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MANAGEMENT AND PREVENTIVE PRACTICES FOR *PLASMODIUM FALCIPARUM* MALARIA TRANSMISSION IN SELECTED RURAL COMMUNITIES OF ADAMAWA STATE, NIGERIA

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Abstract

Malaria, particularly *Plasmodium falciparum* malaria, remains a major public health challenge among children under five in rural communities of Adamawa State. This study assessed malaria prevalence, treatment practices, and preventive measures in Bazza, Mboi, and Yebbi. A cross-sectional design was adopted using structured questionnaires administered to caregivers. Data on demographic characteristics, housing conditions, treatment behavior, and preventive practices were collected and analyzed using descriptive statistics. The results showed that children aged 1–2 years had the highest vulnerability, with reported cases of 277 (72.1%), 200 (52.1), and 195 (50.8) in Bazza, Mboi, and Yebbi, respectively. Overcrowding was evident, with 568 (49.3%) children living in sleeping spaces of 3–4 persons, and the majority of respondents 459 (39.8%) residing in family houses. Regarding treatment of malaria, 887 respondents used antimalarial drugs representing 380(99.0), 253(65.9) and 254(66.1) for Bazza, Mboi and Yebbi respectively, with 374 (32.5%) specifically using artemisinin-based combination therapies (ACTs). Rapid response to treatment was reported within 24–48 hours by a large proportion of respondents. However, 311 (27.0%) respondents indicated inability to use ACTs due to cost, while a few relied on herbal remedies 28 (2.4%). In terms of management, 414 respondents reported malaria episodes within the last three months in Bazza 163(42.4), Mboi 116(30.2) and Yebbi 135(35.2) and 754 representing Bazza 357(93.0), Mboi 173(45.1) and Yebbi 224(58.3) underwent diagnostic testing, mainly microscopy 61% and rapid diagnostic tests 39%. Preventive practices showed moderate uptake, with high utilization of long-lasting insecticidal nets (LLINs) (mean = 3.94 in Mboi; 3.81 in Yebbi) and insecticide spraying (mean = 4.34 in Mboi; 4.12 in Yebbi), though alternative measures such as burning coils were also reported. In conclusion, despite considerable use of recommended treatment and preventive strategies, significant gaps remain in affordability, housing conditions, and consistent utilization of effective interventions. Strengthening access to affordable ACTs, improving living conditions, and enhancing community-based malaria education are essential to reduce transmission.

Keywords: *Plasmodium falciparum*, Malaria, Antimalarial drugs, LLINs, Mosquitoes

Introduction

Malaria remains one of the most significant public health challenges globally, with *Plasmodium falciparum* malaria accounting for the majority of severe morbidity and mortality, particularly in sub-Saharan Africa (World Health Organization [WHO], 2023). According to the World Health Organization, Africa bears over 90% of the global malaria burden, with Nigeria contributing the highest number of cases and deaths worldwide (Ibeji *et al*., 2022; WHO, 2022). Nigeria has the highest prevalence of malaria, with approximately 50% affecting children. Children under five years of age are vulnerable to the risk of malaria spread (Isiko *et al*., 2024).

The transmission of *Plasmodium falciparum* occurs through the bite of infected female *Anopheles* mosquitoes, a process strongly influenced by environmental, socioeconomic, and behavioral factors prevalent in rural settings (Chilot *et al*., 2023). In rural communities of Adamawa State, malaria transmission is sustained by favorable climatic conditions, poor housing infrastructure, limited access to healthcare services, and inadequate implementation of preventive measures (Wahedi *et al*., 2020). Despite ongoing national and international interventions, such as the distribution of insecticide-treated nets (ITNs), indoor residual spraying (IRS), and prompt case management using artemisinin-based combination therapies (ACTs), malaria remains endemic in many parts of the state (National Malaria Elimination Programme [NMEP], 2021). The persistence of transmission is often linked to gaps in community knowledge, attitudes, and practices regarding malaria prevention and treatment. Effective management of *Plasmodium falciparum* malaria involves early diagnosis, appropriate treatment, and adherence to recommended therapeutic guidelines. However, in many rural Nigerian communities, treatment-seeking behavior is influenced by cultural beliefs, economic constraints, and reliance on informal healthcare providers, which may contribute to delayed or inappropriate treatment (Okeke *et al*., 2016). Preventive practices, including consistent use of ITNs, environmental sanitation, and community participation in vector control programs, are critical components in reducing malaria transmission. Nevertheless, the uptake and sustained use of these interventions remain suboptimal in several rural settings.

