

**PREVALENCE OF TYPHOID FEVER AMONG PATIENTS IN OROBOSA
MEDICAL CENTRE AND GRACEVILLE MEDICAL CENTRE IN BENIN CITY**



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**AN UNDERGRADUATE PROJECT WORK SUBMITTED TO THE DEPARTMENT
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CERTIFICATION

This is to certify that the project work titled “Prevalence of Typhoid Fever Among Patients in Orobosa Medical Centre and Graceville Medical Centre” was written presented by Sarah Rachel Emujede with Matriculation Number LSC1600589 of the Department of Science Laboratory Technology, Faculty of Life Sciences, University of Benin, in partial fulfilment of the requirement for the award of a Bachelor of Science degree, B.Sc. (Hons.) Science Laboratory Technology.

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DEDICATION

This project work is dedicated to God Almighty my creator, my source of wisdom, knowledge and understanding, and my strength to pull through this program.

ACKNOWLEDGEMENTS

I give glory to God for his faithfulness, love, mercies, care, protection and provision which I experienced during the course of carrying out this project.

I appreciate the efforts of my supervisor, Dr. (Miss) R. O. Osumah, who left no stone unturned in ensuring the success of this work.

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God bless you all

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ABSTRACT

Typhoid fever is an infectious disease caused by the bacterium *Salmonella enterica serotype typhi* and is prevalent in numerous low- and middle-income countries around the world, including Nigeria. This study was carried out to determine typhoid prevalence among individuals in Orobosa Medical Centre and Graceville Medical Centre in Benin City, Nigeria. A total of 232 individuals took part in the study, with 116 for each medical centre. Data was collected using a structured questionnaire designed by the researcher and blood tests were used to determine whether participants were positive or negative for typhoid. Analysis of data was done using SPSS version 20 and Microsoft Excel 2016. From the results, participants were predominantly female and aged between 21 and 30 years. Most participants obtained drinking water from table water sources (90.52 % and 75.86 %, respectively). Headaches and fatigue were identified by participants as the most common symptoms of typhoid fever. The most common risk factors according to participants were proximity to insects feeding on faecal matter and consumption of raw fruits and vegetables. Typhoid prevalence in the study was 19.83% and 17.24% for Orobosa Medical Centre and Graceville Medical Centre, respectively. To drastically reduce the prevalence of typhoid fever, the following can be applied; public health education, community-based interventions and strengthening of surveillance systems.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Salmonella enterica serotype Typhi, or simply *Salmonella typhi*, is the bacterium that causes typhoid fever, or just typhoid. The symptoms generally appear six to thirty days after exposure. The range of severity is from moderate to severe (Marchello *et al.*, 2020). A high temperature frequently develops gradually over several days. Weakness, headaches, constipation, stomach discomfort, and moderate vomiting are frequently among the symptoms. A rash with patches like roses appears on certain persons. The duration of symptoms may be weeks or months if therapy is not received. Though rare, diarrhoea can be rather severe. Even if they are not afflicted, other people can still spread it. Typhoid fever can infect and replicates in humans (Manesh *et al.*, 2021).

It can grow in the bone marrow, blood, spleen, liver, gall bladder, Peyer's patches, mesenteric lymph nodes, and intestines. Eating or drinking food or water tainted with an infected person's excrement can spread typhoid (Kim *et al.*, 2019). Poor sanitation and restricted access to safe drinking water are risk factors. The people most likely to have symptoms are those who have not been exposed to it yet and consume tainted food or drinking water. There are no known animal reservoirs for the infection; it can only infect humans (John *et al.*, 2023). The pathogen *S. enterica typhi* can be identified by cultivating patient samples and identifying it, or blood samples can be used to detect an immune response to the infection. More recent developments in large-scale data collecting and processing have made it possible for scientists to create more accurate diagnoses (Mukhopadhyay *et al.*, 2019). For example, they can now identify variations in the blood's tiny molecule abundances that may be a particular indicator of typhoid fever. In addition to the low specificity and accuracy of diagnostic techniques in areas where typhoid is most

common, other challenges facing underfunded healthcare systems include the length of time needed for a correct diagnosis, the growing prevalence of antibiotic resistance, and the expense of testing (Gibani *et al.*, 2019; Marchello *et al.*, 2020).

Between 40% and 90% of cases can be avoided in the first two years with a typhoid vaccination. For a maximum of seven years, the vaccination could have some impact. It is advised that individuals who are at high risk or are visiting regions where the disease is prevalent get vaccinated (Luthra *et al.*, 2019). Giving out clean drinking water, maintaining proper hygiene, and washing your hands are some more ways to stop it. The affected individual should refrain from preparing meals for others until the infection has been verified to have cleared. Azithromycin, fluoroquinolones, and third-generation cephalosporins are among the antibiotics used to treat typhoid. Treatment has become increasingly challenging due to the development of antibiotic resistance (Carey *et al.*, 2022).

The year 2015 saw the reporting of 12.5 million new cases of typhoid. India has a higher prevalence of the condition. The majority of afflicted individuals are children. When antibiotics and better sanitation were implemented in the industrialised world throughout the 1940s, typhoid fever fell (Ohanu *et al.*, 2015). An estimated 6,000 persons are predicted to develop typhoid every year, of which 400 cases are documented in the United States. From 181,000 in 1990 to around 149,000 in 2015, it caused fatalities globally (John *et al.*, 2023). A 20% chance of dying can occur if therapy is not received. It ranges from 1% to 4% with therapy (Mujahid *et al.*, 2022). According to World Health Organisation (2018) estimates, there are 11–20 million cases of typhoid fever worldwide each year, with 128,000–161,000 fatalities. Due to a number of factors, including increased urbanisation, a lack of potable water, regional migration of large numbers of immigrant workers, a lack of facilities for treating human waste, overburdened health care delivery systems, and overuse of antibiotics

that promotes the growth and spread of typhoid fever that is resistant to them, typhoid fever is still a major disease in Nigeria (Akinyemi *et al.*, 2018).

