

Incidence of Typhoid Fever among Patients Diagnosed with Malaria in Gwagwalada, FCT

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Abstract

Malaria, typhoid and their co-infection remain the most common febrile illnesses in Nigeria, with overlapping clinical symptoms, making diagnosing almost difficult. This study was aimed at investigating the incidence of typhoid fever among patients diagnosed with malaria infection. 100 blood samples, collected from febrile patients (63 females and 37 males) between the ages of 11–60 years were screened for malaria parasites using thick and thin blood film stains. Typhoid fever was screened using the Widal-agglutination test and re-confirmed with blood culture, followed by biochemical characterization. 62 (62%) samples were positive for malaria. Of all 62 malaria positive samples, 27 (43.5%) were positive for widal test while 35 (56.4%) were negative. Blood culture confirmed 33 (53.2%) of 62 malaria-positive samples for *Salmonella* spp., indicating a marked discrepancy between the two diagnostic methods. Malaria-typhoid co-infection recorded 15 (24.1%). The 21–30 years of age group recorded the highest number of malaria to typhoid cases, while age 11-20 years recorded the highest number of co-infection. Females (63%) constituted a higher proportion of the study population than males (37%). The association between the number of malaria positive cases with age and positive cases for widal and culture was not statistically significant. The findings revealed that although malaria typhoid co-infection is genuinely present in the study population, the Widal test overestimates its true prevalence due to its low specificity. It is recommended that blood culture be adopted as a confirmatory diagnostic tool to improve the accuracy of typhoid fever diagnosis among malaria patients.

Introduction

Infectious diseases remain one of the many public health challenges in sub-Saharan Africa and Nigeria due to environmental, infrastructural limitations and socio-economic factors which impedes disease prevention and its control (Ologunde et al., 2026). Among the Infectious disease, is malaria and typhoid. Malaria is a mosquito-borne infectious disease of humans and

other animals caused by a parasitic protozoans of the genus *Plasmodium* (WHO, 2025). It consists of five species: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae* and *Plasmodium knowlesi*, commonly transmitted in humans by the female anopheles' mosquito (Iwuafor et al., 2016; Odikamnoro et al., 2017; Lee et al., 2022). The disease is widespread in tropical and subtropical regions in a broad band around the



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equator, including major Sub-Saharan Africa, Asia, and the America (Kwiek et al., 2023; CDC 2024). It's prevalent in tropical and subtropical regions because of rainfall and warm temperatures. An estimate of 3.3 billion people in 97 countries around the world are at constant risk of being infected with the parasite (WHO, 2014; Iwuafor et al., 2016; Odikamnoru et al., 2017). Infection from malaria parasite places a high burden on the poor (Okolo et al., 2023) and most vulnerable communities like Gwagwalada, FCT where we have large population of people and settlements.

Typhoid fever on the other hand is a common worldwide systemic infectious disease characterized by an acute illness, with its first clinical manifestations, fever, headache, abdominal pain, relative bradycardia, splenomegaly, and leucopenia (NCBI Bookshelf, 2023). It is caused by a gram negative bacteria, *Salmonella typhi* (Odikamnoru et al., 2017). Risk factors include poverty as a result of poor hygiene and sanitation (Wain et al., 2015). An estimated 16-33 million cases of typhoid fever occur annually and in the pre-antibiotic era, the case fatality was 10-20%. Today, with prompt treatment, it is less than 1% (Kariuki et al., 2021).

Due to geographical overlap, incidence of malaria and typhoid fever remain diseases of major public health importance in the tropics, causing significant morbidity and mortality (Buckle et al 2012; Odikamnoru et al., 2017). As a result, they constitute the two important diagnoses to be ruled out in the diagnosis of fever in the tropics (Olowolafe et al 2024), and their high prevalence has made them become almost a house-hold name to every Nigerian living in the country (Olowolafe et al 2024). While high prevalence of malaria is already an established fact, the last decade has recorded an unusually high number of illnesses that have been diagnosed with malaria co-existing with typhoid fever (Odikamnoru et al., 2017; Kanjilal et al., 2006).