The interplay between management strategies and preventive practices at the community level is essential for designing context-specific interventions. This study, therefore, seeks to assess the management and preventive practices for *Plasmodium falciparum* malaria transmission in selected rural communities of Adamawa State. By identifying existing gaps and challenges, the study aims to contribute to evidence-based policy formulation and improved malaria control efforts in the region.

MATERIALS AND METHODS

Study Area

Adamawa State is located on latitude 9°19’60.00”N and longitude 12°29’59.99”E with about 28,700km^2 land area (NIPC, 2020). It has an average rainfall between 900 and 1100mm (Akosim *et al*., 1999). Adamawa State has a tropical climate with a mean monthly temperature from 26.7°C to 27.8°C (Adebayo and Umar, 1999). Three study sites were selected one from three Local Government Areas (LGA) of Adamawa State. Each of the LGA was selected from the three different vegetational zones in the State. This is because; vegetation strongly influences mosquito breeding, survival, and transmission dynamics. From Sudan savanna, the site selected is Bazza in Michika LGA (10°34’19”N and 13°19’6”E); in Northern guinea savanna is Mboi in Song LGA (09°55’20”N and 12°31’12”E); and in southern guinea savanna is Yebbi from Ganye LGA (8°35’50”N and 11°54’51”E), as shown in Figure 1.

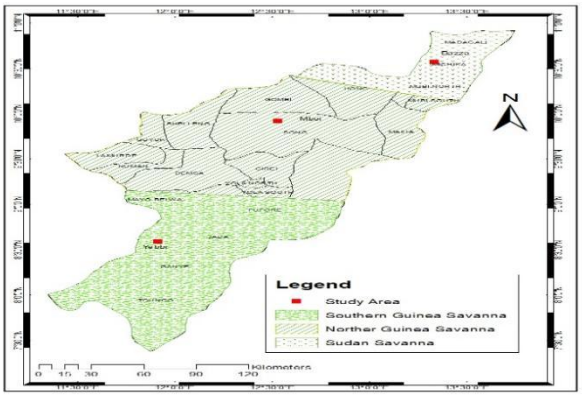

Figure 1: The map of Adamawa State showing the study areas

Study Design and Target Population

A purposive study design was employed. Children under 5 years of age were used. Participants were recruited during two distinct season periods i.e. dry season (November to April) and wet season (May to October). Eligible participants, were children whose parent consented and were treated recently with antimalarial treatment.

Ethical Approval

Ethical approval for the study was obtained from Adamawa State Ministry of Health and Human Services via a letter with reference number *S/MOH/11371*, and an approval number *ADHREC14/05/2025/016*.

Sample Collection and Laboratory Analysis

Peripheral blood samples were collected via finger prick. Thick and thin blood films were prepared, stained with Giemsa solution, and examined under light microscopy for malaria parasites following WHO standards (WHO, 2023). HRP2-based Rapid Diagnostic Tests (RDTs) were also used to complement microscopy findings.

Data Collection on Malaria and its Prevention Practices

Data was collected using structural questionnaire. The questionnaire was designed to collect the socio-demographic characteristics of the respondents. The data collected on malaria and its prevention practices using questionnaire was randomly selected among individuals in the study area. The questionnaire was directed to household members, who are 18 years and above, and it was administered to only one person in the households involved in the study communities.

