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Prevalence and Associated Risk Factors of *Borrelia* spp. in Febrile Patients in Kwara State, Nigeria: A Comparative Cross-Sectional Study

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Abstract
Tick-borne relapsing fever (TBRF), caused by various species of Borrelia bacterium, is a significant yet neglected public health threat in Africa. This hospital-based cross-sectional study determined the prevalence of Borrelia spp. in febrile patients across three hospitals in three senatorial regions of Kwara State, Nigeria, from January to November 2024, and assessed associated risk factors. A total of 150 blood samples were collected (50 per hospital: General Hospital Offa [semi-urban], Cottage Hospital Tsaragi [rural], and Sobi Specialist Hospital Ilorin [urban]) and analyzed using the culture technique method in Barbour-Stoenner-Kelly medium. The overall prevalence was 6.0% (9/150) and prevalence varied significantly (p=0.04) by location, with the highest rate at the Cottage Hospital Tsaragi (Kwara North region: rural) (12.0%), followed by General Hospital Offa (Kwara South region: semi-urban) (4.0%) and the Sobi Specialist Hospital Ilorin (Kwara Central region: urban) (2.0%). Demographic factors like sex and age were not significantly associated with infection. The predominance of non-specific symptoms like fever (91.3%) and headache (70.0%) complicates clinical diagnosis. These findings indicate a heightened risk of Borrelia infection in rural, livestock-farming communities of the Kwara North region, underscoring its role as a cause of undifferentiated febrile illness. This necessitates enhanced surveillance, improved diagnostic capacity, and targeted public health interventions in endemic areas of Nigeria.
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Keywords: Borrelia, Tick-Borne Relapsing Fever, Prevalence, Febrile Illness, Kwara State

Introduction

Tick-borne diseases (TBDs) represent a growing and significant challenge to global public health, particularly in tropical and subtropical regions such as Nigeria, where suitable ecological niches for vectors abound (Dantas-Torres et al., 2012; Parola et al., 2005). Among these diseases, tick-borne relapsing fever (TBRF), caused by various species of spirochetes within the genus Borrelia, is a debilitating zoonosis characterized by recurrent episodes of high fever, separated by afebrile intervals that are similar to malaria or typhoid fever (Cutler, 2015). In Africa, TBRF is primarily transmitted to humans through the bite of infected soft ticks belonging to the genus Ornithodoros, which often inhabit rodent burrows, animal shelters, and cracks in mud walls in rural settings (Ola-Fadunsin et al., 2025; Talagrand-Reboul et al., 2018).

The clinical presentation of TBRF is non-specific, typically presenting a sudden onset of high fever, severe headache, myalgia, and arthralgia, which are easily misdiagnosed as most common febrile illnesses such as malaria, typhoid fever, or viral infections (Cutler et al., 2009). This diagnostic dilemma, compounded by the lack of specific clinical signs and no access to diagnostic tools in many endemic regions, leads to significant underreporting and

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mismanagement of cases (Magaia et al., 2020; Sarih et al., 2003). Consequently, the true burden of TBRF across much of sub-Saharan Africa, including Nigeria, remains insignificantly defined and underestimated (Reye et al., 2012; Vial et al., 2006).

Nigeria, as a developing country with a significant portion of its population, most especially Northern Nigerians engaged in livestock farming, creates extensive human-tick interfaces (Akande & Fagbemi, 2020). Kwara State, located in the North-Central region, is characterized by diverse ecological zones supporting both crop agriculture and livestock production, particularly in its rural communities. These activities usually encourage close contact with cattle, sheep, and goats, which significantly increases the risk of human exposure to Ornithodoros ticks (Adejoh et al., 2019). Previous entomological surveys in Nigeria have confirmed the presence of Ornithodoros ticks in abundance and have detected Borrelia DNA in these vectors, confirming the existence of enzootic cycles (Kamani et al., 2023; Reye et al., 2012). However, there is a critical gap in contemporary data on the prevalence of Borrelia infections in the human population of Kwara State.

This study aims to bridge this knowledge gap by systematically investigating the prevalence of Borrelia species among febrile patients presenting at three hospitals representing different ecological and socio-economic settings and three senatorial regions in Kwara State. Furthermore, it seeks to identify demographic and location-based factors associated with infection, thereby providing crucial epidemiological data to inform public health policy, improve clinical awareness, and provide a guide to the development of targeted prevention and control strategies.

Materials and Methods

A hospital-based cross-sectional study was conducted from January to November 2024. The study sites were purposively selected to represent different ecological and socio-economic settings and senatorial regions in Kwara State, Nigeria:

i. General Hospital Offa: Semi-urban area with moderate agricultural activities locates at Kwara South region.
ii. Cottage Hospital Tsaragi: Rural area characterized by intensive livestock farming and most Fulani settlement located in the Kwara North region.
iii. Sobi Specialist Hospital, Ilorin: Urban setting, which is the state capital, with a lower likelihood of occupational tick exposure, located in the Kwara Central region.