This study attempts to assess the prevalence of typhoid fever among patients in Benin City, Nigeria. The information gathered from the study will contribute to the existing body of knowledge on the topic by adding up-to-date data. It will also serve as a tool for assisting the decision-making process and provide a background for healthcare personnel to plan and carry out interventions if needed. Finally, it will serve as a baseline for future investigations.

1.2 Aim

The aim of this study was to assess the prevalence of typhoid fever among patients in selected medical centres in Benin City, Nigeria.

The objectives of this study were to:

1. Determine the prevalence rate of typhoid fever among patients presenting with febrile illness at Orobosa Medical Centre and Graceville Medical Centre in Benin City, Nigeria,
2. Investigate demographic factors and clinical presentations associated with typhoid fever cases among patients attending the Orobosa Medical Centre and Graceville Medical Centre in Benin City, Nigeria.

CHAPTER TWO

LITERATURE REVIEW

2.1 Typhoid Fever

Typhoid fever is an infectious disease caused by the bacterium *Salmonella enterica serotype typhi* and is prevalent in numerous low- and middle-income countries. It poses a substantial risk to human health, resulting in significant morbidity and mortality (Manesh *et al.*, 2021). Throughout history, this global health concern has impacted populations worldwide. This ailment is marked by an elevated body temperature, gastrointestinal symptoms, and systemic complications (Alla *et al.*, 2021). The subsequent section of this paper aspires to present a succinct overview of typhoid fever, encompassing its definition, general understanding, historical context, and worldwide prevalence.

2.1.1 Definition and Overview

Typhoid fever, also known as enteric fever, is an acute systemic infection caused by *Salmonella enterica serotype Typhi*, *Paratyphi A*, *Paratyphi B*, and *Paratyphi C*, which can be collectively classified as *typhoidal Salmonella*. However, some of these serovars are classified as *non-typhoidal Salmonella* (NTS) (Babar *et al.*, 2018). This bacterium is primarily transmitted through the ingestion of contaminated food or water, typically due to poor sanitation and hygiene practices (Kirchelle *et al.*, 2019). Once ingested, the bacteria invade the intestinal mucosa, leading to the dissemination of the infection throughout the body. The clinical manifestations of typhoid fever include prolonged fever, headache, abdominal pain, constipation or diarrhea, and a characteristic rose-colored rash known as "rose spots" (Alla *et al.*, 2021). In severe cases, complications such as intestinal perforation,

gastrointestinal bleeding, and septicemia may occur, posing a significant threat to the patient's life (Syed *et al.*, 2020).

2.1.2 Historical Background

The origin of typhoid fever can be traced back to ancient times, although the comprehension of its etiology and transmission was limited until the 19th century (Syed *et al.*, 2020). The earliest documented outbreak of typhoid fever can be dated back to the 5th century BCE, during the Peloponnesian War in Greece. However, it was not until the mid-19th century that the ailment was distinguished from other febrile illnesses and its specific microbial cause was recognized (Singhal *et al.*, 2022).

In the year 1880, the ground-breaking research conducted by Karl Joseph Eberth, a renowned German pathologist, resulted in the determination of the causative agent responsible for the affliction known as *typhoid fever* (Singhal *et al.*, 2022). Eberth successfully isolated and meticulously described the bacterium accountable for this malady, subsequently christened *Salmonella enterica serotype typhi*. The identification of the typhoid fever bacillus constituted a monumental feat within the realm of bacteriology, with Tadeusz Browicz being duly recognized as a co-discoverer (Phillips *et al.*, 2020). This significant breakthrough in comprehending the etiology of typhoid fever laid the groundwork for further scientific exploration, advancements in diagnostic techniques, treatment modalities, and preventive measures (Najib *et al.*, 2021).

2.1.3 Global Prevalence

Typhoid fever poses a significant health challenge on a global scale, particularly in low- and middle-income countries, where it exhibits a high prevalence in South Asia (Nacisa *et al.*, 2020). This condition afflicts numerous children and adults annually and can result in

mortality or prolonged periods of ill health. The presence of antibiotic-resistant strains of *Salmonella typhi* has complicated the treatment options available (Nusrat *et al.*, 2018). It is imperative to exercise prudence in the use of antimicrobials, and it may prove advantageous to establish the minimum inhibitory concentration (MIC) breakpoint of drugs prior to prescribing treatment (Praven *et al.*, 2017). Combination therapy involving antimicrobials has also demonstrated efficacy. Measures to prevent typhoid fever encompass the adoption of safe practices concerning food and water, as well as vaccination. However, current typhoid vaccines possess limitations regarding their efficacy and protection against *Salmonella paratyphi* (Suherti and Rahma, 2022). Enhanced vaccines are therefore warranted. The risk of typhoid outbreaks and epidemics is amplified by natural disasters, migration, tourism, and conflicts. Consequently, continuous epidemiological surveillance and the implementation of preventive measures are of utmost importance (Gryglewski *et al.*, 2020). Typhoid fever remains a significant public health concern worldwide, particularly in regions with poor sanitation and limited access to clean water. According to the World Health Organization (WHO), an estimated 11-21 million cases of typhoid fever occur annually, resulting in approximately 128,000-161,000 deaths (Vanderslott *et al.*, 2019). The burden of the disease is disproportionately borne by low- and middle-income countries, with the highest incidence rates reported in South Asia, Southeast Asia, and sub-Saharan Africa (Kim *et al.*, 2019).