Data Analysis

Data were analyzed using statistical software (SPSS version 23.0). Prevalence of *P. falciparum* was computed as the proportion of individuals testing positive in each season. Chi-square tests were used to compare seasonal differences, with significance set at $p < 0.05$.

RESULTS AND DISCUSSION

Prevalence of malaria infection among Children under five years according to place of residence

The results from Bazza, Mboi and Yebbi revealed that the Children between the ages of 1 and 2 years were more infected with malaria attack 277 (72.1%), 200 (52.1%), and 195 (50.8% for Bazza, Mboi and Yebbi, respectively), followed by those between the age group of 3-4 in Bazza and age group 5-6 from Mboi and Yebbi, respectively. The results indicate that Children between the ages of 1 and 2 years were more vulnerable to malaria infection across the study areas. The sleeping spaces of the children were also considered, where Bazza and Yebbi significantly recorded higher rates (61.5% and 41.9%, respectively). Types of dwelling structures of the respondents which ranges from family house, duplex, two/three bedrooms flats, mini/self-contained flats and single room. 188 (48.9%) of the respondents from Bazza live in the family houses which is the highest compared to other dwelling structures. Mboi also recorded highest (40.1%) respondents living in the family houses, but Yebbi has more (48.9%) respondents dwelling in two-bedrooms structures.

Table 1: Prevalence of malaria infection among Children under five years according to place of residence

		Bazza		Mboi		Yebbi	
Questions	**Parameter**	**No. of Resp. (%)**	**Mean± SD**	**No. of Resp. (%)**	**Mean± SD**	**No. of Resp. (%)**	**Mean± SD**
Number of children under 5 years	1-2	277 (72.1)	4.45±1.88	200 (52.1)	4.09±1.92	195 (50.8)	3.93±2.12
	3-4	77 (20.1)	4.45±2.17	58 (15.1)	4.17±2.00	73 (19.0)	4.05±2.26
	5-6	30 (7.8)	3.63±2.02	126 (32.8)	4.14±1.99	116 (30.2)	3.80±1.91
Number of sleeping space	1-2	90 (23.4)	3.43±1.64	68 (17.7)	3.62±1.99	71 (18.5)	2.76±1.61
	3-4	236 (61.5)	4.42±1.85	171 (44.5)	4.08±1.87	161 (41.9)	4.07±2.01
	5-6	45 (11.7)	5.07±2.22	89 (23.2)	4.45±1.89	90 (23.4)	437±2.17
	7-8	13 (3.4)	5.77±2.55	56 (14.6)	4.34±2.14	62 (16.2))	4.18±2.16
Types of Dwelling Structure That the Respondent Lives	Family house	188 (48.9)	4.59±2.20	154 (40.1)	4.25±2.06	117 (30.5)	4.43±2.40
	Duplex	5 (1.3)	3.20±1.92	21 (5.5)	4.43±1.86	39 (10.2)	4.28±1.92
	Two/three bedroom	120 (31.3)	4.53±1.59	116 (30.2)	4.39±1.86	131 (34.1)	3.82±1.91
	Mini flat/self-count	16 (4.2)	3.81±1.68	20 (5.2)	3.75±1.94	19 (4.9)	4.32±1.87
	Room and parlous	50 (13.0)	3.24±1.34	56 (14.6)	3.34±1.50	62 (16.2)	2.89±1.49
	Single room	5 (1.3)	2.40±1.67	17 (4.4)	3.82±2.38	16 (4.2)	3.50±2.10

The malaria treatment practices among the respondents

The result revealed that most 380(99.0), 253(65.9) and 254(66.1) of the respondents from Bazza, Mboi and Yebbi respectively use drugs to treat malaria infection. Respondents (887) across all the study areas use drug for treatment. And about 215(56.4) respondents from Bazza, 181(47.1) respondents from Mboi get 1-2 days of drug treatment and 195(50.8) respondents from Yebbi respond to drug treatment within 24 hours. Most of the respondents 122(31.8), 101(26.3) and 96(25.0) use ACT as a mean of malaria infection treatment. ACT is a drug of choice among respondents 319(83.1) across all the study areas. This was followed by Artesunate 52(13.5), 50(13.0), and 50(13.0) across the communities and Artemether + Lumefantrine in Yebbi 50 (13.0). The use of ACT for treatment was sorted for among the respondents 374(97.4) across all the study areas.