A total of 150 consenting febrile patients (temperature $\geq 37.5°C$) were recruited consecutively, with 50 participants enrolled from each study hospital. Ethical approval was obtained from the Kwara State Ministry of Health, and informed consent was obtained from all participants. A structured questionnaire was used to collect demographic, clinical, and all other data.

Two milliliters of venous blood were collected from each participant under aseptic conditions by physicians managing the patients. The samples were transported to the laboratory aseptically for analysis immediately. Barbour-Stoenner-Kelly (BSK-II) medium was prepared aseptically according to the manufacturer's instructions, and each sample was inoculated into the prepared Barbour-Stoenner-Kelly (BSK-II) medium and incubated at 33°C in an incubator for up to 14 days. Cultures were examined every three-day interval for Borrelia (spirochete) growth using dark-field microscopy. A sample was considered positive if motile spirochetes were observed under the microscope.

Data were analyzed using SPSS version 25. Descriptive statistics were used to summarize demographic and clinical characteristics. The Chi-square test was used to test for associations between categorical variables, and a p-value of less than 0.05 was considered statistically significant.

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Results

Demographic Characteristics of Participants

A total of 150 participants were enrolled in this study, and the overall male-to-female gender ratio was 1.5:1, that is 90 males and 60 females. The mean age was 38.2 ± 14.5 years, with no significant difference in age or gender distribution across the three hospitals (p>0.05) (Table 1).

Table 1: Demographic Characteristics of Febrile Patients Across the Three Study Hospitals

Characteristics	GHO (n=50)	CHT (n=50)	SSHI (n=50)	Total (N=150)	p-value
Gender					0.72
Male	30 (60%)	32 (64%)	28 (56%)	90 (60%)	
Female	20 (40%)	18 (36%)	22 (44%)	60 (40%)	
Age (Years)					0.55
18-30	16 (32%)	14 (28%)	18 (36%)	48 (32%)	
31-45	20 (40%)	22 (44%)	17 (34%)	59 (39%)	
>45	14 (28%)	14 (28%)	15 (30%)	43 (29%)	

Note: GHO= General Hospital Offa, CHT= Cottage Hospital Tsaragi, SSHI= Sobi Specialist Hospital Ilorin

Clinical Presentation

Fever (91.3%) and headache (70.0%) were the most common symptoms reported by participants, followed by myalgia (57.3%). The distribution of these symptoms was not significantly different across the hospitals (Table 2).

Table 2: Clinical Symptoms Presented by Febrile Patients Across the Three Study Hospitals

Symptoms	GHO (n=50)	CHT (n=50)	SSHI (n=50)	Total (N=150)	p-value
Fever	45 (90%)	48 (96%)	44 (88%)	137 (91%)	0.38
Headache	35 (70%)	40 (80%)	30 (60%)	105 (70%)	0.21
Myalgia	28 (56%)	33 (66%)	25 (50%)	86 (57%)	0.15

Note: GHO= General Hospital Offa, CHT= Cottage Hospital Tsaragi, SSHI= Sobi Specialist Hospital Ilorin

Prevalence of Borrelia spp. and Associated Factors

The overall prevalence of Borrelia species was 6.0%, that is, 9 positives out of 150. The prevalence varied significantly by hospitals or senatorial regions in Kwara State (p=0.04), with the highest rate found at Cottage Hospital Tsaragi of the Kwara North senatorial region with 6 positives out of 50 (12.0%), followed by General Hospital Offa of the Kwara South senatorial region with 2 positives out of 50 (4.0%) and Sobi Specialist Hospital Ilorin of the Kwara Central senatorial region with 1 positive out of 50 (2.0%) (Table 3). Therefore, there was no statistically significant association between Borrelia infection and gender or age group (p>0.05).

Table 3: Prevalence of Borrelia spp. Infection by Hospital and Demographic Factors

Factors	Categories	Number Tested	Number Positive (%)	p-value
Hospital	GHO	50	2 (4.0%)	0.04
	CHT	50	6 (12.0%)	
	SSHI	50	1 (2.0%)	
Gender				0.39
	Male	90	7 (7.8%)	
	Female	60	2 (3.3%)	
Age Group				0.82
	18-30	48	3 (6.3%)	
	31-45	59	4 (6.8%)	
	>45	43	2 (4.7%)	
Overall		150	9 (6.0%)	

Note: GHO= General Hospital Offa, CHT= Cottage Hospital Tsaragi, SSHI= Sobi Specialist Hospital Ilorin

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Discussion

This study provides compelling evidence of autochthonous Borrelia transmission among febrile patients in hospitals of three senatorial regions in Kwara State, Nigeria, with a prevalence of 6.0%. This figure is significant and significantly positions TBRF as a non-negligible cause of undifferentiated fever in the regions, a finding consistent with studies from other parts of Africa where TBRF is often overlooked in the differential diagnosis of fever (Cutler et al., 2009).