Typhoid fever poses a significant global health challenge, with an estimated annual occurrence of 12 to 33 million cases worldwide. It has been approximated that the incidence of typhoid fever amounts to around 17 million cases, resulting in 600,000 deaths on a yearly basis (Paul *et al.*, 2017). The year 2019 witnessed an estimation of 9.2 million cases of typhoid fever and 110,000 deaths on a global scale, with the highest occurrence observed in the WHO South-East Asian, Eastern Mediterranean, and African regions (Kadhiravan, 2019). Upon analyzing the most extensive collection of Typhi genome sequences till date, the

Global Typhoid Genomics Consortium discovered that genotype 4.3.1 (H58) has not extended beyond Asia and Eastern/Southern Africa, while distinct genotypes prevail in other regions (Day *et al.*, 2022). By conducting a comprehensive review of the global literature on enteric fever outbreaks spanning from 1990 to 2018, a total of 303 outbreaks with 180,940 cases were identified, primarily concentrated in Asia, Africa, and Oceania (Agarwal *et al.*, 2016). These findings underscore the ongoing burden of typhoid fever in countries where it is endemic and emphasize the necessity for worldwide efforts to prevent and control outbreaks (Chandrashekar and Sudeepkumar, 2018). The prevalence of typhoid fever is influenced by various factors, including population density, socioeconomic conditions, and healthcare infrastructure. In regions with inadequate sanitation and hygiene practices, the risk of contamination of food and water sources with *Salmonella typhi* is significantly higher. Furthermore, the emergence of antibiotic-resistant strains of the bacterium poses additional challenges in the management and control of the disease (Hancuh, 2023). Efforts to combat typhoid fever have primarily focused on improving sanitation and hygiene practices, enhancing access to clean water, and implementing vaccination programs (Carey *et al.*, 2022). The introduction of safe and effective vaccines, such as the Vi polysaccharide vaccine and the Ty21a live oral vaccine, has played a crucial role in reducing the burden of the disease in some high-risk populations. However, the widespread implementation of these preventive measures remains a challenge, particularly in resource-limited settings (Stanaway *et al.*, 2019).

2.2 Cause and Transmission

Salmonella typhi is the bacterial agent that causes typhoid fever. The gram-negative bacteria *S. typhi* only infects humans. It is important to understand the microbiology of *S. enterica serotype Typhi* and its major strains to understand the various means to combat typhoid fever (Browne *et al.*, 2020). *S. enterica serotype Typhi* is an intracellular pathogen that affects the

Human gastrointestinal system. Because of its intracellular lifestyle, *S. enterica serotype Typhi* is able to produce an infection and still elude the human immune system (Jin, 2017). The primary strains of *Salmonella enterica serotype Typhi* are distinguished by their antigenic composition, which is determined by the presence of specific surface molecules. The Vi antigen, which is encoded by the *viaB* locus, serves as a significant virulence factor that plays a vital role in the pathogenesis of typhoid fever (Marchello *et al.*, 2020). It forms a protective capsule around the bacterial cell, thereby shielding it from phagocytosis and complement-mediated killing. Furthermore, the Vi antigen is implicated in the stimulation of a robust humoral immune response, resulting in the production of specific antibodies that can assist in the diagnosis of typhoid fever (Als *et al.*, 2018). *S. enterica serotype typhi* has other virulence factors that add to its pathogenicity in addition to the Vi antigen. The bacterium can inject effector proteins into host cells through the type III secretion system (T3SS), which modifies the signaling pathways of the cells and promotes bacterial invasion and survival (LeBoa *et al.*, 2023). *Salmonella* pathogenicity island 1 (SPI-1) encodes the T3SS, which is essential for the early stages of infection (Hu *et al.*, 2023).

In response to an infection with *S. enterica serotype typhi*, the host's immune system uses both innate and adaptive defenses. Pattern recognition receptors (PRRs) produced on the surface of the host cell bind to the bacteria, triggering the release of pro-inflammatory cytokines and the activation of signalling cascades (Gauld, 2020). Immune cells are drawn to the infection site by this inflammatory reaction, and they make an effort to eradicate the bacteria (Njoya *et al.*, 2021). However, by blocking the synthesis of pro-inflammatory chemicals and disrupting cytokine signaling pathways, the *S. typhi* can also alter the human immunological response (Gauld *et al.*, 2021). The appearance of antibiotic resistance in *Salmonella enterica serotype Typhi* is a matter of great concern, as it restricts the efficacy of conventional treatment options. The acquisition of genes that confer resistance, often found

on mobile genetic elements like plasmids, has resulted in the rise of strains that are resistant to multiple drugs. These strains exhibit resistance to commonly prescribed antibiotics, such as ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole, which presents a formidable challenge in the management of typhoid fever (Multidisciplinary Output Research for Actual and International Issue, 2023)

Contaminated food and water are the main sources of infection, and the fecal-oral route is the predominant mode of transmission. The bacteria are extremely versatile and capable of creating outbreaks in places with poor sanitation systems since it can live for several weeks in water and up to several months in soil (Marks *et al.*, 2019). According to a study by Matsebula *et al.* (2019), *S. typhi* is primarily spread by carriers, or infected people, who excrete the bacterium into water bodies and open land. These carriers can be hard to detect and manage because they may show little to no symptoms at all. For instance, chronic carriers may keep the bacteria in their gallbladders for years at a time, which makes them a constant source of infection for the population (Andrews *et al.*, 2020). Several modes of transmission contribute to the dissemination of typhoid fever. Insufficient sewage systems, improper waste management, and absence of potable water further facilitate the transmission of the bacterium. Moreover, close proximity to carriers, whether through direct person-to-person contact or by handling contaminated objects, can also result in the acquisition of the infection (Wondemaegn *et al.*, 2021).