Respondents 144(37.5), 118(30.7) and 112(29.2) from Bazza, Mboi and Yebbi respectively agreed that

the drug is effective/strong, while respondents 96(25.0), 96(25.0) and 91(23.7) from Bazza, Yebbi and Mboi respectively state that the choice of ACT was brought pursuant to its cheapness and affordability. While respondents 22(5.7), 57(14.8) and 42(10.9) from Bazza, Mboi and Yebbi respectively resort to use of ACT without any good reason. Some respondents 112(29.2), 96(25.0), and 103(26.8) from Bazza, Mboi and Yebbi could not use ACT due to it high cost/unaffordability, while from Bazza 18(4.7), Mboi 29(7.6) and Yebbi 34(8.9) do not even know the drug at all. The respondents who could not use ACT for no reason or the other was not significant.

Table 2. Malaria Treatment Practices Among Respondents

Question	Parameter	Bazza N (%)	Mean ± SD	Mboi N (%)	Mean ± SD	Yebbi N (%)	Mean ± SD
What do you usually treat malaria with?	Herbs	4 (1.0)	5.50±2.08	131 (34.1)	4.17±1.95	130 (33.9)	4.25±2.24
	Drugs	380 (99.0)	4.30±1.95	253 (65.9)	4.10±1.95	254 (66.1)	3.74±1.97
How soon do you respond to symptoms?	Within 24 hrs	163 (42.4)	4.23±1.93	135 (35.2)	4.25±2.00	195 (50.8)	3.94±2.13
	1–2 days	215 (56.4)	4.41±1.20	181 (47.1)	4.02±1.92	183 (47.7)	3.91±2.06
	After 3 days	6 (1.6)	3.17±0.98	68 (17.7)	4.15±2.02	6 (1.6)	3.17±0.98
Please, Name the Drugs You Prefer Taking Against or for Malaria	ACT	122 (31.8)	4.05±2.02	101 (26.3)	3.75±1.95	96 (25.0)	3.55±2.10
	Artemether + Lumefantrine	45 (11.7)	4.73±1.75	47 (12.2)	4.36±1.82	50 (13.0)	4.14±2.00
	Artesunate	52 (13.5)	4.42±1.64	50 (13.0)	4.30±1.89	50 (13.0)	3.72±1.98
	Quinine	16 (4.2)	5.00±1.86	20 (5.2)	3.80±2.35	24 (6.3)	3.75±2.05
	Chloroquine	36 (9.4)	4.47±2.06	46 (12.0)	4.30±1.81	40 (10.4)	4.30±2.15
	Amodiaquine	31 (8.1)	4.90±1.68	34 (8.9)	4.85±1.84	35 (9.1)	4.20±2.11
	Maldox	23 (6.0)	4.22±2.58	26 (6.8)	4.42±2.35	23 (6.0)	3.91±2.50
	Amatem	6 (1.6)	3.83±1.72	10 (2.6)	3.30±1.57	16 (4.2)	4.63±2.13
	Artemether	44 (11.5)	3.73±2.04	37 (9.6)	3.86±2.01	41 (10.7)	3.76±1.92
	Amaterm forte	5 (1.3)	4.00±1.00	7 (1.8)	4.14±1.46	5 (1.3)	4.00±1.00
	Herbs	4 (1.0)	5.00±2.08	6 (1.6)	4.17±1.47	4 (1.0)	5.50±2.08
If ACT Is Used, What Influenced Your Choice of ACT in Treating Malaria	Effective/Strong	144 (37.5)	4.24±1.90	118 (30.7)	4.08±1.96	112 (29.2)	3.82±1.94
	Cheaper/Affordable	96 (25.0)	4.53±1.87	91 (23.7)	4.30±1.85	96 (25.0)	4.14±2.09