Nigeria is highly endemic with both infections and they have become almost a household name to every Nigerian. In Africa and Nigeria, most of the typhoid cases are diagnosed on the basis of clinical symptoms and a single Widal test is often

performed in hospitals and private laboratories with blood culture seldom carried out, creating a paucity of reports on microbial investigations. It is even more worrisome as most clinicians are used to linking every symptom and sign to a single pathology, thereby misdiagnosing (Olowolafe et al 2024). Also, in areas where malaria and typhoid fever are co-endemic, clinicians often treat infected patients irrationally, which may lead to the emergence of drug resistance, extra cost on patients (Rufai et al., 2022; Ohanu et al., 2003) and an increase in the economic burden of the sufferers. This study therefore explores the prevalence of malaria in febrile patients and the incidence of typhoid and co-infection of malaria and typhoid in patients attending health care in Gwagwalada Area Council, FCT

Materials and Methods

Study Area

This study was carried out in Gwagwalada Area Council, Federal Capital Territory, Nigeria. Gwagwalada is located in the Guinea Savannah ecological zone with an alternating wet and dry season, moderate relative humidity, and seasonal changes in ambient temperature. Gwagwalada, FCT is part of Nigeria's North-Central geopolitical zone, alongside Benue, Kogi, Kwara, Nasarawa, Niger, and Plateau states with geographical coordinates approximately 8.9508° N latitude and 7.0767° E longitude (Bashir et al., 2021), Figure 1.

Ethical Consideration

Ethical consideration was obtained from the University of Abuja Teaching Hospital, Gwagwalada, FCT, Abuja. Consent was sought from all participants and for the minors, permission was sort from their close relatives. Only those who consented were enrolled in the study and given questionnaire before sample collection. Information of all participants were treated as confidential and results from the study was used only for research purpose. Selected patients presented symptoms of fever, joint pain, stomach and abdominal pain, suggestive of malaria or typhoid fever.

Study Population

The study population involved a total of one hundred (100) febrile patients, consisting of sixty-three (63) females and thirty-seven (37) males of age groups 11-60 years, presenting with symptoms suggestive of malaria and/or typhoid fever. Participants were selected from outpatient departments of the hospital and sample size was one hundred (100).

Collection of Blood Samples

5 mL of venous blood sample was collected aseptically from each patient using sterile syringes and needles (venipuncture method). Blood was transferred into plain sterile tubes for Widal test and Brain Heart Infusion broth (BHI) before culturing on agar plates. Another portion was transferred into EDTA tubes for malaria testing. All samples were properly labeled with patient ID, date, and time of collection and transferred to the Microbiology Laboratory, University of Abuja (Cattoir. et al., 2018).

Laboratory Procedures

Malaria Diagnosis: 100 blood samples were examined and for the presence of malaria parasites using standard size thick and thin blood films preparation. Slides were thoroughly air-dried and the thin films fixed with absolute methanol for malaria species identification. The blood films were stained with 10% (v/v) Giemsa solution for 20 minutes for the detection of *Plasmodium* parasites. Malaria microscopy was later carried out.

Cultivation, isolation, and identification of *Salmonella* spp from blood.

Blood in brain heart infusion broth (BHI) broth was incubated aerobically at 35–37 °C for 7 days with intermittent cultivation on solid media plates, namely, MacConkey agar (MAC), blood agar (BA) and chocolate agar (CA) on day 2, day 4, and day 6. Samples from BHI broth that showed no growth up to 6 days, were sub-cultured on day 7 before it was discarded. Also, on each day of subcultivation, broth tubes were examined for turbidity of blood-broth mixture, growth of microcolonies, haemolysis, colour changes and gas production. For 24–48 hours, the BA and MAC agars were

incubated aerobically at 35–37 °C and anaerobically at CA in micro-aerophilic conditions (5–10% CO₂) for 24–48 hours. Isolates from the subcultures were Gram stained (Opota et al., 2015; Rufai et al., 2022).

