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Malaria and Typhoid Co-infection among Patients Attending Health Facilities in Bauchi North, Bauchi State Nigeria

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Abstract

Malaria and typhoid fever are among the most prevalent infectious diseases in tropical and subtropical regions, often co-existing in a single patient and complicating diagnosis, treatment, and management. The co-infection is influenced by various socioeconomic, environmental, and behavioral factors, resulting in increased morbidity and, in severe cases, mortality. This study aimed to assess the prevalence of malaria and typhoid co-infection and identify associated risk factors among patients attending health facilities in Bauchi North, Nigeria. A total of 300 blood samples were collected from patients at Extreme Hospital, Azare, Bauchi North. Malaria diagnosis was conducted using microscopy with Giemsa-stained thick blood films, while typhoid was diagnosed using the Widal test. The overall prevalence of malaria and typhoid co-infection was 38%, with the highest rate observed among females (24%) and adults aged 25–64 years. No cases were recorded among elderly individuals aged 65 years and above. A higher prevalence was found in rural areas (25.33%) and among middle-income groups (19%). Among all risk factors examined, only the residence of the patients showed a statistically significant association with co-infection. This study highlights the substantial burden of malaria and typhoid co-infection in Bauchi North, emphasizing the role of residence as a critical risk factor. The findings highlighted the need for tailored public health interventions, particularly in rural areas, to reduce the prevalence of these co-infections.

Keywords: Azare, Co-infection, Extreme, Hospital, Prevalence, Widal

INTRODUCTION

Malaria is a severe and potentially fatal illness caused by protozoan parasites from the *Plasmodium* genus, which are transmitted via the bites of infected female anopheles mosquitoes (Antonio-Nkondjio *et al*., 2019; Mohammed *et al*., 2020). This disease is a major cause of child mortality and contributes to economic challenges for low-income households. Common symptoms of malaria include fever, fatigue, vomiting, and headaches, with severe cases leading to jaundice, seizures, coma, or death (Mohammed *et al*., 2020). In 2018, the World Health Organization (WHO) reported approximately 228 million malaria cases and 405,000 related deaths, with 93.8% of these fatalities occurring in sub-Saharan Africa (Sale *et al*., 2020). The most severe infections are due to *Plasmodium falciparum*, the deadliest of the four malaria parasites affecting humans (Simon-Oke and Akinbote, 2020).

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Typhoid fever, on the other hand, is an acute systemic disease caused by the bacterium *Salmonella typhi*, which is Gram-negative and oxidase-negative (Mohammed *et al*., 2020). This illness is primarily spread through the consumption of contaminated food and water. Globally, around 33 million cases of typhoid fever are reported each year, resulting in approximately 216,000 deaths, predominantly in endemic regions (Mohammed *et al*., 2020). Outbreaks are common in sub-Saharan Africa and parts of Southeast Asia (WHO, 2016). The WHO has highlighted typhoid fever as a significant public health concern, especially affecting children, young adults, and pregnant women (WHO, 2016). The infection's hallmark symptom is a gradually increasing fever, accompanied by lethargy, skin rashes, loss of appetite, constipation, abdominal pain, diarrhoea, hepatosplenomegaly, bradycardia, and headaches (Ubengama *et al*., 2019).

In resource-limited settings within developing countries, co-morbidity of significant diseases such as malaria and typhoid fever is common and closely linked to poverty and underdevelopment, resulting in significant illnesses and death in areas with warm, humid climates, inadequate sanitation, poverty, and limited public awareness. Studies on the co-infection of malaria and typhoid fever have been conducted in various African countries, including Nigeria, Zambia, Burkina Faso, and Cameroon (Mawili-Mboumba *et al*., 2013; Ogah *et al*., 2013; Chilongola *et al*., 2018). Co-infection with both diseases can complicate diagnosis, treatment, and management, leading to increased morbidity and, in some cases, mortality (Mohammed *et al*., 2020). The co-existence of these diseases in a single patient may also be influenced by socioeconomic, environmental, and behavioral factors (Chilongola *et al*., 2018). Despite prior studies, detailed data on the co-infection of malaria and typhoid in Bauchi North remains limited. This study aimed to provide updated epidemiological data on malaria and typhoid co-infection within the population of Bauchi North, Bauchi state Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted at Extreme Hospital Azare Bauchi State. It is one of the standard secondary medical centers in the state, providing several kinds of medications and treatments. The hospital is located at State Low-cost, along Kano-Maiduguri By-pass Azare Bauchi state Nigeria.