	Availability	79 (20.6)	4.49±2.18	76 (19.8)	4.29±2.17	83 (21.6)	4.08±2.22
	Prescribed by doctor	43 (11.2)	4.18±1.91	42 (10.9)	4.00±1.78	51 (13.3)	3.78±2.09
	No reason	22 (5.7)	3.45±1.82	57 (14.8)	3.81±1.98	42 (10.9)	3.48±2.25
Reasons for not using ACT	Don't know drug	18 (4.7)	3.72±1.56	29 (7.6)	4.17±1.17	34 (8.9)	4.00±1.92
	Not available	27 (7.0)	4.70±1.92	28 (7.3)	4.60±2.20	26 (6.8)	4.11±1.90
	High cost	112 (29.2)	4.50±1.80	96 (25.0)	4.30±1.85	103 (26.8)	3.87±1.95
	Uncertainty of efficacy	73 (19.0)	4.26±1.94	65 (16.9)	3.77±1.93	68 (17.7)	3.91±2.06
	Fear of bitter taste	29 (7.6)	3.52±2.17	33 (8.6)	3.42±2.23	30 (7.8)	3.83±2.39
	Not prescribed	46 (12.0)	4.52±2.07	50 (13.0)	4.16±2.04	44 (11.5)	3.93±2.26
	Fear of side effects	27 (7.0)	4.44±2.15	28 (7.3)	4.68±1.11	29 (7.6)	4.20±2.38
	Prefer other drugs	23 (6.0)	4.30±2.28	27 (7.0)	3.96±1.89	27 (7.0)	3.96±2.23
	No reason	27 (7.0)	4.22±1.89	28 (7.3)	4.14±1.92	22 (5.7)	3.45±1.95

The malaria infection and management measures among the respondents

Table 3 showed that 163(42.4) respondents from Bazza,116(30.2) in Mboi and 135 (35.2) in Yebbi had malaria infection less than three months. 414(108.8) respondents across the study areas stated that, the last time they had malaria infection was less than three months. Few respondents 159(41.4), 124(32.3), 171(44.5) from Bazza, Mboi and Yebbi respectively had malaria infection in the last six months. About 120, 90 and 95 respondents from Bazza, Mboi and Yebbi, totally 305 respondents resort to the use of ACT for the treatment of malaria infection and 3(0.8) Bazza, 13(3.4) Mboi and 12(3.1) Yebbi respondents depends on herbs only. The use of drugs, mostly (431) was prescribed by medical doctor, and followed by those who get prescription from the nurses (191) across all the study areas. The least (24) were those who get prescription from neighbours across all the communities. About 357(93.0), 173(45.1), 224(58.3) respondents from Bazza, Mboi and Yebbi respectively tested for malaria infection giving a total of 754 respondents across the study areas. The respondents from Bazza 248(64.6), Mboi 234(60.9) and Yebbi 221(57.6) used microscopy method test for malaria, About 703 resorts to microscopy test, while 449 used rapid diagnostic tests (RDT).