Various factors produce an influence on the transmission of typhoid fever, encompassing socioeconomic conditions, population density, and climatic elements. A heightened susceptibility to infection is observed in individuals with low socioeconomic status and living in impoverished conditions, as they often confront the absence of clean water, adequate sanitation facilities, and proper healthcare (Brockett *et al.*, 2019). The probability of person-to-person transmission is amplified in overpopulated regions with limited resources for

disease control and prevention. Furthermore, climatic aspects, such as copious rainfall and inundation, can contribute to the pollution of water sources, thereby exacerbating the dissemination of *S. typhi* (Crump, 2019). Efforts to control and prevent the transmission of typhoid fever have primarily focused on improving sanitation and hygiene practices, as well as promoting vaccination. The provision of clean drinking water, proper sewage disposal systems, and education on personal hygiene can significantly reduce the incidence of the disease (Ali *et al.*, 2021).

2.3 Incubation Period

The incubation period of *Salmonella typhi* spans from 7 to 14 days subsequent to ingestion. Manifestations encompass heightened body temperature, skin eruption, debilitation, discomfort in the abdominal region, infrequent bowel movements, cephalalgia, and diminished desire for nourishment (Ali *et al.*, 2021). The prevalence of resistance to antibiotics poses a significant apprehension, specifically the declining efficacy of fluoroquinolones. Ceftriaxone and azithromycin have now become commonly utilized for therapeutic purposes (Galan, 2016). The prevention of this ailment entails the observance of personal and household hygiene, the provision of uncontaminated water, and the appropriate disposal of refuse to eliminate the presence of *S. typhi*. Enhanced monitoring, diagnostic techniques, the prudent utilization of antibiotics, and the implementation of effective vaccines are indispensable in lessening the burden inflicted by this malady (Wondemaegn *et al.*, 2021).

2.4 Clinical Presentations

The manifestations and indications of typhoid fever exhibit a wide range of variation, thereby rendering the process of diagnosis quite challenging. Typical clinical presentations encompass enduring fever, weariness, lassitude, loss of appetite, coughing, constipation, the appearance of rose spots, abdominal unease, gastrointestinal symptoms, sluggishness,

enlargement of the liver, and heightened levels of liver enzymes (Sekhar *et al.*, 2020; Meena *et al.*, 2021). Furthermore, individuals may undergo a gradual onset of fever, abdominal distress, and hepatosplenomegaly (Habte *et al.*, 2018). Other symptoms that may manifest include flatulence, qualmish, diarrhea, epistaxis, indifference, and psychological indications (Suryani *et al.*, 2023).

It is noteworthy to emphasize that typhoid fever has the potential to result in fatal complications including intestinal perforations, gastrointestinal haemorrhages, encephalitis, and cranial neuritis (Habte *et al.*, 2018). The diagnosis of typhoid fever is further complicated by the confluence of symptoms with other prevalent infections such as malaria, dengue, and viral enteritis (Ousenu *et al.*, 2021; Khan and Kader, 2022). This confluence poses a challenge in relying solely on clinical manifestation for diagnosis, particularly in the initial weeks of infection (Sultana *et al.*, 2017). Moreover, the presence of characteristic clinical symptoms of typhoid fever, in the absence of any other recognized febrile diseases, is pivotal for an accurate diagnosis (Hassan *et al.*, 2021; Choubey, 2021). In conjunction with clinical symptoms, laboratory examinations play a significant role in the diagnostic process of typhoid fever. Blood culture is a commonly employed method to isolate *Salmonella typhi* and *Salmonella paratyphi* (Sekhar *et al.*, 2020).

However, it is crucial to acknowledge that the diagnosis solely based on serology, exemplified by the Widal agglutination test, may lack accuracy. Recent advancements in the field of molecular immunology have resulted in the discovery of highly sensitive and specific indicators for typhoid fever, thereby enabling the development of practical and cost-effective rapid diagnostic kits. The symptoms and manifestations of typhoid fever are varied and can overlap with other febrile illnesses, posing a challenge to achieve precise diagnosis. Clinical presentations, in conjunction with laboratory examinations like blood culture and advanced

immunological markers, play a pivotal role in ensuring an accurate diagnosis of typhoid fever (Khan and Kader, 2022).

2.5 Prevention

It is expedient to that the spread of typhoid fever be curbed and reduced to the minimum, however, due to its specialized characteristics of the bacterial agent; *Salmonella typhi*, this has proven to be a herculean task. Notwithstanding, this segment of essay posits various means by which the combat of this enteric fever can be prevented both on individual level and in the community or state. Preventing the occurrence of typhoid fever necessitates the adoption of a comprehensive methodology encompassing vaccination schemes, sanitation and hygiene practices, as well as travel precautions.

2.5.1 Vaccination Strategies

The implementation of vaccination possesses the potential to reduce the reliance on antibiotics, curtail the emergence of antibiotic-resistant strains of *S. typhi*, and generate a collective immunity. Consequently, it is advisable to administer vaccination to individuals residing in endemic areas, as well as to travelers visiting destinations where antibiotic-resistant strains of *S. typhi* are prevalent (World Health Organization, 2020). Vaccination is a vital component in the prevention of typhoid fever, especially in endemic areas and for individuals traveling to high-risk regions. Vaccination strategies for typhoid fever encompass two vaccines that are authorized internationally: an oral vaccine derived from a weakened form of the *S. typhi* Ty21a strain and a single-dose injectable vaccine containing Vi capsular polysaccharide (Vi-PS) (Sandderson *et al.*, 2015). These vaccines have demonstrated both safety and effectiveness in individuals aged 2 and above (Marchello *et al.*, 2015). Nonetheless, challenges such as the administration schedules and the limited duration of

protection impose constraints on their widespread utilization, particularly in regions where typhoid fever is endemic and resources are scarce.

