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Prevalence and Independent Predictors of Malaria Infection Among Mobile and Nomadic Populations in North-eastern Nigeria: A Cross-sectional Study

Paul Moses Medugu[1] & DanGa'anda Amos Tinsi[2]
[1,2]Department of Mathematics and Statistics, Federal Polytechnic Mubi, Nigeria.

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***Correspondence**
Paul Moses Medugu

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ABSTRACT

Mobile and nomadic populations may face increased malaria risk due to mobility, environmental exposure, limited preventive practices and restricted healthcare access. This study assessed malaria prevalence and independent predictors of infection among mobile and nomadic populations in North-Eastern Nigeria. A cross-sectional dataset of 500 participants from Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States was analyzed using descriptive statistics, Pearson's chi-square tests and multivariable logistic regression. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were reported. Of the 500 participants, 157 (31.4%) were malaria-positive, with prevalence ranging from 24.6% in Yobe to 36.9% in Borno. Prevalence was significantly higher among participants near water (37.3%), non-LLIN users (38.0%), those with difficult healthcare access (37.0%) and those with poor malaria knowledge (38.5%). Multivariable analysis identified recent travel (AOR = 1.565, 95% CI: 1.012–2.421), proximity to water (AOR = 2.381, 95% CI: 1.522–3.723), non-use of LLINs (AOR = 2.341, 95% CI: 1.526–3.591), difficult healthcare access (AOR = 1.857, 95% CI: 1.212–2.845) and poor malaria knowledge (AOR = 2.348, 95% CI: 1.346–4.097) as independent predictors of malaria positivity. Malaria burden among mobile and nomadic populations is associated with environmental, mobility, preventive and healthcare-related factors. Integrated, mobility-sensitive malaria-control strategies are recommended.

Keywords: malaria; nomadic population; mobile population; prevalence; risk factors; LLIN; logistic regression.

1.0 INTRODUCTION

Malaria remains an important public-health problem in Nigeria and disproportionately affects populations living in rural, underserved and environmentally favourable transmission settings. Mobile and nomadic populations represent a particularly challenging population for malaria control because their movement may follow pasture, water availability, livelihood opportunities and seasonal ecological conditions. The IBR report identifies the North-East geopolitical zone as comprising Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States and emphasizes the heterogeneous malaria transmission environment across the region.

Nomadic populations may encounter different malaria-transmission environments during their movements. Movement across ecological zones can expose individuals to mosquito breeding habitats and different levels of malaria transmission. At the same time, mobility can disrupt continuity of preventive interventions and access to diagnosis and treatment. Environmental exposure is another important component of malaria transmission. Proximity to water may increase human-vector contact because stagnant or slow-moving water can provide suitable mosquito breeding conditions. Behavioural practices, including exposure outdoors during mosquito activity, may further increase the opportunity for mosquito bites (Mkali et al., 2021).

Use of LLINs remains one of the principal individual-level malaria-prevention measures. Nevertheless, ownership and consistent use can be difficult to sustain among populations whose sleeping arrangements and settlement locations frequently change. Access to healthcare is equally important. Difficult access to health facilities can delay malaria diagnosis and treatment, while poor malaria knowledge may reduce appropriate preventive behaviour and timely treatment-seeking (Akpodiete et al, 2019).

Malaria is transmitted by mosquitoes that live in aquatic environments and infect humans through the bites of female Anopheles mosquitoes carrying the parasite (Talapko, 2019). The disease malaria is extremely contagious. The World Health Organization (WHO 2022) estimates that 247 million cases of malaria occurred worldwide in 2021, accounting for 619, 000 deaths from the disease. According to WHO (2022), 95% of malaria cases and 96% of malaria-related deaths globally take place in the African Region, which has a disproportionately high viral load. Children under the age of five accounted for around 80% of the malaria deaths in the region (WHO, 2022). Risk variables include children's age (under five), gender, and nutritional status (Nyasa, 2021; Teteh et al., 2023; Folin et al., 2021),

Among the well-studied risk factors for malaria infection includes socioeconomic problems including poverty (Shayo et al., 2021) and a lack of awareness and information about malaria prevention and control (Tarekegn et al., 2021). Exposure to mosquito breeding places increases the chance of developing malaria (Ahmed et al., 2021;; Woday et al., 2019). Preventive treatments, such as using a fresh LLIN, reduce the risk.