Table 3: Malaria infection and management measure among the communities

Question	Parameter	Bazza N (%)	Mean ± SD	Mboi N (%)	Mean ± SD	Yebbi N (%)	Mean ± SD
When Was the Last Time You or Your Household Had Malaria?	> 3 months	163 (42.4)	4.44±2.06	116 (30.2)	4.20±2.12	135 (35.2)	4.16±2.20
	4–6 months	159 (41.4)	4.16±1.74	124 (32.3)	4.08±1.76	171 (44.5)	3.75±1.98
	7–9 months	32 (8.3)	4.38±2.00	49 (12.8)	3.92±1.78	28 (7.3)	3.64±1.97
	10–12 months	9 (2.3)	3.89±2.85	44 (11.5)	4.30±2.05	9 (2.3)	3.89±2.85
	≥12 months	21 (5.5)	4.57±2.27	51 (13.3)	4.10±2.12	41 (10.7)	3.98±1.97
What Antimalarial Drugs Did You or Any Member of Your Household Took the Last Time You Had Malaria	ACT	120 (31.3)	4.20±2.10	90 (23.4)	3.78±2.05	95 (24.7)	3.68±2.13
	Artemether	83 (21.6)	3.83±1.93	83 (21.6)	4.07±1.94	78 (20.3)	3.58±2.06
	Artesunate	86 (22.4)	4.50±1.91	86 (22.4)	4.35±1.92	84 (21.9)	3.88±2.03
	Amodiaquine	28 (7.3)	4.57±1.45	32 (8.3)	4.28±1.63	27 (7.0)	4.11±1.85
	Quinine	12 (3.1)	4.83±1.70	12 (3.1)	4.42±2.23	16 (4.2)	4.81±2.37
	Chloroquine	22 (5.7)	4.55±1.95	22 (5.7)	4.36±1.99	22 (5.7)	3.77±1.97
	Malforte plus	5 (1.3)	4.20±0.84	15 (3.9)	3.53±1.88	17 (4.4)	4.94±2.11
	Artemether + Lumefantrine	19 (4.9)	5.00±1.91	19 (4.9)	4.32±1.97	19 (4.9)	4.58±1.29
	Maldox	6 (1.6)	4.50±2.51	12 (3.1)	4.33±2.19	14 (3.6)	3.43±1.83
	Herbs	3 (0.8)	6.00±1.73	13 (3.4)	4.46±1.71	12 (3.1)	4.83±1.59
Who prescribed the drugs?	Medical doctor	160 (41.7)	4.34±1.93	94 (24.5)	4.40±1.98	177 (46.1)	3.62±2.05
	Nurse	67 (17.4)	4.97±1.92	68 (17.7)	4.16±1.93	56 (14.6)	2.05±2.05
	Relation	18 (4.7)	4.00±2.22	34 (8.9)	4.29±1.85	17 (4.4)	2.20±2.21
	Self-prescription	18 (4.7)	4.22±1.80	45 (11.7)	4.00±1.86	18 (4.7)	2.05±2.05
	Pharmacist	10 (2.6)	3.40±1.84	37 (9.6)	3.86±1.72	15 (3.9)	1.87±1.88
	Drug hawkers	6 (1.6)	3.40±1.52	22 (5.7)	4.23±1.82	32 (8.3)	4.53±4.53
	Patent	36	3.56±1.99	49	3.67±2.11	41	3.63±1.93

	medicine sellers	(9.4)		(12.8)		(10.7)	
	Friends	6 (1.6)	6.17±1.83	18 (4.7)	4.33±2.20	15 (3.9)	5.60±1.88
	Neighbors	6 (1.6)	4.25±2.75	14 (3.6)	3.86±2.28	4 (1.0)	4.25±2.75
	Others	60 (15.6)	4.12±1.79	3 (0.8)	4.00±2.65	9 (2.3)	2.78±0.97
Did You Had Test for Malaria the Last Time to Confirm, If It Was Malaria?	Yes	357 (93.0)	4.37±1.96	173 (45.1)	4.14±1.98	224 (58.3)	3.86±2.10
	No	23 (6.0)	3.52±1.52	126 (32.8)	4.10±1.90	145 (37.8)	4.06±2.07
	Can't remember	4 (1.0)	4.00±1.15	85 (22.1)	4.11±1.98	15 (3.9)	3.33±1.72
If yes, which method of test was conducted	Rapid diagnostic test (RDT)	136 (35.4)	4.29±2.07	150 (39.1)	4.01±2.01	163 (42.4)	3.88±2.15
	Microscopy (laboratory)	248 (64.6)	4.33±1.90	234 (60.9)	4.19±1.91	221 (57.6)	3.94±2.03

