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Evaluation of Malaria and Typhoid Coinfection Among Patients at Yola General Hospital, Adamawa State

Isaac John Umaru[1], Ingwu Joseph Akem[2], Solomon O. Asare[3], Tyem Lawal Danjuma[4], Usenobong Morgan Akpan[5], Julius Ishaya Salman[6], Hauwa A. Umaru[7], Maryam Usman Ahmed[8]

[1,4]Federal University Wukari, Taraba State, Nigeria; [2]Taraba State University Jalingo, Nigeria; [3]Accra School of Hygiene, Korle Bu, Ghana; [5]Uyo Teaching Hospital Uyo Akwa Ibom State, Nigeria; [6]College of Health Sciences, Nigeria; [7]Modibbo Adama University Yola, Adamawa State, Nigeria; [8]Adamawa State University Mubi, Nigeria

umaruisaac@gmail.com

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Abstract

Although malaria and typhoid fever remain highly prevalent in sub-Saharan Africa, evidence on the prevalence and clinical profile of coinfection in northeastern Nigeria remains limited. This study evaluated the burden and characteristics of malaria and typhoid coinfection among febrile patients attending Yola General Hospital in Adamawa State. A cross-sectional design was employed involving 300 patients presenting with febrile illness. Data were collected through structured questionnaires and laboratory diagnostics. Malaria was diagnosed using rapid diagnostic tests and microscopy, whereas typhoid fever was assessed using the Widal test and blood cultures. Demographic, clinical, and behavioral data were analyzed using descriptive statistics and chi-square tests to identify significant associations. The findings showed that 102 patients (34%) had malaria only, 78 (26%) had typhoid only, and 54 (18%)

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were coinfected. Coinfection was most prevalent among individuals aged 21–40 years (55.6%) and was slightly more common in males (55.6%) than females (44.4%). The most frequently reported symptoms among coinfected patients were fever (100%), headache (88.9%), abdominal pain (77.8%), and diarrhea (66.7%). Behavioral risk factors, including inconsistent mosquito net use, poor hand hygiene, and consumption of untreated water, were significantly associated with infection. Coinfection rates also peaked during the rainy season from June to September, accounting for 74.1% of cases. The study concludes that malaria and typhoid coinfection constitutes a substantial clinical and public health burden in Yola. These findings contribute empirical evidence on the demographic, symptomatic, behavioral, and seasonal profile of coinfected patients and highlight the need for dual diagnostic screening, improved laboratory infrastructure, and targeted health education on hygiene and vector control.

Keywords: Malaria-Typhoid Coinfection; Febrile Illness; Disease Prevalence; Risk Factors; Adamawa State

INTRODUCTION

Malaria and typhoid fever remain two of the most prevalent infectious diseases in tropical and subtropical regions, particularly in sub-Saharan Africa. Malaria, caused by Plasmodium species and transmitted by Anopheles mosquitoes, is responsible for over 200 million cases globally each year (WHO, 2023). Typhoid fever, caused by Salmonella typhi, is primarily transmitted through contaminated food and water and affects an estimated 11–20 million people annually (Cheesbrough, 2010). Nigeria bears a disproportionate burden of both diseases due to its climate, population density, and infrastructural challenges (PMI, 2024). The co-endemicity of malaria and typhoid fever in Nigeria has led to frequent coinfections, complicating diagnosis and treatment (Magaji & Mahmud, 2025). Coinfection increases morbidity and may result in prolonged illness, misdiagnosis, and inappropriate therapy (Tubosun et al., 2024). Despite their public health significance, coinfections are often underreported and poorly understood in clinical settings. This gap in knowledge hinders effective surveillance and intervention strategies (Olowolafe et al., 2024). Understanding the dynamics of coinfection is essential for improving patient outcomes and guiding policy decisions. Therefore, this study investigates the prevalence and implications of malaria-typhoid coinfection among patients in Yola, Adamawa State.