Biochemical characterization of bacteria.

Isolates from the subcultures were identified through series of biochemical tests. Biochemical tests such as citrate utilization, indole production, the production of urease, hydrogen sulphide production, presence of oxidase, carbohydrate metabolism (triple sugar iron agar) were used to identify the pathogens in positive cultures. Gram-negative rods that were oxidase negative with the characteristic red slope/yellow butt reaction on triple sugar iron agar either with or without production of H₂S were confirmed positive for *Salmonella* spp. *S. paratyphi* A produced no H₂S with gas production while *S. typhi* spp produced weak H₂S (Rufai et al., 2023).

Typhoid fever was screened for using rapid slide titration method to detect *Salmonella* antigens; somatic (O) and flagella (H) antigens (Medsorce Ozone Biomedicals, India). Briefly, 50 µL of test serum was placed in two circles on a glass slide and equal volumes each of positive control and normal saline in each of the last two circles respectively. A drop each of O and H antigens was added to the test serum in each circle and then to the negative and positive controls. The content of each circle was mixed using the disposal mixing sticks provided and spread to the entire circle, after which it was rocked gently for 1 minute and observed for agglutination. Antibody titration was performed for the slide reactive samples using the tube technique.

A titre of 1:80 (anti-TO) and ≥ 1:160 (anti TH) was considered positive for typhoid fever, and usually suggestive of infection. Bacteria identification of *Salmonella typhi* and paratyphi was carried out by culturing the blood in BHI for 5days before culturing on Salmonella Shigella agar and Macconkey agar for 24-48 hours at a temperature of 35–37 °C, aerobically. This was followed by biochemical characterization of all isolates (Ochei & Kolhatkar, 2010; Rufai et al., 2022).

Socio-demographic and clinical data collection.

Patient's whose body temperature, was 37.5°C and had consented were randomly selected. A questionnaire designed and deployed using an android technology, ordinary data kit (ODK) was administered to all participants in the study in English. Those who cannot read or understand English, were assisted. Each subject was assigned an identification number. The questionnaire was made up of a section on the date of interview and individual serial number; a demographic section including age, sex, marital status, educational level and sources of drinking water. Some participants were also interviewed, guardians answering for children aged 10-14 years.

Data analysis.

Descriptive statistics were presented as percentages. Continuous variables were presented as mean with standard deviation (SD) while the Chi square test (χ^2) was used to determine the association of infection status among different age groups with limiting error at 0.05 as an indicator of statistical significance with confidence interval of 95%.

Results

Number of positive and negative samples

A total number of 100 blood samples was collected from febrile patients (63 females and 37 males) between the ages of 11–60 years. 62 (62%) samples were positive for malaria while 38 (38%) were negative. Of all the 62 malaria positive samples, widal test confirmed 27 (43.5%) positive for typhoid fever and 35 (56.4%) negative, Table I. Blood culture confirmed the presence of *Salmonella typhi* and *Salmonella para-typhi* in 33 (53.26%) of the 62 malaria-positive samples whereas 29 (46.7%) were negative, indicating a marked discrepancy between the two diagnostic methods. Malaria typhoid co-infection using widal test was positive for 15 (24.1%) and negative for 47 (75.8%), Figure II. All *Salmonella* isolates showed smooth, flat, translucent, pink colour on Xylose Lysine Deoxycholate agar. There was no statistical significant association between the proportion of typhoid-positive cases by culture method and widal test as $p > 0.05$, Table I. Figure II shows the

bar chart of malaria cases, typhoid, widal and malaria typhoid co-infection.