Malaria prevention practices and utilization of LLIN's by respondents

Table 4 shows malaria preventive practices and utilization of Long-Lasting Insecticidal Nets (LLINs) among respondents in Bazza, Mboi, and Yebbi. Sleeping under LLINs is a common practice, especially in Mboi (mean = 3.94±1.89) and Yebbi (mean = 3.81±2.11). Insecticide spraying is also widely used in Mboi (mean = 4.34±1.86) and Yebbi (mean = 4.12±2.08). Burning coils/grasses is used less frequently, but has a high mean score in Mboi (mean = 5.67±2.12), indicating some respondents rely on it. Cutting bushes/grasses around homes is another common practice in Mboi (mean = 4.04±2.06) and Yebbi (mean = 4.11±2.00). The data suggests that respondents use a mix of preventive measures, with LLINs and insecticide spraying being more common.

Table 4. Malaria Preventive Practice and Utilization of LLIN's by Respondents

Question	**Parameter**	**Bazza N (%)**	**Mean ± SD**	**Mboi N (%)**	**Mean ± SD**	**Yebbi N (%)**	**Mean ± SD**
What Preventive Measures Do You Take Against Malaria in your Household	Sleeping under ordinary net	12 (3.1)	1.00±0.00	11 (2.9)	4.18±1.89	12 (3.1)	4.25±1.71
	Sleeping under LLINs	120 (31.3)	1.12±0.35	146 (38.0)	3.94±1.89	152 (39.6)	3.81±2.11
	Sleeping with windows closed	42 (10.9)	1.07±0.26	12 (3.1)	4.25±1.76	9 (2.3)	3.67±1.73
	Screening of windows with nets	15 (3.9)	1.20±0.56	6 (1.6)	3.50±1.38	11 (2.9)	4.09±2.12
	Use of insecticide spraying	74 (19.3)	1.00±0.00	89 (23.2)	4.34±1.86	89 (23.2)	4.12±2.08

	Burning coil/grass as repellant	14 (3.6)	1.07±0.27	9 (2.3)	5.67±2.12	8 (2.1)	4.25±2.38
	Cutting bushes/grasses	38 (9.9)	1.08±0.27	43 (11.2)	4.04±2.06	38 (9.9)	4.11±2.00
	Draining stagnant water	26 (6.8)	1.04±0.20	32 (8.3)	3.50±1.14	27 (7.0)	3.26±1.87
	Clearing gutters	8 (2.1)	1.00±0.00	6 (1.6)	3.17±0.00	2 (0.5)	4.00±1.41
	Covering body with clothes	22 (5.7)	1.00±0.00	22 (5.7)	4.91±2.87	22 (5.7)	3.27±1.95
	Cover water tanks	7 (1.8)	1.86±0.90	4 (1.0)	5.00±–	7 (1.8)	4.57±2.37
	Use of repellants	6 (1.6)	1.00±0.00	4 (1.0)	4.75±–	7 (1.8)	5.57±2.88
How Many LLINs Does Your Household Have	1–2	79 (20.6)	3.78±1.93	115 (29.9)	3.72±1.76	71 (18.5)	3.30±1.69
	3–4	145 (37.8)	4.26±1.89	155 (40.4)	4.29±1.89	87 (22.7)	4.08±2.00
	5–6	90 (23.4)	4.59±2.08	82 (21.4)	4.39±2.22	75 (19.5)	3.88±2.22
	>6	70 (18.2)	4.64±1.90	32 (8.3)	4.06±2.02	151 (39.3)	4.13±2.18
State the effectiveness ways in which the use of LLN's and home management of malaria could be successfully promoted for prevention and treatment of malaria	Sleeping under LLINs	33 (8.6)	4.73±1.89	66 (17.2)	4.24±2.16	47 (12.2)	4.15±1.99
	Stop using LLINs	59 (15.4)	5.05±2.12	85 (22.1)	4.08±2.08	49 (12.8)	4.59±2.24
	Enlightenment on LLINs	99 (25.8)	4.14±1.96	93 (24.2)	4.05±1.96	95 (24.7)	3.56±2.05
	Campaign against misuse	80 (20.8)	3.98±1.73	60 (15.6)	4.02±1.69	69 (18.0)	3.70±1.94
	Govt. enforcement	64 (16.7)	4.03±2.00	45 (11.7)	4.40±2.00	62 (16.1)	3.77±2.13
	Public sensitization	49 (12.8)	4.41±1.89	35 (9.1)	4.40±1.72	62 (16.1)	4.13±–