The most striking finding was the significant geographical variation in prevalence, with the rural Cottage Hospital Tsaragi of the Kwara North region recording a prevalence of 12.0%, which was six times higher than that of the urban Sobi Specialist Hospital Ilorin of the Kwara Central region with 2.0%. This gradient strongly supports the recorded and established epidemiology of TBRF as an environmentally and occupationally linked disease (Talagrand-Reboul et al., 2018; Vial et al., 2006). Kwara North senatorial region, Tsaragi's setting, characterized by intensive livestock farming and agricultural activities, provides an ideal environment for Ornithodoros tick reservoirs, which thrive in animal shelters and burrows. The frequent human-tick contact in such dwellings communities directly increases the risk of Borrelia transmission, a phenomenon well-documented in similar rural, agro-pastoral communities across West Africa (Akande & Fagbemi, 2020; Kamani et al., 2023; Reye et al., 2012). The low prevalence in Sobi Specialist Hospital, Ilorin, in the Kwara Central region, which is the state capital, reflects the reduced tick habitat and different lifestyle in an urban center.

The clinical presentation of positive cases in our study was dominated by non-specific symptoms such as fever, headache, and myalgia, which showed no significant difference from the symptom profile of negative patients. This finding underscores a critical challenge in clinical management and treatment. TBRF is a great mimicker of common disease symptoms. In malaria endemic regions like Nigeria, these symptoms almost invariably lead to a general presumptive diagnosis and treatment for malaria, leaving TBRF undiagnosed and untreated (Magaia et al., 2020; Sarih et al., 2003). This diagnostic gap can lead to severe complications in some cases, including neurological involvement and adverse pregnancy outcomes, and contributes to the cycle of empirical treatment and persistent morbidity as well as antimicrobial resistance threat (Cutler et al., 2015).

While we observed a higher numerical prevalence in males (7.8%) compared to females (3.3%), this difference was not statistically significant. However, this trend may reflect greater occupational exposure for men through farming and animal husbandry activities, but the lack of significance suggests that domestic exposure, perhaps through infested housing, also plays a crucial role in Borrelia transmission, affecting all household members (Adejoh et al., 2019; Ola-Fadunsin et al., 2025).

A limitation of this study is the total reliance on culture for diagnosis, which though specific but has lower sensitivity compared to molecular methods like PCR (Cutler et al., 2010). This implies that the true prevalence of Borrelia infection in our study population is likely higher than reported here. Furthermore, our study was hospital-based, potentially missing community cases that do not seek formal healthcare.

Conclusion

This study unequivocally demonstrates that Borrelia infections are a public health important and under-recognized cause of febrile illness in Kwara State, disproportionately affecting rural communities with livestock-based economies. The non-specific clinical presentation necessitates a paradigm shift in fever diagnosis and management.

Recommendations

To mitigate the public health impact of TBRF, we recommend:

i. Enhanced Clinical Awareness: Integrating TBRF into the differential diagnosis of acute febrile illness, especially in patients from rural areas unresponsive to anti-malarial therapy.
ii. Improved Diagnostic Capacity: Building capability for PCR-based detection in state-level reference laboratories to confirm suspected cases and conduct surveillance.
iii. Targeted Public Health Interventions: Implementing community health education programs focusing on improving housing structures to prevent tick infestation and promoting the use of acaricides in animal shelters.

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iv. Further Research: Future studies should employ molecular techniques to determine the genetic diversity of circulating Borrelia species and conduct more extensive eco-epidemiological surveys to map risk areas and vector distribution comprehensively and develop rapid diagnostic kits using antigen antibody reactions.

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Declarations and Statements

Ethics approval and consent to participate

This study was approved by the Kwara State Ministry of Health, Ilorin, Nigeria and written informed consent was obtained from all participants.

Consent to participate

Written informed consent was obtained from all study participants prior to enrollment.

Consent to publish

Not applicable. No individual patient data are presented in this manuscript.

Clinical trial number

Not applicable.

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Competing Interests

The authors declare no conflicts of interest.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Olakunle Oluseyi Ayanda, John Olarewaju Adeyemi, Oluwatobiloba Sunday Abegunde and Stephen Kayode Ojo. The first draft of the manuscript was written by Olakunle Oluseyi Ayanda and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.