Widal titre distribution of typhoid cases (Widal titre O and H antigen)

The widal titre distribution among the 27 (43.5%) positive cases showed that the predominant titre for both O and H antigens was 1:60. For Antigen O, 12 (44.4%) cases had a titre of 1:60, followed by 8 (29.6%) for a titre of 1:80 and 7 (25.9%), had a titre of 1:180, Table 2. Similarly, the H antigen had the highest cases recorded as 14 (51.9%) at a titre of 1:160 while 8 (29.6%) and 5 (18.5%) had titre of 1:180 and 1:80 respectively. Using a defined cutoff mark of $>1:60$, titre of 1:80, 1:160 and 1:180 were considered reactive and positive. From the result, the predominant titre was at 1:160, Table 2.

The Sociodemographic Characteristics of the Study Among Participants

From Table 3, the sociodemographic characteristics of the study with respect to age shows that age group 21–30 years had the highest representation of malaria at 17 (27.4%), followed by age group 11-20, 15 (24.1%). Patients aged between 31-40 and 41-50 had a tie of 11 (17.7%) while the least frequency of malaria, 8 (12.9%) was recorded for age group 51-60. Statistical analysis shows there was no statistical significance between age group and malaria infection status. For widal test, age group 21-30 also recorded a higher frequency of 9 (33.3%) while the least was 3 (11.1%) for age group 51-60. Cases positive for blood culture also had age group 21-30 as the highest with frequency of 11 (33.3%). Age 11-20 recorded the highest frequency for malaria and typhoid co-infection. Females were more represented in the study and they had more number of positive cases for Malaria and widal test. This may be as a result of healthcare-seeking behavior of the participants. Overall, the results show that young adults, particularly those within 21–30 years of age bracket, were the most affected group in this study as seen in Figure 3. This may be attributed to their higher exposure to risk factors such as outdoor activity, food handling, and occupational exposure compared to other age groups.