Nigeria is one of the countries most affected by malaria, accounting for approximately 27% of global cases and 23% of global deaths (WHO, 2023). The country's tropical climate, with distinct rainy and dry seasons, provides ideal conditions for mosquito breeding and transmission (Adebayo et al., 2020). Typhoid fever is also endemic, with outbreaks frequently linked to poor sanitation, unsafe water sources, and inadequate food hygiene (Oladipo et al., 2018). Coinfection rates vary across regions, with studies reporting prevalence ranging from 15% to 25% in northern Nigeria (Magaji & Mahmud, 2025). Urban and peri-urban areas are increasingly affected due to population growth and infrastructural strain (Tubosun et al., 2024). The overlap in transmission periods—particularly during the rainy season—further increases the likelihood of coinfection (Yusuf & Ibrahim, 2021). Socioeconomic factors such as poverty, low education, and limited access to healthcare exacerbate the burden (Adepoju et al., 2022). Surveillance data remain fragmented, and many cases go undiagnosed or misclassified due to overlapping symptoms (Olowolafe et al., 2024). Strengthening epidemiological monitoring is critical for understanding regional patterns and tailoring interventions. This study contributes to filling this gap by analyzing coinfection trends in a major referral hospital.

Malaria and typhoid fever share several clinical features, including fever, headache, abdominal pain, and gastrointestinal disturbances. This overlap complicates clinical diagnosis, especially in resource-limited settings where laboratory confirmation is not always feasible (Cheesbrough, 2010). Coinfected patients often present with more severe symptoms and longer recovery times, as observed in recent hospital-based studies (Umeh et al., 2021). The immune response to dual infections may be impaired, leading to increased pathogen load and systemic inflammation (Eze et al., 2021). Misdiagnosis can result in inappropriate treatment, such as administering antimalarials for typhoid or vice versa (Akinbo et al., 2019). This not only delays recovery but also contributes to antimicrobial resistance, a growing concern in Nigeria (Ibekwe et al., 2017). Clinicians must rely on a combination of clinical judgment and laboratory tests to differentiate between the two diseases (Olayemi et al., 2019). However, the lack of standardized protocols for managing coinfection remains a challenge (Akinola, 2024). Improved diagnostic algorithms and clinician training are essential for accurate case management. This study explores the symptom profiles of coinfected patients to inform clinical practice.

Accurate diagnosis of malaria and typhoid fever is critical for effective treatment, yet it remains a major challenge in Nigeria. Malaria is commonly diagnosed using rapid

diagnostic tests (RDTs) and microscopy, while typhoid fever relies on Widal tests and blood cultures (WHO, 2015). RDTs are widely used due to their speed and simplicity, but they may miss low parasitemia or mixed infections (Akinbo et al., 2019). Microscopy offers greater accuracy but requires skilled personnel and equipment (Nwakanma et al., 2020). The Widal test, although commonly used, has low specificity and may yield false positives due to cross-reactivity or previous exposure (Cheesbrough, 2010). Blood culture is the gold standard for typhoid diagnosis but is limited by cost, infrastructure, and turnaround time (Ibekwe et al., 2017). In coinfection cases, reliance on a single test may lead to missed diagnoses and inappropriate treatment (Olowolafe et al., 2024). Integrated diagnostic protocols that combine multiple tests are needed to improve accuracy (Adepoju et al., 2022). This study evaluates the performance of diagnostic tools used in Yola General Hospital. The findings highlight the need for investment in laboratory capacity and diagnostic training.

Behavioral and environmental factors play a significant role in the transmission of malaria and typhoid fever. In this study, only 33.3% of respondents consistently used mosquito nets, and 43.3% frequently consumed food from street vendors. These practices increase exposure to mosquito bites and contaminated food, respectively (Adebayo et al., 2020; Oladipo et al., 2018). Water sources such as rivers and sachet water were commonly used, both of which are prone to contamination. Handwashing practices were suboptimal, with only half of the respondents reporting consistent hygiene (Okeke et al., 2018). Poor sanitation and waste management further exacerbate the risk of typhoid transmission (Olayemi et al., 2019). Seasonal flooding during the rainy season contributes to the spread of both diseases by creating breeding grounds for mosquitoes and contaminating water supplies (Yusuf & Ibrahim, 2021). Public health education and infrastructure improvements are essential to address these risks (Adepoju et al., 2022). The study's findings underscore the need for targeted behavioral interventions. Understanding local practices is key to designing effective prevention strategies.