Azare is the headquarter of Katagum zone (Bauchi North), Bauchi Sate of Nigeria. It was founded by Mallam Zaki who received his flag office from Shehu Usman Danfodio in the year 1814. It is bounded to the east by Damban LGA and Potiskum Yobe State and to the south by Misau Local Government, in the west by Jama'are Local Government, and to the north by Itas/Gadau Local Government Area of Bauchi State. It is located at 11040'27"N 10011'28E coordinates: 11040'27"N1001128E. Bauchi North consisted of seven local governments, including Gamawa, Giade, Itas-Gadau, Jama'are, Katagum, Shira, and Zaki local governments. The nearby local governments in the region include Misau and Dambam in Bauchi central, Gwaram, Buji, Kiyawa, and Hadejia in Jigawa satae. (Aliyu, 2015).

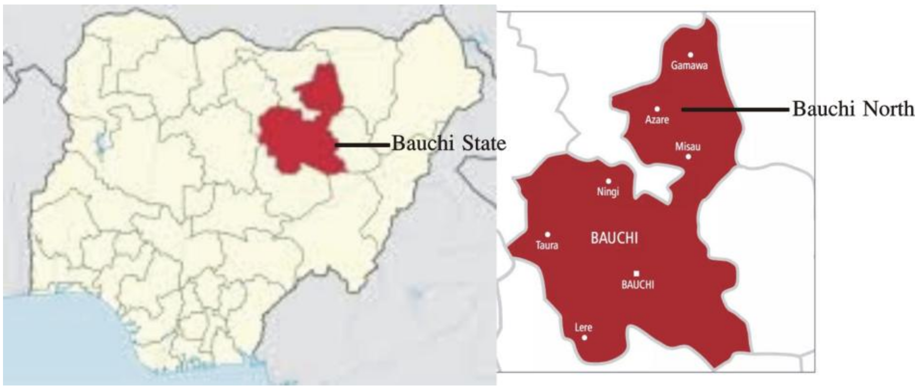

Figure 1: Map of Bauchi state showing the study area

Study Design and Population

A cross-sectional descriptive study was conducted among patients attending Extreme Hospital Azare, Bauchi North, Bauchi State Nigeria. The study population comprised patients attending this hospital with suspected cases of malaria and/or typhoid fever. All patients with no sign and symptoms of the infection, or not willing to participate in the study were excluded.

Sample Size Determination

The sample size was calculated using a standard formula for cross-sectional studies (Cochran's formula)

$n = z^2p (1-p) / d^2$

where: "n" is the minimum sample size, "z" is 1.96 for the 95% confidence level, "p" is the prevalence (20.9%) from the previous study by Sule *et al*. (2024). "d" is precision (5%) for the current study. Therefore, 300 patients attending Extreme Hospital Azare, Bauchi North, Bauchi State were enrolled for the study.

Ethical Approval

Ethical approval bearing reference number EHA/11/07/24/02 was sought and obtained from research and ethics committee of Extreme Hospital Azare, Bauchi North, Bauchi State Nigeria.

Sample Collection

For this study, three hundred (300) blood samples were collected from the patients to test for the presence of malaria and typhoid pathogens. Meanwhile, structured questionnaires were administered to collect data on the demography of the patients and the risk factors of the infection.

Laboratory Examination of the Blood Samples

Thick blood films were prepared to detect the malaria parasite. A drop of blood was placed in the center of clean slides, spread with a spreader to create thick blood smears, and allowed to air-dry. Subsequently, the smears were stained using 10% Giemsa stain for about ten minutes. The slides were then washed, air dried, and examined microscopically under an oil immersion objective lens using x40 and x100 magnifications. Presence of trophozoites, schizonts or gametocytes which appear dark-blue on a light-blue background indicated positive result (Iwuafor *et al*., 2016).

Widal agglutination test was done by dropping 50µL of the serum from each sample into eight separate circles on a plastic test slide. Equal volumes of positive control serum and normal saline were dropped in the final two circles on the slide. A drop of each of the Widal test antigens were added and mixed with the serum and each of the negative and positive controls in the corresponding circles on the test slide. Agglutination was observed after rocking the slide for five minutes (Buckle *et al*. 2012).