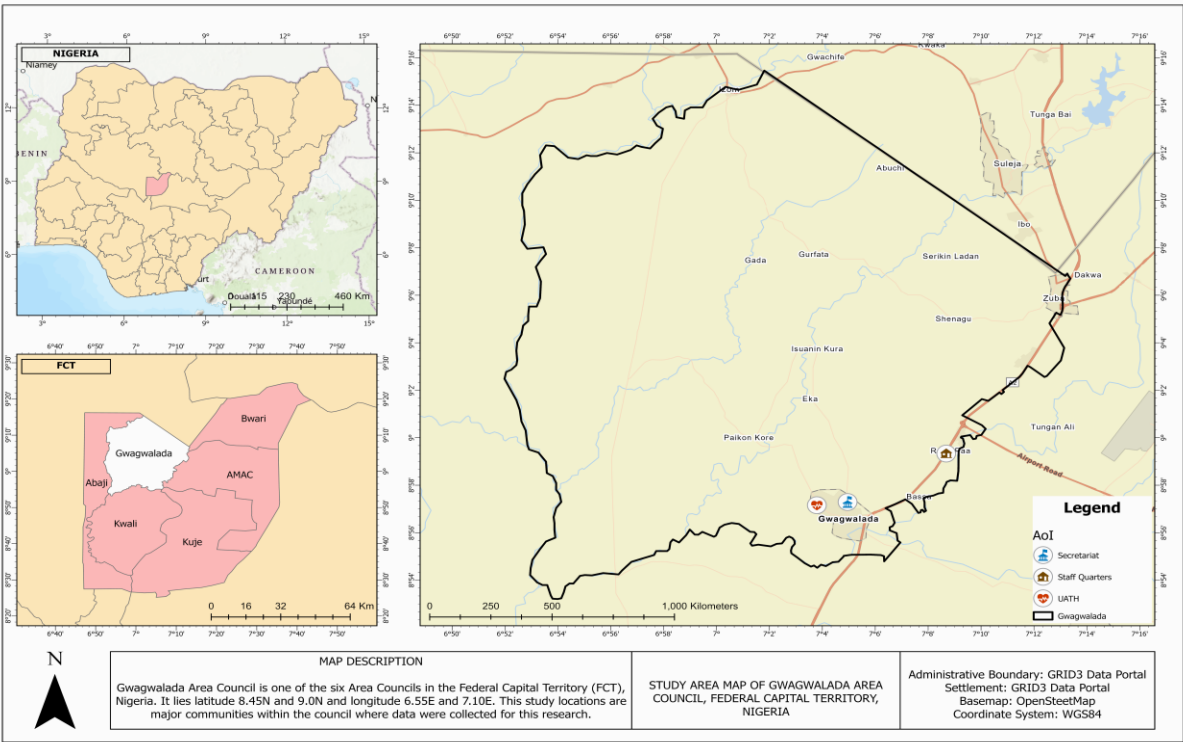


Figure 1: Map of Gwagwalada Area Council.

Table 1: The sample size, number of positive and negative samples.

Type of cases	Test size	Sample No.	of positive	No. of negative	Total (%)	p-value
Malaria	100	62 (62%)	38 (38%)	100%		0.281
Typhoid (culture method)	62	33 (53.2%)	29 (46.7%)	100%		
Widal test	62	27 (43.5%)	35 (56.4%)	100%		
Malaria-Typhoid co-infection	62	15 (24.1%)	47 (75.8%)	100%		

Key: No.: number; %: percentage

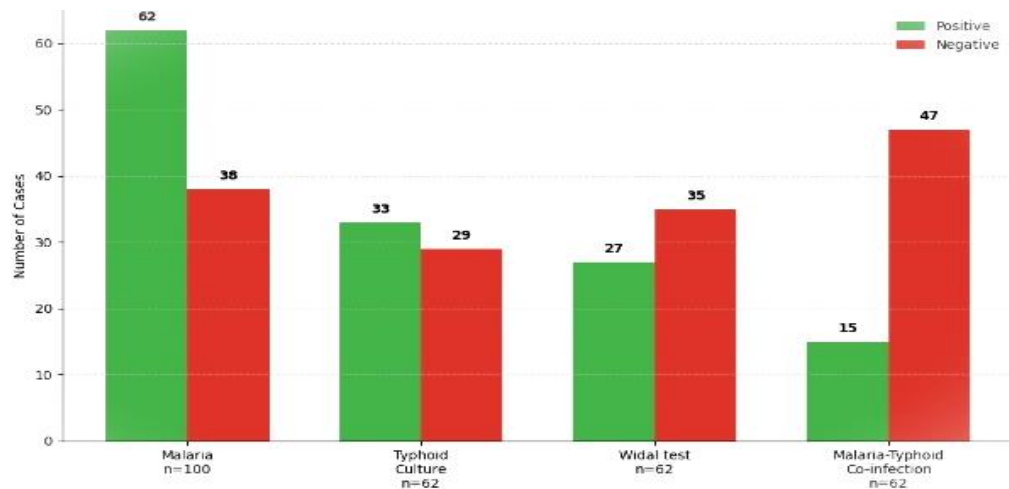


Figure 2: shows a bar chart of malaria cases, typhoid, widal and malaria typhoid co-infection.

Table 2: Distribution of Widal titres among 27 widal-reactive cases.

Type of cases	Number of cases	Widal Titre to O and H antigen (p=0.416)					Total
		20	40	80	160	180	
Widal Titre O antigen	27			8 (29.6%)	12(44.4%)	7(25.9%)	27 (100%)
Widal Titre H antigen	27			5(18.5%)	14(51.8%)	8(29.6%)	27 (100%)

Table 3: Sociodemographic Characteristics of the Study among Participants.