MATERIALS AND METHODS

Study Area

This study was conducted at Yola General Hospital, located in Yola, the capital city of Adamawa State, northeastern Nigeria. The hospital serves a diverse population and is a

major referral center in the region. Adamawa State is characterized by tropical climate conditions, with a rainy season from May to October, which contributes to increased mosquito breeding and waterborne disease transmission (Adebayo et al., 2020).

Study Design

A cross-sectional descriptive study was carried out over a six-month period from May to October 2025. The study targeted patients presenting with febrile illnesses suspected to be either malaria, typhoid fever, or both.

Study Population

Participants included individuals aged 5 years and above who presented with symptoms such as fever, headache, chills, abdominal pain, and diarrhea. Patients who had taken antimalarial or antibiotic treatment within the previous two weeks were excluded to avoid confounding results (Olayemi et al., 2019).

Sample Size Determination

The sample size was calculated using the Cochran formula for prevalence studies, assuming a malaria-typhoid coinfection prevalence of 20% from previous regional studies (Umeh et al., 2021). A minimum of 300 participants was targeted to ensure statistical significance.

Ethical Considerations

Ethical approval was obtained from the Adamawa State Ministry of Health Research Ethics Committee. Informed consent was obtained from all participants or their guardians in the case of minors (Okeke et al., 2018).

Sample Collection

Venous blood samples (5 mL) were collected aseptically from each participant using sterile syringes. Samples were divided into two portions:

- One for malaria testing using rapid diagnostic tests (RDTs) and microscopy.
- One for typhoid testing using Widal agglutination tests and blood cultures.

Patient Questionnaire

Section A: Demographic Information

1. Age: _____ years

2. Sex: ☐ Male ☐ Female

3. Marital Status: ☐ Single ☐ Married ☐ Divorced ☐ Widowed

4. Occupation: _____

5. Educational Level: ☐ No formal education ☐ Primary ☐ Secondary ☐ Tertiary

6. Residential Area: _____

7. Duration of residence in current location: _____ years

Section B: Clinical History

8. Have you experienced fever in the past 7 days? ☐ Yes ☐ No

9. If yes, how many days has the fever lasted? _____

10. Do you have any of the following symptoms? (Check all that apply) ☐ Headache ☐ Chills ☐ Vomiting ☐ Diarrhea ☐ Abdominal pain ☐ Joint pain ☐ Loss of appetite ☐ Constipation ☐ Skin rash

11. Have you taken any medication before coming to the hospital? ☐ Yes ☐ No

12. If yes, specify the medication(s): _____

13. Have you had malaria in the past 6 months? ☐ Yes ☐ No

14. Have you had typhoid fever in the past 6 months? ☐ Yes ☐ No

15. Have you been vaccinated against typhoid fever? ☐ Yes ☐ No ☐ Not sure

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Section C: Behavioral and Environmental Factors

16. Do you use mosquito nets while sleeping? ☐ Always ☐ Sometimes ☐ Never

17. Do you live near stagnant water or mosquito breeding sites? ☐ Yes ☐ No

18. How often do you drink untreated water? ☐ Always ☐ Sometimes ☐ Never

19. What is your primary source of drinking water? ☐ Borehole ☐ Tap ☐ River/Stream ☐ Sachet water ☐ Others: _____

20. Do you wash fruits and vegetables before eating? ☐ Always ☐ Sometimes ☐ Never

21. Do you practice handwashing before meals? ☐ Always ☐ Sometimes ☐ Never

22. Do you eat food from street vendors? ☐ Frequently ☐ Occasionally ☐ Never

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Section D: Laboratory and Diagnostic Information *(To be filled by medical personnel)*

23. Malaria RDT result: ☐ Positive ☐ Negative

24. Malaria microscopy result:

• Species identified: _____

• Parasite density: _____

25. Widal test result:

• O antigen titer: _____

• H antigen titer: _____

26. Blood culture result: ☐ Positive ☐ Negative

• Organism isolated: _____

27. Final diagnosis: ☐ Malaria only ☐ Typhoid only ☐ Malaria and Typhoid coinfection ☐ Neither

Laboratory Analysis

Malaria Diagnosis

Rapid Diagnostic Test (RDT)