RESULTS

The overall prevalence of malaria and typhoid co-infection recorded in the current study was 38%. The prevalence on the gender basis was found to be 24% and 14% among female and males respectively. On the age basis, the prevalence of 3% was seen among children aged 0-9years, 4% among adolescents aged 10-19years, 7% among young adults aged 20-24 years, 24% among adults aged 25-64years, but none of the elderly individuals aged 65 years and above was found with the infection (Figure 2).

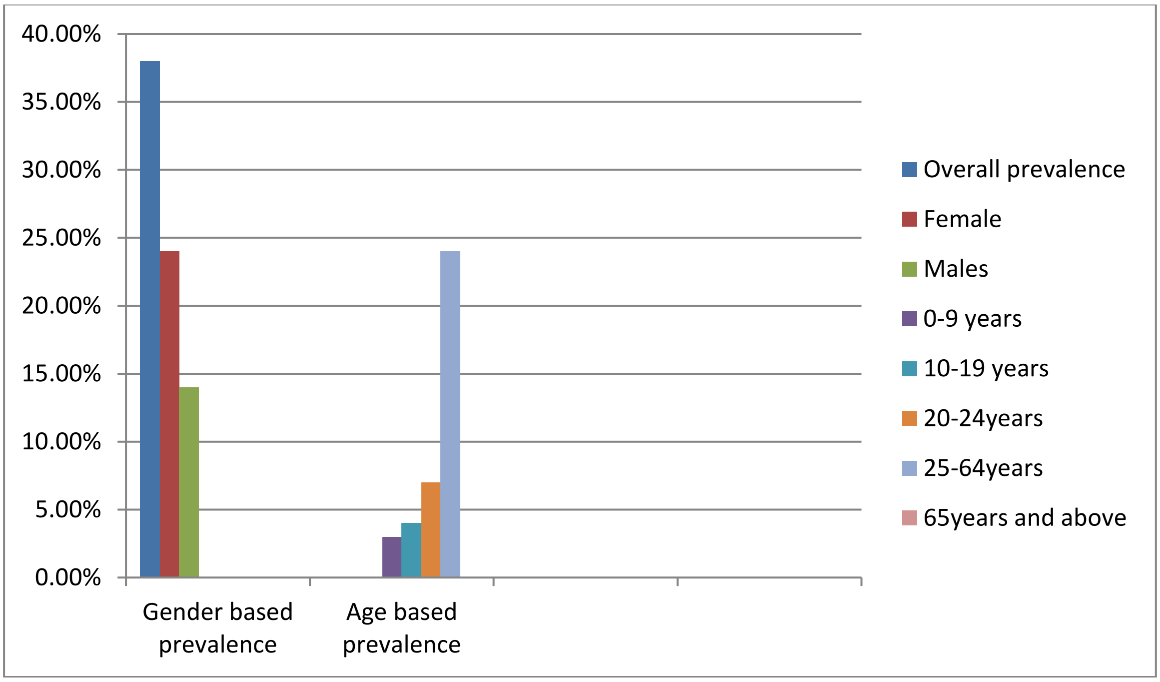

Figure 2: Prevalence of the co-infection in relation to gender and age of the patients attending Extreme Hospital Azare

According to the risk factors of the infection, higher prevalence (25.33%) was recorded in rural than the urban areas (12.67%). The prevalence of 12%, 19% and 7% were noticed among patients from low income, middle income and high income groups respectively. High prevalence (27.67%) was also seen among the patients who had fever two weeks before the study, and 10.33% was recorded among those who had not. Similarly, higher prevalence (25%) was noticed among those who were using net, and 13% among those who were not. Furthermore, higher prevalence (25.67%) was seen among those who were not treating water before drinking, and 12.33% among those who were treating. The prevalence of 14.33% was seen among patients who travelled out of Bauchi state two weeks before the study, and 23.67% among those had not. Also, the prevalence of the infection among those having a patient in their household, and those who have not, were 22% and 16% respectively. High prevalence (23%) was recorded among patients who visited health care facilities for fever medication 2 weeks before the study, and 15% among those who did not. The prevalence of 10%, 26%, 1.33%, and 0.67% were noticed among patients who were using well, tap, river and bottled water as drinking respectively. Lastly, the prevalence of 16% and 22% were seen among patients who consumed contaminated food and those who did not respectively (Table 1).