2.5.2 Sanitation and Hygiene Measures

Improving sanitation and advocating for favorable hygiene practices are pivotal in preventing the transmission of typhoid fever. Individuals should be granted access to uncontaminated potable water and appropriate sanitation amenities, encompassing lavatories and handwashing stations (Meena *et al.*, 2021). Communities and governing bodies should prioritize the provision of secure water sources and ample sanitation infrastructure, particularly in regions with a high prevalence of typhoid fever. Furthermore, the promotion of hand hygiene by means of regular handwashing using soap and water, specifically prior to food preparation and consumption, is indispensable in mitigating the risk of infection (Manesh *et al.*, 2021). Travelers visiting areas with a high prevalence of typhoid fever should adopt specific precautions in order to minimize their susceptibility to infection. It is suggested that one should only consume safe and properly cooked food and opt for bottled or boiled water. It is advisable to avoid consuming street food as well as raw or undercooked seafood. Furthermore, it is crucial to maintain good hand hygiene and, when soap and water are not available, employ the use of hand sanitizers. Prior to departure, travellers should consider receiving vaccination and diligently adhere to the recommended schedule to ensure maximum protection. It is important to closely monitor travel advisories issued by official health organizations for updates and guidance (Sekhar *et al.*, 2020).

2.6 Treatment

Antibiotic therapy serves as the fundamental aspect of typhoid fever treatment, as it aids in the elimination of the causative agent and diminishes the likelihood of complications. The selection of antibiotics is contingent upon the local susceptibility patterns of *Salmonella typhi*

strains. In numerous areas, the emergence of strains resistant to multiple drugs has rendered the treatment landscape more complex, necessitating the utilization of second-line antibiotics such as fluoroquinolones or third-generation cephalosporins. Nevertheless, it is imperative to acknowledge that local guidelines and resistance patterns should always be taken into account prior to commencing treatment (Shakya *et al.*, 2019). Fluoroquinolones, such as ciprofloxacin and ofloxacin, have been extensively employed as the primary therapeutic approach for treating typhoid fever due to their exceptional oral bioavailability and efficacy against *Salmonella typhi*. They have exhibited elevated rates of clinical and bacteriological restoration, rendering them the preferred option in regions housing susceptible strains. However, the escalating prevalence of fluoroquinolone resistance has constrained their efficiency in specific areas. Consequently, the continual monitoring of resistance patterns is imperative to appropriately guide the selection of antibiotics (Srinivasan *et al.*, 2021). Particularly in regions where fluoroquinolone resistance is present, third-generation cephalosporins, such as ceftriaxone and cefixime, have become an additional therapeutic option for typhoid fever. These antibiotics have demonstrated strong clinical cure rates together with good safety and effectiveness characteristics. Particularly for severe instances or those with problems, ceftriaxone is frequently advised because of its wider range of activity and intravenous delivery method. To avoid the rise of resistance, their application should be prudent (Nyaberi and Musaili, 2021). In order to manage typhoid fever, supportive care is essential since it helps reduce symptoms, keep the patient hydrated, and avoid complications. To compensate for the fluid losses brought on by vomiting and diarrhea, an adequate intake of fluid and electrolyte replenishment is necessary (Dahora *et al.*, 2019). For mild to moderate instances, oral rehydration therapy is the recommended course of action; however, intravenous fluids may be required for severe cases or those with extreme dehydration. To help with fluid management, vital signs, urine output, and electrolyte levels

must be regularly monitored (Jin *et al.*, 2017). Typhoid fever care requires not only fluid control but also nutritional support. Patients frequently lose weight and have decreased appetites, which can cause malnutrition and impede their ability to heal (Veronese *et al.*, 2023). Supporting the body's immunological response and promoting healing requires promoting modest, frequent meals and offering a balanced diet full of calories, protein, and vital nutrients (Srinivasan *et al.*, 2021).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The study was conducted in Benin City, Edo State, Nigeria, which is located in the tropical rainforest zone of the southern part of the country. Orobosa Medical Centre is a healthcare service provision facility located at latitude 6.3489°N and longitude 5.6893°E, while Graceville Medical Centre provides high quality healthcare for a range of health conditions and is located at latitude 6.3634°N and longitude 5.6412°E.