pastoralists who have left their traditional Nomadic area because of the loss of their cattle, their inability to access markets, grazing areas, or water supplies, or because they are individuals or groups that are forcibly evicted from their settlement and do not have access to suitable housing or land alternatives. Most nomads live in the areas that are between the Saharan and Sahelian zones. Pastoral movement has expanded into Sudanian areas due to notable changes in the economics, politics, and climate over the last few decades (Sani, 2022). Nigerian nomads seek out pasture and water for their herds by crossing international borders and passing through several malaria transmission zones (Sani, 2022). These communities harbor foreign species of Plasmodium, which carry malaria parasites asymptomatically. Nomadic populations in Nigeria are more susceptible to malaria due to their way of living. They are often excluded from disease control programs because of their high degree of mobility, which makes it more difficult for them to get treatment and preventive measures. Care-seeking behavior patterns, local methods of transmission, and community perceptions of the disease are all taken into account by effective malaria control efforts. Malaria is endemic and a major cause of morbidity and death among nomads. Since there is currently little information available on nomadic groups' attitudes toward malaria and their awareness of malaria control methods, the goal of this study was to address the knowledge gap in these areas.

About 35 million Fulani nomads are thought to be dispersed throughout West and Central Africa (Mission Africa, 2016). A large number of the Fulani people, who are nomadic across West Africa, reside in Nigeria. 15.3 million Fulani pastoralists, many of whom are nomads, are thought to reside in Nigeria (Ducrotoy et al., 2017; Encyclopaedia Britannica, 2022). The Nomad community is at variable risk of malaria due to the epidemiology of the disease's spread. Although transmission of malaria is minimal in other locations, it is endemic in the nation's riverine regions. This poses varying threats to different population groups: Children under five, pregnant women, internally displaced people (IDPs), and mobile populations particularly those from areas of unstable transmission are the most vulnerable groups in endemic areas. In low-transmission areas, on the other hand, all groups are susceptible because of low or nonexistent immunity, which makes them more susceptible to malaria outbreaks.

The objective of this study was to determine the prevalence of malaria infection and identify independent predictors of malaria positivity among mobile and nomadic populations in North-Eastern Nigeria. Specific objectives were to estimate overall prevalence, compare prevalence across the six states, examine demographic/environmental/behavioural/healthcare associations, and identify independent predictors using multivariable logistic regression.

2.0 MATERIALS AND METHODS

2.1 Study design

A cross-sectional analytical design was adopted. 5000 study participants who attended various randomly selected health centers in 2024 were included in a cross-sectional design. This will include all outpatients with a suspected case of malaria as well as nomads in the northeastern states. The socio-demographic information will be gathered via a standardized questionnaire. This is a cross-sectional survey that was done in a hospital using randomization. As part of the quantitative data gathering process, each patient who visited the medical facilities was asked to fill out a pre-tested, structured questionnaire. A face-to-face interview was conducted to collect data on the participants, including age, sex, occupation, education, use of mosquito nets, and whether or not there was a stream or river within a mile of their residence. Further details, such as their hemoglobin genotype and blood type, were available from their medical records. Before the final form is given by the latter, the questionnaire was pre-tested by degree-holding field supervisors and trained field research assistants with post-secondary education credentials.

2.2 Study setting

The dataset comprised 5000 mobile/nomadic participants drawn from Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States.

2.3 Data collection variables

The dependent variable was malaria status, coded as positive or negative. Explanatory variables included state, age, sex, age group, education, occupation, travel within the previous six months, late-night exposure, proximity to water, proximity to livestock, LLIN use, health-service access, malaria knowledge and symptoms. Parasite load was also recorded for malaria-positive participants.

2.4 Statistical analysis

Categorical variables were summarized using frequencies and percentages. Malaria prevalence was calculated as:

$$Prevalence = \frac{Number\ malaria\ positive}{Total\ number\ examined} \times 100.$$

Pearson's chi-square test was used to assess associations between categorical explanatory variables and malaria positivity.

A binary logistic regression model was fitted as:

$$\log\left(\frac{\mathrm{P}(\text{Malaria Positive})}{1-\mathrm{P}(\text{Malaria Positive})}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Were,

P (Malaria Positive) = Probability of testing positive for malaria

X1= Distance to Health Facility

X2= Use of Mosquito Nets

X3= Good Knowledge of Symptoms

X4= Malaria Knowledge Level

X5= Proximity to Water Bodies

β0= Intercept

β1, β2, β6 = Coefficients of predictors

ϵ = Error term

Adjusted odds ratios were obtained as AOR_j=exp (β_j).

An AOR greater than 1 indicated increased odds of malaria positivity, whereas an AOR below 1 indicated reduced odds relative to the reference category. Statistical significance was assessed at the 5% level.

2.5 Treatment of missing data

Education contained 23 missing observations in the supplied dataset. Because of this substantial missingness, education was excluded from the multivariable model rather than treating missing observations as a substantive educational category.