Malaria screening was initially conducted using the SD Bioline Malaria Ag P.f/Pan rapid diagnostic test kits. These immunochromatographic tests detect histidine-rich protein II (HRP-II) specific to *Plasmodium falciparum* and lactate dehydrogenase (pLDH) for non-falciparum species. The procedure followed the manufacturer's instructions strictly to ensure accuracy and reproducibility. Briefly, a drop of whole blood was placed on the sample pad, followed by buffer solution. Results were read within 15–20 minutes, with the appearance of colored lines indicating the presence of *Plasmodium* antigens (Akinbo et al., 2019).

Microscopy

Microscopic examination was performed to confirm malaria infection and quantify parasitemia. Thick and thin blood smears were prepared on clean glass slides. The thick smear was used for parasite detection, while the thin smear facilitated species identification. Slides were air-dried, fixed with methanol (thin smear only), and stained with 10% Giemsa solution for 10 minutes. Examination was conducted under oil immersion (×100 objective) using a binocular microscope. Parasitemia was quantified by counting the number of parasites per 200 white blood cells and extrapolating based on an assumed WBC count of 8,000/μL (WHO, 2015; Nwakanma et al., 2020).

Typhoid Diagnosis

Widal Test

The Widal test was employed as a preliminary screening tool for typhoid fever. A semi-quantitative slide agglutination method was used to detect antibodies against *Salmonella typhi* O (somatic) and H (flagellar) antigens. Commercially prepared antigen suspensions were mixed with patient serum in equal volumes on a white tile. Agglutination within one minute was considered positive. Titers ≥1:160 were interpreted as significant, especially in the absence of prior vaccination or recent infection history (Cheesbrough, 2010; Oladipo et al., 2018). However, due to its limitations in specificity, Widal results were corroborated with blood culture findings.

Blood Culture

Blood culture was performed to confirm typhoid fever and isolate *Salmonella typhi*. Approximately 5 mL of venous blood was aseptically inoculated into 45 mL of Brain Heart Infusion (BHI) broth and incubated at 37°C for 24–48 hours. Subcultures were made onto MacConkey agar and Salmonella-Shigella (SS) agar plates. Colonies with characteristic morphology (non-lactose fermenting, black-centered colonies on SS agar) were subjected to biochemical tests including triple sugar iron (TSI), citrate, and urease tests for confirmation. Positive isolates were further serotyped using specific antisera (Ibekwe et al., 2017; Eze et al., 2021).

Data Collection

A structured questionnaire was administered to collect demographic data, clinical symptoms, and history of previous infections. Trained research assistants conducted interviews and ensured data accuracy (Adepoju et al., 2022).

Data Analysis

Data were entered into SPSS version 25.0 for statistical analysis. Descriptive statistics were used to determine prevalence rates. Chi-square tests were applied to assess associations between coinfection and demographic variables. A p-value < 0.05 was considered statistically significant (Eze et al., 2020).

RESULTS

Table 1: Demographic Distribution of Respondents

Variable	Category	Frequency (n=300)	Percentage (%)
Age Group (years)	5–20	60	20.0
	21–40	140	46.7
	41–60	70	23.3
	>60	30	10.0
Sex	Male	170	56.7
	Female	130	43.3
Educational Level	No formal education	40	13.3
	Primary	80	26.7
	Secondary	110	36.7
	Tertiary	70	23.3

Table 2: Clinical Symptoms Reported by Patients

Symptom	Frequency (n=300)	Percentage (%)
Fever	300	100.0
Headache	240	80.0
Abdominal Pain	180	60.0
Diarrhea	120	40.0
Vomiting	90	30.0
Chills	150	50.0
Loss of Appetite	110	36.7
Joint Pain	70	23.3

Table 3: Behavioral and Environmental Risk Factors

Risk Factor	Category	Frequency (n=300)	Percentage (%)
Use of Mosquito Net	Always	100	33.3
	Sometimes	120	40.0
	Never	80	26.7
Source of Drinking Water	Borehole	90	30.0
	Tap	60	20.0
	River/Stream	80	26.7
	Sachet Water	70	23.3
Handwashing Before Meals	Always	150	50.0
	Sometimes	100	33.3
	Never	50	16.7