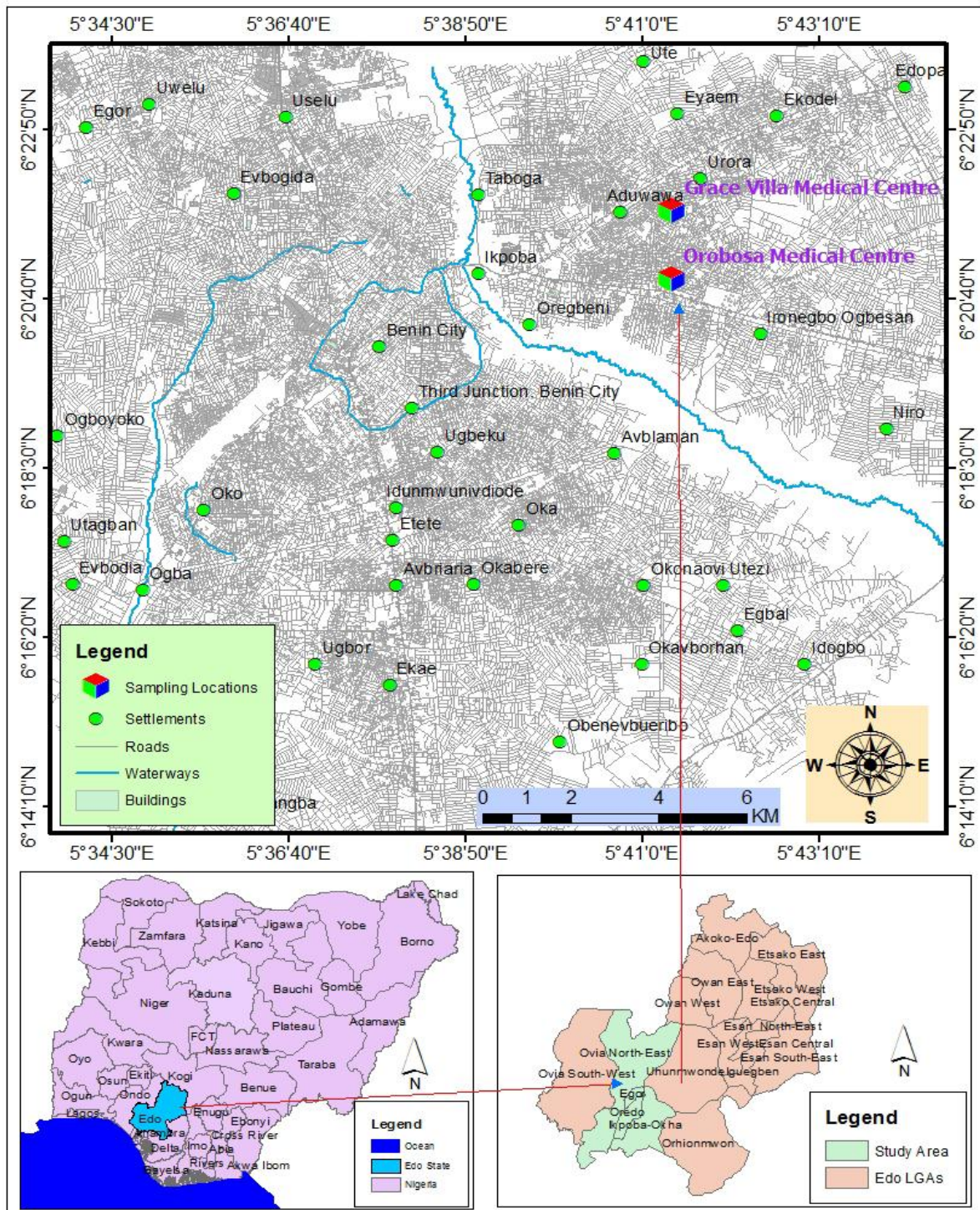


Figure 1: Map of Benin Metropolitan Showing Sampling Locations.

Source: GIS and Remote Sensing Software Arc Map 10.1 Department of Geography ABU, Zaria 2024.

3.2 Study Population

The study population comprised of patients with clinical signs and symptoms of typhoid fever with request of widal test from physicians at Orobosa Medical Centre and Graceville Medical Centre who gave consent to participate in the study.

3.3 Inclusion criteria

Patients attending Orobosa Medical Centre and Graceville Medical Centre who are presenting signs and symptoms of typhoid fever and give consent.

3.4 Exclusion criteria

Patients attending Orobosa Medical Centre and Graceville Medical Centre who do not show signs and symptoms of typhoid fever and do not give consent.

3.5 Sample size

The sample size used in this study was determined using the formula developed by Kaur (2021). The sample size was calculated as follows:

$$n_o = \frac{Z^2 pq}{e^2}$$

Where, n_o = sample size, Z = z-score at 5% confidence limit (1.96), e = error margin, p = population proportion with the attribute (18.6%), $q = 1 - p$.

$$n_o = \frac{(1.96)^2 \times (0.186)(0.814)}{0.05^2}$$

$$n_o = 232.65$$

Therefore, a total of 233 participants were included in the study.

3.6 Administration of questionnaire

A structured questionnaire was used to obtain socio-demographic characteristics and risk factors associated with *S. typhi* infection among the study population.

3.7 Serology

The stripe test was used in the detection of antibodies specific to *Salmonella typhi* in the blood samples of the participants. Using a sterile syringe, exactly 5 ml of blood from each consented patient was aseptically collected. The sample was then centrifuged to separate the serum and antibodies. The serum was then mixed with O and H antigens specific to *Salmonella typhi*. The formation of visible clumps or ‘stripes’ as a result of agglutination was observed in the mixture. Agglutination suggests that the patient may have been exposed to the pathogen and may have contracted typhoid fever if there are antibodies against *Salmonella typhi* antigens in their serum.

3.8 Data Analysis

The data collected in the study were analysed using SPSS version 20 and Microsoft Excel 2016 sheets. The data collected by questionnaires were summarised using descriptive statistics (frequencies and percentages) and presented in tables and labelled accordingly.

CHAPTER FOUR

RESULTS

4.1 Socio-demographic information of participants

The socio-demographic data of the participants are presented in Table 4.1 below.

For Orobosa Medical Centre, there were more female (62.93%) than male (37.07%) participants. Individuals aged 21 - 30 years were the most prevalent in the sample (38.79%). Individuals with occupation category 'Others' made up 31.03% of the total sample and the most common marital status among participants was "Single" (57.76%).