Table 1: Logistic regression analyses for the risk factors associated with the co-infection

Variables	Positive	Negative	Total	Prevalence (%)	COR(CI 95%)	AOR
Residence						
Rural	76	148	224	25.33	2.056(1.206-3.503)*	
Urban	38	38	76	12.67	1	
Socioeconomic status						
Low income	36	71	107	12.00	2.071(0.996-4.306)	
Middle class	57	95	152	19.00	1.713(0.855-3.434)	
High class	21	20	41	7.00	1	
Fever in past 2 weeks						
Yes	83	126	209	27.67	0.811(0.484-1.360)	
No	31	60	91	10.33	1	
Use of net						
Yes	75	121	196	25.00	0.952(0.583-1.556)	
No	39	65	104	13.00	1	
Travelling in past 2 weeks						
Yes	43	65	108	14.33	0.902(0.556-1.464)	
No	71	121	192	23.67	1	
Patients in the house						
Yes	66	125	191	22.00	1.541(0.950-2.500)	
No	48	61	109	16.00	1	
Visit to HCF in past 2 weeks						
Yes	69	95	164	23.00	0.667(0.415-1.071)	
No	45	91	136	15.00	1	
Water treatment						
Yes	37	60	97	12.33	0.958(0.581-1.580)	
No	77	126	203	25.67	1	
Source of drinking water						
Well	30	68	98	10.00	0.550(0.110-2.747)	
Tap	78	108	186	26.00	0.346(0.072-1.675)	
River and others	4	2	6	1.33	0.125(0.013-1.245)	
Bottled water	2	8	10	0.67	1	
Consumption of contaminated food, vegetables or fruits						
Yes	48	88	136	16.00	1.260(0.787-2.019)	
No	66	98	164	22.00	1	

COR: Crude odds ratio, CI: Confidence interval, "*": significant at 0.05 level of significance

From the results for the logistics regression analysis, the crude odds ratio (COR) and confidence interval (CI) for the males were [COR(CI 95%): 2.056(1.206-3.503)]. Also, [COR(CI 95%): 2.071(0.996-4.306)] and [COR(CI 95%):1.713(0.855-3.434)] were recoded among low and middle-income groups respectively. Similarly, [COR(CI 95%): 0.811(0.484-1.360)] were seen among those who had fever 2 weeks before the study. Among those who were using net, [COR(CI 95%):0.952(0.583-1.556)] were noticed. For the patients who travelled out of Bauchi state, [COR(CI 95%): 0.902(0.556-1.464)] were recorded. Also, [COR(CI 95%): 1.541(0.950-

2.500)] and [COR(CI 95%): 0.667(0.415-1.071)] were seen among those living with a fever patient in their household, and those who visited healthcare facilities for fever medication respectively. For those from rural areas, [COR(CI 95%): 2.056(1.206-3.503)] were noticed. For the source of drinking water, [COR(CI 95%): 0.550(0.110-2.747)] were recorded among those using well as source of drinking water, [COR(CI 95%): 0.346(0.072-1.675)] among those using tap, and [COR(CI 95%): 0.125(0.013-1.245)] among those using river. Also, [COR(CI 95%): 0.958(0.581-1.580)] were recorded among those who were treating water before drinking. Finally, [COR(CI 95%): 1.260(0.787-2.019)} were noticed among those who consumed contaminated food (Table 1). No adjusted odds ratio was calculated as only residence of patients was found statistically associated with malaria and typhoid co-infection in the study area.

DISCUSSION

The overall prevalence of malaria and typhoid co-infection was 38% among patients attending the selected healthcare facility in Bauchi North, Bauchi State, Nigeria. This prevalence is notably higher than the findings of Francky *et al*. (2023) (30.3%), Igiri *et al*. (2018) (22.7%), and Sule *et al*. (2024) (20.9%), but comparable to that reported by Odikamnoro *et al*. (2017) (36.2%) and Sangare *et al*. (2021) (34.3%). However, it significantly exceeded the 14.36% prevalence recorded by Ekesiobo *et al*. (2008). These variations in prevalence might be attributed to differences in study locations, sample sizes, diagnostic methods, or socio-environmental factors such as access to clean water and healthcare.

Gender analysis in this study revealed a higher prevalence of co-infection among females (24%) compared to males (14%). This finding aligns with the reports of Francky *et al*. (2023) and Sule *et al*. (2024), who also observed higher prevalence among females. However, it contrasts with the findings of Simon-Oke and Akinbote, (2020) who reported a higher prevalence among males. The gender disparity in this study could be influenced by socio-cultural factors, such as differing exposure to infected vectors or water sources, and health-seeking behaviors that may predispose females to greater risk.