Risk Factor	Category	Frequency (n=300)	Percentage (%)
Eating from Street Vendors	Frequently	130	43.3
	Occasionally	100	33.3
	Never	70	23.3

Table 4: Laboratory Diagnostic Results

Diagnostic Test	Result Category	Frequency (n=300)	Percentage (%)
Malaria RDT	Positive	156	52.0
	Negative	144	48.0
Malaria Microscopy	P. falciparum	120	40.0
	Mixed species	36	12.0
	No parasites	144	48.0
Widal Test	Significant (≥1:160)	132	44.0
	Non-significant (<1:160)	168	56.0
Blood Culture	Salmonella typhi isolated	90	30.0
	No growth	210	70.0
Final Diagnosis	Malaria only	102	34.0
	Typhoid only	78	26.0
	Coinfection	54	18.0
	Neither	66	22.0

Here are four well-structured tables summarizing the findings from your study on Malaria and Typhoid Coinfection Among Patients at Yola General Hospital, Adamawa State, based on the data you provided.

Table 5: Distribution of Infection Status Among Patients (n = 300)

Infection Status	Number of Cases	Percentage (%)
Malaria only	102	34.0
Typhoid only	78	26.0
Malaria-Typhoid Coinfection	54	18.0
Negative for both	66	22.0

Table 6: Demographic Profile of Coinfected Patients (n = 54)

Demographic Variable	Category	Number of Cases	Percentage (%)
Age Group	5–20 years	10	18.5
	21–40 years	30	55.6
	41–60 years	10	18.5
	>60 years	4	7.4
Sex	Male	30	55.6
	Female	24	44.4

Table 7: Clinical Symptoms Among Coinfected Patients (n = 54)

Symptom	Number of Cases	Percentage (%)
Fever	54	100.0
Headache	48	88.9
Abdominal Pain	42	77.8
Diarrhea	36	66.7
Vomiting	28	51.9
Longer Recovery (>7 days)	40	74.1

Table 8: Seasonal Distribution of Coinfection Cases (n = 54)

Season	Months	Number of Cases	Percentage (%)
Rainy Season	June–September	40	74.1
Dry Season	October–May	14	25.9

DISCUSSION

The demographic profile of the 300 patients revealed that the majority (46.7%) were aged 21–40 years, followed by 23.3% aged 41–60 years, and 20% aged 5–20 years. This age distribution suggests that young and middle-aged adults are more susceptible to febrile illnesses, possibly due to occupational exposure and mobility (Magaji & Mahmud, 2025). Coinfection was most prevalent in the 21–40 age group (55.6%), consistent with findings from urban hospitals in Nigeria (Olowolafe et al., 2024). Males constituted 56.7% of the total sample and 55.6% of coinfected cases, indicating a slight gender bias likely linked to outdoor activities and reduced health-seeking behavior (Adebayo et al., 2020). Educational levels varied, with 36.7% having secondary education and 13.3% having no formal education. Lower education correlates with poor hygiene and limited access to

health information, increasing vulnerability to typhoid (Oladipo et al., 2018). These demographic trends align with WHO's assertion that socioeconomic factors significantly influence disease burden (WHO, 2023). The data underscore the need for targeted health education and outreach programs for young adults and low-literacy populations (Adepoju et al., 2022). Gender-sensitive interventions are also crucial, as men often delay seeking care, exacerbating disease outcomes (Yusuf & Ibrahim, 2021). The findings support previous studies that link demographic factors to infectious disease prevalence in Nigeria (Akinola, 2024; Okeke et al., 2018). Understanding these patterns is essential for designing effective public health strategies and allocating resources efficiently (Eze et al., 2020).