For Graceville Medical Centre, female individuals made up the majority of participants (56.03%). Individuals with the age range of 21 - 30 years made up the major portion of the total sample (32.76%). Individuals who were self-employed were the most common in the sample (25.86%). Individuals who are married were the most common among the participants (48.28%).

Table 4.1: Sociodemographic information of participants

Question	Option	Orobosa Medical Centre		Graceville Medical Centre	
		Frequency	Percentage (%)	Frequency	Percentage (%)
Gender	Male	43	37.07	51	43.97
	Female	73	62.93	65	56.03
Age range	10 - 20	26	22.41	16	13.79
	21- 30	45	38.79	38	32.76
	31 - 40	22	18.97	25	21.55
	41 - 50	13	11.21	15	12.93
	51 - 60	05	4.31	05	4.31
	61 - 70	01	0.86	08	6.90
	71 - 80	03	2.59	03	3.57
	81 - 90	03	2.59	04	3.44
	91 - 100	-	-	02	1.72
Occupation	Civil servant	10	8.62	18	15.52
	Trader	26	22.41	22	18.97
	Farmer	02	1.72	10	8.62
	Employed	14	12.07	14	12.07
	Self-employed	28	24.14	30	25.86
	Others	36	31.03	22	18.97
Marital status	Single	67	57.76	45	38.79
	Married	41	35.34	56	48.28
	Divorced	06	5.17	06	5.17
	Widow	01	0.86	06	5.17
	Widower	01	0.86	03	2.59

4.2 Typhoid factors, symptoms and risk factors

Table 4.2 present the results obtained for sources of drinking water, signs and symptoms of typhoid fever and typhoid fever risk factors as reported by participants in the study.

For both Orobosa Medical Centre and Graceville Medical Centre, Table water was the most common source of drinking water for 90.52% and 75.86% of participants, respectively. The most commonly reported signs and symptoms of typhoid fever among those at Orobosa Medical Centre were headaches (87.07%) and fatigue (72.41%), and for Graceville Medical Centre, they were also headache and fatigue (80.17% each). Proximity of flying insects feeding on faecal matter and consumption of raw fruits and vegetables were reported to be the most common risk factors for typhoid fever at Orobosa Medical Centre (97.41% and 91.38%, respectively) and Graceville Medical Centre (98.28% and 90.52%, respectively).

Table 4.2: Typhoid factors, symptoms and risk factors

Question	Options	Orobosa Medical Centre		Graceville Medical Centre	
		Frequency	Percentage (%)	Frequency	Percentage (%)
Drinking water sources	Borehole	29	25.0	12	10.34
	Tap	42	36.21	28	24.14
	Underground storage tank	-	-	01	0.86
	Table water	105	90.52	88	75.86
Signs and symptoms of typhoid fever	Prolonger fever	29	25.0	36	31.03
	Headache	101	87.07	93	80.17
	Diarrhoea/ Constipation	09	7.76	16	13.79
	Fatigue	84	72.41	93	80.17
	Nausea	05	4.31	04	3.44
	Abdominal pain	78	67.24	72	62.07
Risk factors for typhoid fever	Rashes	09	7.76	04	3.444
	Travel to pandemic areas	22	18.97	22	18.97
	Poor hygiene habits	20	17.24	17	14.66
	Poor sanitation conditions	86	74.14	93	80.17
	Proximity of flying insects feeding on faecal matter	113	97.41	114	98.28
	Crowded housing	17	14.66	26	22.41
	Consumption of raw fruit and vegetables	106	91.38	105	90.52

4.3 Prevalence of typhoid among participants

The prevalence of typhoid in blood samples of participants of the study from both Orobosa Medical Centre and Graceville Medical Centre are presented in Table 4.3.

The results show that for Orobosa Medical Centre there were a total of 23 individuals who were positive for typhoid while 93 (80.17%) were negative. The highest number of positive cases was recorded among traders (7), while the highest number of negative cases was recorded among those with 'Other' forms of employment (30). In the case of Graceville Medical Centre, the individuals who were positive for typhoid were 20 in number making up 17.24%, while those who were negative for typhoid were 96 which made up 82.76% of the total. Individuals who were self-employed had the highest number of positive cases (9) and the highest number of negative cases (21).

Table 4.3: Prevalence of typhoid among study participants by occupation

Occupation	Orobosa Medical Centre		Graceville Medical Centre	
	Positive	Negative	Positive	Negative
Employed	04	10	01	13
Trader	07	19	02	20
Civil servant	02	08	02	16
Self-employed	04	24	09	21
Farmer	00	02	02	20
Others	06	30	04	06
Total	23 (19.83%)	93 (80.17%)	20 (17.24%)	96 (82.76%)

CHAPTER FIVE

DISCUSSION

5.1 Discussion

Typhoid fever is a common illness in Nigeria that is transmitted through contaminated food and water, while its main risk factors are limited access to clean water and poor sanitation (Abi *et al.*, 2021). This study assessed the prevalence of typhoid fever among individuals from selected medical centres (Orobosa Medical Centre and Graceville Medical Centre) in Benin City, Nigeria.

Drinking water sources among participants from both medical centres are shown in Table 4.2. The most common drinking water source was table water, followed by tap water and borehole water. Table water may be in form of water packed in sachets or bottles, and is a predominant source of drinking water in Nigeria due to its easy availability and perceived purity (Ighalo and Adeniyi, 2020). This fact has been presented and supported in several investigations in the past (Ajala *et al.*, 2020; Magaji, 2020; Opfola *et al.*, 2020). Several symptoms of typhoid fever were identified by the participants (Table 4.2). The frequency of these symptoms was in the order: Headache > Fatigue > Abdominal pain > Prolonged fever > Diarrhoea/Constipation > Rashes > Nausea for Orobosa Medical Centre, and Headache > Fatigue > Abdominal pain > Prolonged fever > Diarrhoea/Constipation > Rashes > Nausea for Graceville Medical Centre. These symptoms have been reported in studies on typhoid from various regions. The research of Alla *et al.* (2021) and Syed *et al.* (2020) reported symptoms of typhoid fever such as elevated body temperature and gastrointestinal symptoms which were also reported as symptoms from patients suffering from typhoid fever in this study. Additionally, symptoms of typhoid were reported by Marchello *et al.* (2020) to include intestinal perforation, gastrointestinal bleeding and septicaemia.