Parameters of study	Distribution/Category	Frequency			
		No. +ve for Malaria p-value = 0.389	No. +ve for widal p-value = 0.416	No. +ve for blood culture p-value = 0.144	No. of +ve co-infection
Age (years)	11-20	15 (24.1%)	6 (22.2%)	9(27.2%)	6(40%)
	21-30	17 (27.4%)	9(33.3%)	11(33.3%)	5(33.3%)
	31-40	11 (17.7%)	4(14.8%)	4(12.1%)	-
	41-50	11 (17.7%)	5(18.5%)	6(18.1%)	-
	51-60	8 (12.9%)	3(11.1%)	3(9.0%)	4(26.6%)
Sex		+ve for all cases		-ve for all cases	
				Total	
	Male (37)	22 (59.5%)		15(40.5%)	
	Female (63)	40 (63.5%)		23(36.5%)	
Residence of +ve cases	Rural	19 (30.6%)			
	Urban	43 (69.4%)			
Marital status	Married	35 (56.5%)			
	Single	18 (29.0%)			
	Minors	9 (14.5%)			
Source of drinking water	Borehole water	8 (12.9%)			
	Municipal tap water	32 (51.6%)			
	Sachet water	22 (35.5%)			

Key: %: percentage, +ve: positive, -ve: negative, No.: number,

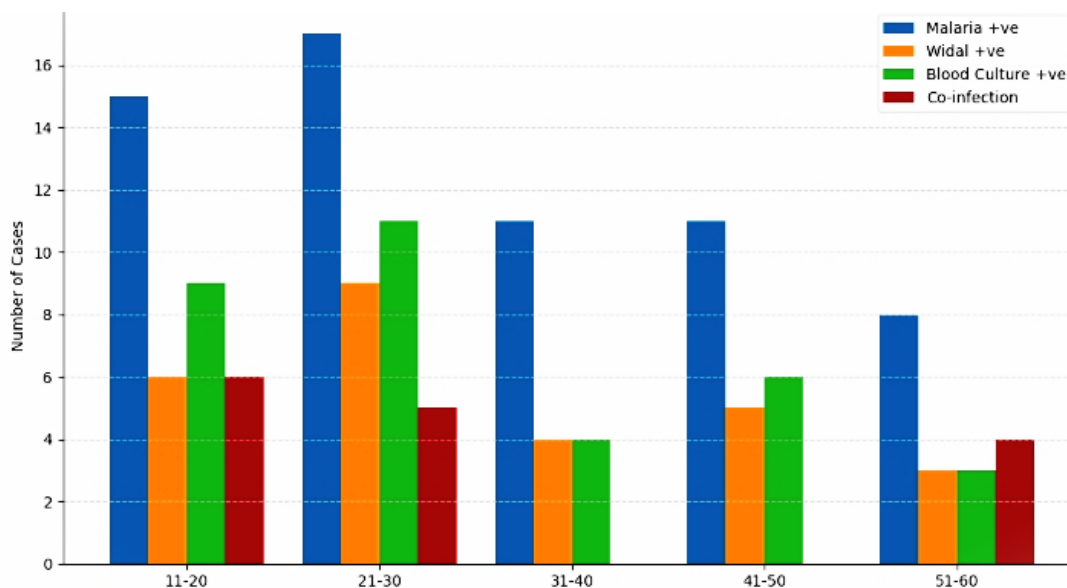


Figure 3: The Sociodemographic distribution of Malaria and Typhoid Infection

Discussion

Malaria and typhoid fever continue to be one of the major diseases of public health concern, especially in tropical countries like Nigeria, and are known to present clinically similar symptoms, with fever being the major presentation (Igharo et al., 2012; Rufai et al., 2022). The present study, conducted among 100 febrile patients, within age group of 11-60 revealed a prevalence of 62% for malaria. Malaria positive samples subjected for typhoid fever test revealed prevalence of 27% for widal agglutination test, 33% for blood culture and malaria-typhoid co-infection, 24.1%.

From the findings, the burden of malaria was high, which is similar to the result of Odikamnoro et al., 2017 and Ologunde et al., (2026) with prevalence of 54.2% and 53.1% respectively. Rufai et al. (2022) on the other hand, recorded a much lower prevalence of 36.3% for malaria parasite. The current work also shows that mosquitoes breeding and transmission of infection from mosquito bite was high amongst participants. This can be as a result of the time and season of conducting the study (April to August, 2026). Other environmental factors include geographical altitude, rainfall and vegetation during the raining season.