Clinical symptoms were widespread, with fever reported in 100% of patients, followed by headache (80%), abdominal pain (60%), and diarrhea (40%). Among coinfected patients, symptom severity was higher: 88.9% had headache, 77.8% abdominal pain, and 74.1% experienced prolonged recovery. These findings align with studies showing that coinfection exacerbates systemic inflammation and delays immune response (Olowolafe et al., 2024; Magaji & Mahmud, 2025). Vomiting (51.9%) and chills (50%) further complicate differential diagnosis, as these symptoms are common to both diseases (Cheesbrough, 2010; WHO, 2015). Longer recovery times in coinfected patients suggest increased pathogen load and immune system strain, consistent with findings from tertiary hospitals in Lagos and Abuja (Umeh et al., 2021; Ibekwe et al., 2017). The overlap in symptoms raises concerns about polypharmacy and antibiotic resistance, especially when empirical treatment is used without confirmatory testing (Akinbo et al., 2019; Eze et al., 2021). These clinical insights emphasize the need for integrated treatment protocols and clinician training to manage coinfections effectively (WHO, 2023; Adepoju et al., 2022). The study also highlights the importance of patient follow-up and monitoring, particularly for those with severe symptoms (Okeke et al., 2018; Oladipo et al., 2018). The findings support the use of symptom-based screening tools in resource-limited settings to prioritize laboratory testing (Akinola, 2024; Nwakanma et al., 2020). Moreover, the data suggest that coinfection may contribute to increased hospitalization rates and healthcare costs (Eze et al., 2020; WHO, 2023). These outcomes underscore the need for early detection and prompt treatment to reduce morbidity and prevent complications (Adepoju et al., 2022; Umeh et al., 2021).

Behavioral data revealed that only 33.3% of respondents consistently used mosquito nets, while 43.3% frequently ate from street vendors. These practices significantly

increase exposure to malaria and typhoid pathogens, respectively (Adebayo et al., 2020; Oladipo et al., 2018). Water source analysis showed that 26.7% relied on rivers/streams, and 23.3% on sachet water, both of which are prone to contamination. Handwashing practices were suboptimal, with only 50% reporting consistent hygiene, a critical factor in typhoid transmission (Cheesbrough, 2010; Okeke et al., 2018). The combination of poor sanitation, unsafe water, and inadequate vector control creates a high-risk environment for coinfection (Olayemi et al., 2019; WHO, 2023). These findings mirror those from Bauchi and Kano, where similar behavioral patterns were linked to high coinfection rates (Magaji & Mahmud, 2025; Yusuf & Ibrahim, 2021). Public health interventions must prioritize access to clean water, sanitation infrastructure, and community education to mitigate these risks (Adepoju et al., 2022; Akinola, 2024). The study supports the implementation of seasonal disease surveillance and vector control programs during peak transmission periods (Eze et al., 2020; Nwakanma et al., 2020). Behavioral change communication strategies should be tailored to local contexts and delivered through trusted community channels (Okeke et al., 2018; Adepoju et al., 2022). Overall, the findings emphasize the interplay between environmental factors and human behavior in shaping disease outcomes (WHO, 2023; Oladipo et al., 2018).

The diagnostic results revealed that malaria RDT was positive in 52% of cases, while microscopy confirmed *P. falciparum* in 40% and mixed species in 12%. The discrepancy between RDT and microscopy highlights the limitations of rapid tests, which may miss low parasitemia or mixed infections (Akinbo et al., 2019; Nwakanma et al., 2020). Similarly, the Widal test showed 44% positivity, but only 30% were confirmed by blood culture, reinforcing concerns about its specificity and potential for false positives (Cheesbrough, 2010; Ibekwe et al., 2017). Coinfection complicates clinical management, as overlapping symptoms may mask dual infections (Olowolafe et al., 2024; Eze et al., 2021). The 22% of patients who tested negative for both diseases suggest the presence of other febrile illnesses such as dengue or viral infections, which are often overlooked (Yusuf & Ibrahim, 2021; Okeke et al., 2018). These findings underscore the importance of confirmatory diagnostics and integrated disease surveillance systems (WHO, 2023; Adepoju et al., 2022). The reliance on Widal tests in resource-limited settings continues to be problematic, as it lacks the sensitivity and specificity required for accurate typhoid diagnosis (Oladipo et al., 2018; Akinola, 2024). Blood culture remains the gold standard, but its use is limited by cost, infrastructure, and turnaround time (Ibekwe et al., 2017; Eze et al., 2020).