Regarding age, the prevalence was highest among adults aged 25–64 years (24%), followed by young adults aged 20–24 years (7%), adolescents aged 10–19 years (4%), and children aged 0–9 years (3%). Interestingly, no co-infections were recorded among the elderly aged 65 years and above. The high prevalence among adults aligns with the findings of Okere *et al.* (2015) and Simon-Oke and Akinbote. (2020), who reported high prevalence among young and middle-aged adults. However, it differs from the reports of Francky *et al.* (2023), who observed a higher prevalence among children, and Sule *et al*. (2024), who noted the highest prevalence among elderly individuals. The elevated prevalence among adults in this study may reflect their increased occupational exposure, particularly in agricultural or outdoor activities, where contact with vectors is higher. The absence of co-infection among elderly individuals could be due to lower outdoor exposure, improved immunity from previous infections, or smaller sample sizes in this age group. Conversely, the relatively low prevalence among children and adolescents may be due to limited exposure to risk factors or early treatment interventions for febrile illnesses.

Also, a higher prevalence of the infection was observed in rural areas (25.33%) compared to urban areas (12.67%). This observation aligns with the reports of Onyido *et al*. (2014) and Sahar Traoré *et al*. (2015), who also found a higher prevalence in rural regions. The disparity between rural and urban areas may be attributed to inadequate access to clean water, poor sanitation, and limited healthcare services in rural settings, all of which increase the risk of infections.

The study also identified socioeconomic status as a significant factor, with the highest prevalence among individuals from middle-income families (19%), followed by low-income (12%) and high-income families (7%). These findings partially align with Onyido *et al*. (2014) and Sahar Traoré *et al*. (2015), who reported a higher prevalence among low-income groups. The relatively high prevalence among middle-income families in this study could reflect differential exposure to risk factors, such as occupational or environmental conditions, or differences in access to preventive measures. Also, low-income group might have no access to the healthcare facilities due to poverty, therefore, their health status might not be known.
Patients who had a fever two weeks before the study exhibited a significantly higher prevalence (27.67%) than those who did not experience fever (10.33%). This supports the understanding that fever is a hallmark symptom of malaria and typhoid co-infection, often indicating active or recent infection. Interestingly, higher prevalence was recorded among individuals who reported using bed nets (25%) compared to those who did not (13%). While counterintuitive, this might reflect improper use of bed nets or external factors, such as the quality or condition of the nets.

Water treatment and source were also critical factors. A significantly higher prevalence (25.67%) was recorded among those who did not treat their drinking water compared to those who did (12.33%). Additionally, individuals using river water (1.33%) and well water (26%) as drinking sources exhibited higher prevalence than those using tap water (10%) or bottled water (0.67%). These findings align with Odikamnoro *et al*. (2017), who associated high prevalence of co-infection with the use of untreated well and river water. This underscores the importance of improving access to safe drinking water and promoting water treatment practices.

The study also highlighted insignificant role of travel history, with a lower prevalence (14.33%) among individuals who had traveled outside Bauchi State within two weeks before the study compared to those who had not (23.67%). This indicated that, the patients have acquired the infection at their living environments. Similarly, individuals living with infected patients exhibited a higher prevalence (22%) than those who did not (16%), suggesting the potential for intra-household transmission or shared environmental risk factors. Lastly, a higher prevalence (22%) was recorded among patients who consumed uncontaminated food compared to those who consumed contaminated food (16%). This finding contradicts conventional expectations, possibly due to inaccuracies in self-reported dietary habits or other confounding factors. Statistically, all of the risk factors assessed in the study were not significantly associated with the co-infection in the study population.

On the other hand, the logistic regression analysis results indicated that, all of the risk factors analyzed were not statistically influencing the likelihood of the development and spread of the co-infection in the study population, except for the residence of the patients, where individuals from rural areas were 2 times more likely to develop the infection than those from urban areas.

CONCLUSION

This study revealed a significant prevalence of malaria and typhoid co-infection among patients attending the selected healthcare facility in Bauchi North, with higher rates observed in females, adults aged 25–64 years, and rural residents. The findings underscore the critical role of residence as a key risk factor, highlighting the need for targeted public health interventions in rural communities. Addressing the burden of malaria and typhoid co-infection requires integrated diagnostic, preventive, and management strategies tailored to the socioeconomic and environmental contexts of affected populations. This research provided valuable insights to guide policy development and resource allocation for improved healthcare outcomes in the region.

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