Out of the 62 malaria-positive samples, 43.5% were reactive for typhoid fever by the Widal agglutination test while blood culture confirmed

Salmonella spp. in 53.2% of the samples. The incidence of *Salmonella* in blood culture is similar to the result of Ologunde et al. (2026), 53.1% and Odikamnoro et al. (2017), 54.2%. The discrepancy between Widal and blood culture highlights a major diagnostic challenge and speaks on the relevance of blood culture as it remains the gold standard for typhoid diagnosis. However, its cost, and delay in results often limit its use in resource-limited settings.

Coinfections from *Plasmodium falciparum* and *Salmonella* spp in the work of Rufai et al. (2022) also showed a lesser frequency of 1.9%, compared to the current work recorded at 24.1%. Odikamnoro et al. (2017) on the other hand, recorded a higher prevalence of malaria typhoid co-infection at 36.2%. This high prevalence underscores the continued public health importance of malaria as a leading cause of febrile illness. *Plasmodium* spp. and *Salmonella* spp co-infections was recorded at 1.9%, while malaria and typhoid fever, individually, were responsible for 36.3% and 6.4%, respectively.

All *Salmonella* isolates produced smooth, flat, translucent pink colonies on XLD agar, which is characteristic of *Salmonella* species and further validates the culture findings. The co-infection rate of 24.1% between malaria and typhoid fever is clinically significant. This implies that nearly 1 in 4 patients presenting with malaria may also have

concurrent typhoid infection. Presence of Co-infection in patients can complicate clinical presentation because both diseases present with fever, headache, and body weakness, often leading to prolong prognosis, misdiagnosis and also inappropriate treatment plan leading to increase morbidity. The high co-infection rate observed here aligns with previous studies that reported similar overlap in tropical regions where both pathogens are endemic and share common risk factors such as poor sanitation and contaminated water (Odikamnoru et al., 2017). The interpretation of widal agglutination test result should therefore be carried out with caution in cases of malaria-typhoid infection.

The Widal titre distribution among the 27 reactive cases showed that the predominant titre was 1:160. Using a cutoff of $>1:60$, titres of 1:80, 1:160, and 1:180 were considered positive. The clustering of high titres supports the likelihood of current infection rather than past exposure.

Sociodemographic analysis showed that young adults aged 21–30 years had the highest burden of malaria, 27.4%, and typhoid (33.3%), with 11 (33.3%) for blood culture confirmed cases. The age group between 11–20 years (40%) had the highest co-infection rate. This may be due to increased outdoor activities, occupational exposure, poor food hygiene practices, and lower immunity compared to older adults. The lower prevalence in the 51–60 years age group may reflect acquired immunity or reduced exposure.

Most of the participants are urban residents. This urban predominance could be linked to overcrowding, poor waste disposal, and higher transmission rates in densely populated areas. Most participants had formal education, 87.1%, and were married, 56.5%, reflecting the demographic profile of individuals within the productive age group.

Conclusion

Overall, the study demonstrates the high prevalence of malaria and typhoid in Gwagwalada, FCT and shows that it's of public health importance. It also shows that malaria and typhoid fever is a significant co-pathogen among febrile

patients. The discrepancy between Widal and culture, the high co-infection rate, and the concentration of cases among young urban adults have important implications for diagnosis and treatment. Reliance on clinical diagnosis alone in malaria-endemic areas may lead to over-treatment of malaria and under-treatment of typhoid.

The findings therefore call for the need for integrated febrile illness management that includes screening for both malaria and typhoid, especially in young adults. Blood culture should be encouraged in our healthcare facilities where possible, and public health efforts should focus on sanitation, health education, and targeted interventions in urban and youth populations.

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Author Contributions

All authors contributed equally to the research, approved the final manuscript and gave their consent for submission.

Conflict of interest

The authors declare no conflict of interest.

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