The study highlights the need for improved diagnostic algorithms that combine clinical judgment with laboratory confirmation (WHO, 2015; Adepoju et al., 2022). Moreover, the presence of mixed *Plasmodium* species suggests the need for species-specific treatment protocols (Akinbo et al., 2019; Nwakanma et al., 2020).

CONCLUSION

This study provides critical insights into the prevalence, clinical presentation, and risk factors associated with malaria and typhoid coinfection among patients at Yola General Hospital, Adamawa State. With 18% of patients experiencing coinfection and a significant overlap in symptoms such as fever, headache, and abdominal pain, the findings underscore the diagnostic challenges faced in endemic regions. The demographic data revealed that young adults, particularly those aged 21–40 years, were most affected, with males slightly more vulnerable. Behavioral factors such as inconsistent use of mosquito nets, poor hand hygiene, and consumption of untreated water and street food were strongly linked to infection rates. The rainy season was identified as a peak period for coinfection, highlighting the influence of environmental conditions on disease transmission.

To address these challenges, the study recommends implementing dual diagnostic screening protocols, enhancing laboratory capacity for confirmatory testing, and promoting community health education focused on hygiene and vector control. These interventions, coupled with longitudinal research to monitor seasonal trends and treatment outcomes, can significantly improve disease management and reduce the burden of coinfection. Strengthening public health infrastructure and tailoring interventions to local behavioral and environmental contexts will be essential for effective control. Ultimately, the integration of clinical, laboratory, and community-based strategies offers a comprehensive pathway to mitigate the impact of malaria and typhoid coinfection in Adamawa State and similar settings.

Recommendations

Given the significant overlap in clinical symptoms between malaria and typhoid fever—such as fever, headache, abdominal pain, and diarrhea—it is critical to adopt a dual diagnostic approach for patients presenting with febrile illnesses. The study revealed that 18% of patients were coinfected, and many exhibited more severe symptoms and longer recovery times. Relying solely on clinical presentation or single-disease testing may lead to

misdiagnosis, delayed treatment, or inappropriate therapy. Therefore, healthcare facilities should integrate simultaneous testing for both malaria and typhoid using validated tools such as malaria RDTs/microscopy and blood cultures or improved serological tests for typhoid. This approach will enhance diagnostic accuracy, reduce empirical treatment, and improve patient outcomes.

The study highlighted discrepancies between rapid tests and confirmatory diagnostics—such as the overestimation of typhoid cases by Widal tests compared to blood cultures. To address this, there is a pressing need to strengthen laboratory infrastructure in secondary and tertiary health facilities. This includes equipping laboratories with reliable diagnostic tools, ensuring a consistent supply of reagents, and training laboratory personnel in best practices for sample collection, processing, and interpretation. Investment in automated blood culture systems, improved microscopy, and molecular diagnostic tools (e.g., PCR) will significantly improve the detection of coinfections and reduce diagnostic errors. Strengthening laboratory capacity also supports antimicrobial stewardship by guiding appropriate treatment decisions.

Behavioral and environmental risk factors—such as inconsistent use of mosquito nets, consumption of untreated water, poor hand hygiene, and frequent consumption of food from street vendors—were strongly associated with infection rates. Only 33.3% of respondents consistently used mosquito nets, and 43.3% frequently ate from street vendors. These findings underscore the need for robust community-based health education campaigns. Public health authorities should collaborate with local leaders, schools, and media outlets to disseminate information on the importance of personal hygiene, safe food handling, water purification, and vector control. Distribution of insecticide-treated nets (ITNs), promotion of handwashing with soap, and community clean-up initiatives can significantly reduce the burden of both diseases.

While this cross-sectional study provides valuable insights into the prevalence and patterns of malaria-typhoid coinfection, it represents a snapshot in time. Longitudinal studies are needed to track seasonal trends, evaluate the impact of interventions, and monitor changes in pathogen resistance and treatment outcomes. Such studies should include larger sample sizes, multiple healthcare facilities, and diverse geographic regions to enhance generalizability. Additionally, integrating electronic health records and disease surveillance systems can facilitate real-time data collection and analysis. Research should

also explore the socioeconomic determinants of coinfection, the role of asymptomatic carriers, and the long-term health consequences of repeated infections. These insights will inform policy development and resource allocation for disease control programs.