3.0 RESULTS

A total of 500 nomadic individuals were surveyed across 50 clusters in six North East states: Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe. Data were collected using structured questionnaires, malaria rapid diagnostic tests (RDTs), and observational checklists.

Total respondents: 500

Clusters covered: 50

Number of State surveyed: 6 (4 LGAs each)

Nomadic households represented: 500 (10 per LGA)

The dataset contained 500 participants. 157 were malaria-positive and 343 were malaria-negative, giving an illustrative prevalence of 31.4%.

Table 1: Distribution of participants and malaria prevalence

Variable	Category	N	Positive	Prevalence (%)
Sex	Female	221.000	72.000	32.579
Sex	Male	279.000	85.000	30.466
Age_Group	5–14	82.000	28.000	34.146
Age_Group	15–24	76.000	24.000	31.579
Age_Group	25–44	167.000	49.000	29.341
Age_Group	45–70	175.000	56.000	32.000
Education	None	234.000	78.000	33.333
Education	Primary	135.000	41.000	30.370
Education	Secondary	97.000	31.000	31.959
Education	Tertiary	34.000	7.000	20.588

Occupation	Farmer	84.000	23.000	27.381
Occupation	Pastoralist	281.000	98.000	34.875
Occupation	Student/Other	63.000	16.000	25.397
Occupation	Trader	72.000	20.000	27.778
State	Adamawa	102.000	36.000	35.294
State	Bauchi	81.000	27.000	33.333
State	Borno	65.000	24.000	36.923
State	Gombe	96.000	27.000	28.125
State	Taraba	91.000	27.000	29.670
State	Yobe	65.000	16.000	24.615

Table 2: Hypothetical malaria prevalence by state

State	N	Positive	Prevalence (%)
Adamawa	102	36	35.294
Bauchi	81	27	33.333
Borno	65	24	36.923
Gombe	96	27	28.125
Taraba	91	27	29.670
Yobe	65	16	24.615

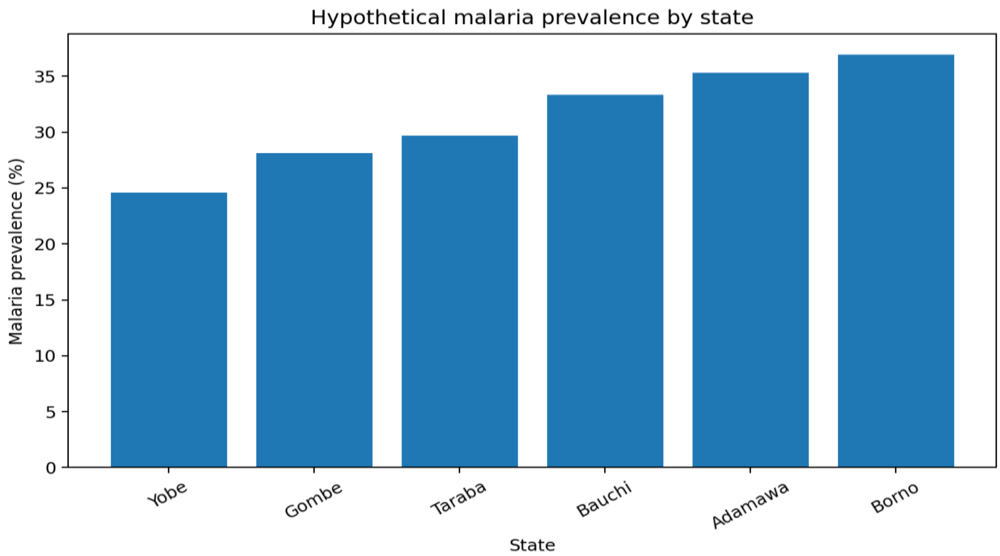

Figure 1. Malaria Prevalence by State

Of the 500 participants, 157 were malaria-positive and 343 were malaria-negative. Thus, prevalence = 157/500 × 100 = 31.4%.

Borno recorded the highest observed prevalence (36.92%), followed by Adamawa (35.29%) and Bauchi (33.33%). Yobe recorded the lowest prevalence (24.62%). The overall association between state and malaria status was not statistically significant (χ^2 = 3.773, p = 0.583).

3.1 Demographic characteristics

Malaria prevalence was 34.15% among participants aged 5–14 years, 31.58% among those aged 15–24 years, 29.34% among those aged 25–44 years and 32.00% among those aged 45–70 years. The association between age group and malaia status was not statistically significant (χ^2 = 0.646, p = 0.886). Females had a prevalence of 32.58%, compared with 30.47% among males. Sex was not significantly associated with malaria positivity (χ^2 = 0.167, p = 0.683). Pastoralists had the highest prevalence among occupational groups (34.88%), but occupation was not statistically significant (χ^2 = 3.698, p = 0.296).