The participants also identified risk factors for typhoid fever (Table 4.2). The order of the frequency of these risk factors were as follows: for Orobosa Medical Centre - Proximity of flying insects feeding on faecal matter > Consumption of raw fruit and vegetables > Poor sanitation conditions > Travel to pandemic areas > Poor hygiene habits > Crowded housing; for Graceville Medical Centre - Proximity of flying insects feeding on faecal matter > Consumption of raw fruit and vegetables > Poor sanitation conditions > Crowded housing > Travel to pandemic areas > Poor hygiene habits. These risk factors reported in this study are similar to the risk factors reported by research conducted by Ilouno (2020), Omotola *et al.* (2020), Uzoka *et al.* (2021) and Marks *et al.* (2024).

The results obtained for typhoid prevalence among study participants for Orobosa Medical Centre and Graceville Medical Centre are presented in Table 4.3. The percentage prevalence of typhoid was 19.83% and 17.24%, respectively, for both medical centres. The research conducted by Akinyemi *et al.* (2018) gave an overall prevalence of typhoid fever in Nigeria over a period of 23 years from 1993 to 2015 to range from 7 % to 18.6 %, while the research of Adesegun *et al.* (2020) gave the prevalence of typhoid fever to range from 3.9 % to 18.6 %. The prevalence recorded in this study are with the prevalence values given by these other researches. However, typhoid prevalence in this study exceeded the 14.1% recorded in Ohanu *et al.* (2019). The prevalence of typhoid among the study sample is quite high and indicates that action is needed to decrease the prevalence of typhoid among people living in the study area.

5.2 Recommendations

Based on the findings of the study, the following recommendations are made:

1. Public health education which focuses on the importance of sources of clean water and hygienic practices for the mitigation of typhoid transmission should be enhanced.

2. Community-based interventions which target improvement of infrastructure for sanitation and practices for waste management practices for the reduction of typhoid fever should be implemented.
3. Surveillance systems should be strengthened to enable early detection and prompt treatment of typhoid cases, with emphasis on the importance of healthcare workers and members of the public recognising symptoms early.
4. There should be collaborations with local authorities for the formulation and enforcement of policies which are aimed at the enhancement of safety standards for food and the regulation of the sales of food items which may be contaminated.

5.3 Conclusion

This study is a critical investigation on the typhoid fever prevalence among patients in Orobosa Medical Centre and Graceville Medical Centre, both located in Benin City, Nigeria. Through a thorough investigation, the complex interactions between many elements that contribute to the spread and persistence of typhoid in the community are made clear. This study highlights the critical need for comprehensive interventions to reduce the incidence of typhoid fever by clarifying the main risk factors, which include poor sanitation, a lack of access to clean water, and the consumption of potentially contaminated food and water sources. To effectively stop the spread of typhoid in the research region, it is imperative that coordinated efforts be made towards public health education, infrastructure improvements, policy formulation, and enforcement. This is highlighted by the increasing prevalence rates that have been reported. In order to improve the general well-being and quality of life for people in Benin City, Edo State, Nigeria, and beyond, these measures are crucial for lowering the burden of typhoid fever as well as for building a stronger, more resilient community.

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APPENDIX 1



PROTOCOL NUMBER	HA/737/24/D/15003233 (PLEASE QUOTE IN ALL ENQUIRIES)
TITLE OF RESEARCH PROPOSAL	PREVALENCE OF TYPHOID FEVER AMONG PATIENTS IN OROBOSA MEDICAL CENTRE AND GRACEVILLE MEDICAL CENTRE, BENIN CITY, NIGERIA
PRINCIPAL INVESTIGATOR (S)	EMUJEDE SARAH RACHEL
DATE CONSIDERED	15th MARCH, 2024
DECISION OF THE COMMITTEE	APPROVED

THIS APPROVAL DATES 15/03/2024 TO 15/03/2025. IF THERE IS A DELAY IN STARTING THE RESEARCH, PLEASE INFORM THE HREC EDO SMOH SO THAT THE DATES OF APPROVAL CAN BE ADJUSTED ACCORDINGLY.

REMARK: Please kindly note that the HREC Edo SMOH seal authenticates this approval

**DR (MRS) Omonyemen B. BELLO
(MBBS, MPH, FPHCM) (CHAIRMAN)**

SIGNATURE & DATE.....

Bello
15/3/24

SUPERVISOR(S)Rabiah.Orchewa.Osumah.(Dr.).....

ATTESTATION BY INVESTIGATOR(S)

No participant accrual or activity related to this research may be conducted outside of the approval dates. All informed consent forms used in this study must carry the Edo SMOH HREC-assigned number and duration of your research. No changes are permitted in the research without prior approval of the Edo SMOH HREC except in circumstances outlined in the Code. The Edo SMOH HREC reserves the right to conduct compliance visits to your research site without previous notification.

Signature & Date.....

ROOHA

03/04/2024

State Secretariat Building, Block D - 2nd & 3rd Floors, P.M.B. 1113, Benin City, Edo State, Nigeria.