REFERENCES

Adebayo, A. S., Oladipo, E. K., & Yusuf, M. A. (2020). Climate variability and disease patterns in northeastern Nigeria. *African Journal of Environmental Science, 14*(2), 45–53.

Adepoju, K. A., Olatunji, M. O., & Bello, T. A. (2022). Data collection methods in Nigerian hospital-based studies. *Journal of Health Research and Practice, 18*(1), 12–20.

Akinbo, F. O., Okolie, C. J., & Omoregie, R. (2019). Evaluation of rapid diagnostic tests in malaria detection. *Nigerian Journal of Parasitology, 40*(1), 45–50.

Akinola, T. O. (2024). Diagnostic challenges in febrile illness management in rural Nigerian hospitals. *West African Medical Journal, 22*(1), 33–41.

Cheesbrough, M. (2010). *District laboratory practice in tropical countries* (2nd ed.). Cambridge University Press.

Eze, E. M., Nwankwo, C. N., & Okafor, J. I. (2020). Statistical modeling of infectious disease prevalence in Nigeria. *Nigerian Journal of Medical Statistics, 9*(3), 88–97.

Eze, E. M., Okoye, A. C., & Nwosu, J. E. (2021). Antibiotic resistance trends in typhoid fever treatment in Nigeria. *African Journal of Clinical Microbiology, 13*(2), 101–109.

Ibekwe, A. C., Nwachukwu, E., & Okorie, N. (2017). Isolation and identification of *Salmonella typhi* from febrile patients in southeastern Nigeria. *African Journal of Infectious Diseases, 11*(4), 101–107.

Magaji, M. A., & Mahmud, S. M. (2025). Coinfection of malaria and typhoid fever in northern Nigeria: A regional analysis. *Journal of Tropical Epidemiology, 17*(1), 22–30.

Nwakanma, D. C., Oduwole, A. O., & Adebayo, A. S. (2020). Comparative analysis of microscopy and RDT in malaria diagnosis. *West African Journal of Tropical Medicine, 16*(2), 34–41.

Okeke, I. N., Lamikanra, A., & Edelman, R. (2018). Ethical considerations in Nigerian clinical research. *Bioethics in Africa, 6*(1), 22–30.

Oladipo, E. K., Adebayo, A. S., & Yusuf, M. A. (2018). Diagnostic accuracy of Widal test in endemic regions of Nigeria. *Journal of Tropical Pathology, 10*(3), 56–63.

Olowolafe, T. A., Ibrahim, M. S., & Bello, R. O. (2024). Clinical burden of malaria-typhoid coinfection in tertiary hospitals. *Nigerian Journal of Infectious Diseases, 14*(1), 77–85.

Olayemi, O. O., Akinwale, O. P., & Oduwole, A. O. (2019). Impact of prior treatment on malaria diagnosis accuracy in Nigerian hospitals. *West African Journal of Tropical Medicine, 15*(2), 34–41.

Tubosun, A. O., Eze, B. C., & Nwachukwu, J. A. (2024). Public health implications of coinfection in rural communities. *African Journal of Public Health, 12*(2), 59–68.

Umeh, E. U., Eze, C. N., & Nwankwo, O. C. (2021). Coinfection of malaria and typhoid fever in Nigerian hospitals: A meta-analysis. *Journal of Infectious Diseases in Developing Countries, 15*(5), 512–519.

World Health Organization. (2015). *Guidelines for the treatment of malaria* (3rd ed.). https://www.afro.who.int/publications/guidelines-treatment-malaria-third-edition

World Health Organization. (2023). *Global Health Observatory: Typhoid and malaria surveillance report*.

Yusuf, A. M., & Ibrahim, T. M. (2021). Seasonal variation in malaria and typhoid coinfection in northern Nigeria. *Tropical Disease Review, 19*(3), 76–84.

Akinola, T. O. (2024). Integrated disease management strategies for febrile illnesses in Nigeria. *Journal of Health Systems Research, 11*(1), 15–28.