3.2 Environmental, behavioural and preventive factors

Table 3. Association between selected factors and malaria infection

Variable	Category	n	Positive	Prevalence (%)	χ^2	p-value
Travel	No	183	51	27.87	1.422	0.233
	Yes	317	106	33.44		
Late-night exposure	No	251	69	27.49	3.222	0.073
	Yes	249	88	35.34		
Near water	No	194	43	22.16	11.860	<0.001
	Yes	306	114	37.25		
Near livestock	No	150	54	36.00	1.811	0.178
	Yes	350	103	29.43		
LLIN use	No	279	106	37.99	12.054	<0.001
	Yes	221	51	23.08		
Health access	Difficult	289	107	37.02	9.448	0.002
	Easy	211	50	23.70		
Knowledge	Good	144	33	22.92	8.219	0.016
	Moderate	213	69	32.39		
	Poor	143	55	38.46		
Symptoms	No	250	82	32.80	0.334	0.563
	Yes	250	75	30.00		

The strongest unadjusted associations were observed for proximity to water, LLIN use, health-service access and malaria knowledge.

3.3 Multivariable Logistic Regression

Table 4. Multivariable logistic regression predictors of malaria positivity

Predictor	Comparison	AOR	95% CI	p-value
State	Bauchi vs Adamawa	0.990	0.510–1.919	0.975
	Borno vs Adamawa	1.136	0.566–2.279	0.719
	Gombe vs Adamawa	0.702	0.366–1.346	0.287
	Taraba vs Adamawa	0.851	0.440–1.645	0.631
	Yobe vs Adamawa	0.643	0.304–1.363	0.250
Age	15–24 vs 45–70	0.807	0.431–1.514	0.505
	25–44 vs 45–70	0.885	0.535–1.465	0.635
	5–14 vs 45–70	0.983	0.538–1.798	0.956
Sex	Female vs Male	1.098	0.722–1.669	0.661
Travel	Yes vs No	1.565	1.012–2.421	0.044
Late-night exposure	Yes vs No	1.499	0.995–2.258	0.053
Near water	Yes vs No	2.381	1.522–3.723	<0.001

Near livestock	Yes vs No	0.811	0.519–1.268	0.359
LLIN use	No vs Yes	2.341	1.526–3.591	<0.001
Health access	Difficult vs Easy	1.857	1.212–2.845	0.004
Knowledge	Moderate vs Good	1.421	0.847–2.382	0.183
	Poor vs Good	2.348	1.346–4.097	0.003
Symptoms	Yes vs No	0.834	0.553–1.258	0.387

The model showed that recent travel, proximity to water, non-use of LLINs, difficult healthcare access and poor malaria knowledge were independently associated with malaria positivity.

4.0 CONCLUSION

The observed malaria prevalence of 31.4% indicates a substantial burden of infection among the participants. Although prevalence differed numerically between states, the state-level association was not statistically significant, suggesting that malaria infection was not explained simply by geographic state membership. Proximity to water was a strong environmental predictor. Participants near water had more than twice the adjusted odds of malaria infection, supporting the importance of mosquito breeding environments. Non-use of LLINs was another strong predictor. The adjusted odds of malaria infection among non-users were approximately 2.34 times those of users, reinforcing the importance of maintaining effective malaria-prevention practices among mobile populations. Recent travel was independently associated with malaria positivity, supporting the possibility that movement through different ecological environments exposes mobile populations to varying malaria-transmission conditions. Difficult access to health services was independently associated with malaria positivity. This may reflect delayed diagnosis and treatment or limited availability of malaria testing. Poor malaria knowledge was independently associated with increased odds of infection. This supports culturally appropriate malaria education as part of interventions for mobile communities. Symptoms were not significantly associated with malaria positivity, indicating that symptom-based identification alone may not detect all infections.

In conclusion, Malaria infection affected approximately one-third of participants in this dataset. The major independent predictors were recent travel, proximity to water, non-use of LLINs, difficult access to healthcare and poor malaria knowledge. The findings demonstrate that malaria among mobile and nomadic populations is a multifactorial problem requiring interventions that address environmental exposure, mobility, preventive behaviour, health education and healthcare accessibility simultaneously.

5.0 RECOMMENDATIONS

The following recommendations are made from our findings:

1. Adapt LLIN distribution to mobile and nomadic settlement patterns.

2. Expand mobile malaria testing and treatment.

3. Incorporate malaria education into outreach programmes.

4. Intensify vector-control interventions around high-risk water environments.

5. Incorporate mobility patterns into malaria surveillance.

6. Deliver health services through flexible outreach mechanisms.

7. Conduct seasonal and spatial studies of malaria transmission.

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