	52 (61.90)	32 (38.10)	84 (33.33)
Karu	41 (48.81)	43 (51.19)	84 (33.33)
Total (62.70%)	158	94	252

Table 4. Prevalence of *S. typhi* infection with respect to gender of the participants

Gender	Number positive (%)	Number negative (%)	Number examined (%)
Male (26.98%)	68 (53.97)	58 (46.03)	126 (50.0)
Female (35.72%)	90 (71.43)	36 (28.57)	126 (50.0)
Total (62.70%)	158	94	252

Table 5. Prevalence of *S. typhi* infection with respect to age of the participants

Age group	Number positive (%)	Number negative (%)	Number examined (%)
1-15 (20.24%)	51 (80.95)	12 (19.05)	63 (25.0)
16-30 (17.46%)	44 (69.84)	19 (30.16)	63 (25.0)
31-45 (13.49%)	34 (53.97)	29 (46.03)	63 (25.0)
46-60 (11.51%)	29 (46.03)	34(53.97)	63 (25.0)
Total (62.70%)	158	94	252

Table 6. Prevalence of *S. typhi* infection in relation to social status

Social Status	Number positive (%)	Number negative (%)	Total number screened (%)
High class	6 (9.68)	56 (90.32)	62 (24.60)
Middle class	52 (74.29)	18 (25.71)	70 (27.78)
Low class	100 (83.33)	20 (16.67)	120 (47.62)
Total	158	94	252

could have hindered growth on culture medium. On the other hand *S. typhi* shares O and H antigen with other *S. serotypes* and has cross-reacting epitopes with other Enterobacteriacae, and this can lead to some false positive results. In areas of endemicity there is often a low background level of antibodies in the normal population. Determining an appropriate titre level for positive result can be difficult since it varies between areas and between times in given areas [25]. An erroneous interpretation of rapid diagnostic tests delays the treatment of actual infection and increases morbidity [26]. Such misleading results using Widal test may keep one away from the true diagnosis because of cross reaction of antigen from other infections with *Salmonella* antibody [27]. Culture technique was preferably adapted in this work as the isolation, characterization and identification of the isolates could be more confirmatory than using serologic Widal test.

The overall prevalence of 62.70% obtained in this work was considered to be high and calls for an urgent control measure in Nasarawa State of Nigeria in particular. The prevalence obtained agrees with the work of Uttah et al. [28] who reported 63.8% prevalence in Etinan General Hospital in Akwa Ibom State of Nigeria. Our prevalence is however higher than the 50.0% prevalence reported by Ajibade [29] in Ekiti State, South Western Nigeria. It is higher than the prevalence of 26.6% and 42.4% reported among University of Ilorin students [30]. Likewise, it is higher than the 42.0% prevalence obtained in Biu, Bornu State [31]. On the other hand, the prevalence recorded in this work is lower when compared with other results from different parts of the country. These include Eze et al. [32], who worked on malaria and typhoid co-infection in University of Nigeria, Nsukka in Enugu State and reported a prevalence of 92.0%. Okonko et al. [33] and Adogo et al. [34] in separate studies reported a prevalence of 92.50% and 67.8% in Ogun State and Niger state, Nigeria. The burden of typhoid fever shows substantial variation within as well as between countries. Commonly identified risk-factors include a lack of clean drinking water, poor sanitation, inadequate hygiene practices and low socio-economic status [35].

Mararaba had the highest prevalence of *Salmonella typhi*, with a prevalence of 77.38% and the least observed prevalence was in Karu, having a prevalence of 48.81%. The high prevalence generally observed here could be due to lack of clean drinking water, proper sanitation and hygiene and also food prepared by infected individuals as suggested by Wain et al. [7]. Mararaba is densely populated and congested when compared to the other two sites studied, a situation that suggests poor hygiene and sanitation, thus the highest prevalence of 77.38%. Masaka, with 61.90% prevalence also had poor sanitation, poor drainage and waste disposal systems, a condition that could lead to contamination of water sources of inhabitants.

The results also revealed a high prevalence of *S. typhi* infection among females than in males which agrees with the findings of Ezeigbo et al. [23]. This disagrees with the separate findings of Okonko et al. [33] and Isa et al. [31] who reported higher prevalence in males than females. The disparity of the infection prevalence among the genders in different geographical areas across the globe is expected as several factors, ranging from cultural to physiologic and immunologic, can affect the disease status of each gender [36].

Children between the ages of 1-15 years were found to have the highest prevalence of the infection (80.95%). This alarming prevalence calls for concern as it indicates a clear danger for rapid transmission of the infection because children interplay or relate easily with one another and they are less hygienic than the adults. This result is in agreement with the report of Virginia et al. [37] in Cibu City. It also agrees with the assertion of WHO [38], which states that the disease often occurs in children and young adults between 5 and 19 years old.

5. CONCLUSION

The prevalence of *Salmonella typhi* infection in Karu local government of Nasarawa State of Nigeria is high, with the overall prevalence of 62.70%. This situation calls for urgent control measures on the part of individuals and the public. Urgent Government intervention is equally of utmost importance to raise public awareness about the disease, as well as intensify public health talks. The government should also improve the living conditions of the people, especially in the areas of environmental sanitation as well as provision of basic life utilities, like the provision of portable water and public toilet. These measures would stem the spread or transmission of the silent killer disease and by so reduce the morbidity and mortality rates associated with the disease.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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