Discussion

The findings of this study provide important insights into the epidemiology and control of *Plasmodium falciparum* malaria among children under five in rural communities of Adamawa State. The higher vulnerability observed among children aged 1–2 years aligns with established evidence that immunity to malaria is not yet fully developed in early childhood, making this age group particularly susceptible to infection and severe outcomes (World Health Organization, 2023). Similar patterns have been reported across sub-Saharan Africa, where younger children consistently show higher malaria prevalence compared to older age groups (Aregawi *et al*., 2021).

Housing characteristics and sleeping arrangements also played a significant role in malaria transmission. The predominance of family houses and increased vulnerability among children in crowded sleeping spaces (3–4 persons) suggest that poor housing structure and overcrowding may enhance human-vector contact. This finding corroborates studies

indicating that inadequate housing, lack of screened windows, and high occupancy rates increase exposure to *Anopheles* mosquitoes (Tusting *et al*., 2020). Thus, environmental and structural interventions remain critical components of malaria control strategies in rural settings.

Regarding treatment practices, the widespread use of antimalarial drugs particularly artemisinin-based combination therapies (ACTs) is consistent with national and global treatment guidelines. The preference for ACTs among respondents reflects improved awareness and availability, as recommended by the World Health Organization (2023). However, the study also identified barriers such as cost, lack of knowledge, and irrational drug use without clear justification. These findings are consistent with reports that affordability and accessibility continue to influence treatment-seeking behavior in Nigeria (National Malaria Elimination Programme, 2021). The persistence of herbal treatment use, though minimal, further highlights the role of traditional practices in malaria management.

The study showed that most respondents sought formal healthcare, with prescription of drugs mainly obtained from medical professionals and a high proportion undergoing diagnostic testing, particularly microscopy. This reflects a positive trend toward evidence-based malaria management, in line with recommendations emphasizing parasitological confirmation before treatment (WHO, 2023). The use of rapid diagnostic tests (RDTs) and microscopy suggests variability in diagnostic methods indicates the capacity of health facilities across communities.

Preventive practices revealed moderate to high utilization of long-lasting insecticidal nets (LLINs) and insecticide spraying, which are proven interventions for reducing malaria transmission. Studies have shown that consistent LLIN use, significantly lowers malaria incidence among children under five (Bhatt *et al*., 2021). However, the continued reliance on less effective methods such as burning coils indicates gaps in knowledge or access to optimal preventive tools.

The findings underscore that while progress has been made in malaria management and prevention, challenges related to socioeconomic factors, housing conditions, and health education persist in most of our rural communities. Addressing these gaps through integrated community-based interventions is essential for sustaining malaria control efforts in rural Nigeria.

Conclusion

The study highlights that *Plasmodium falciparum* malaria remains highly prevalent among children under five in rural communities of Adamawa State, particularly among those aged 1–2 years. The findings observed that overcrowded living conditions and residence in traditional family houses contribute significantly to increased exposure and transmission. While there is a commendable reliance on recommended treatment options, especially artemisinin-based combination therapies (ACTs), challenges such as cost, limited awareness, and occasional dependence on non-standard treatments persist. It was observed most respondents seek professional medical care and utilize diagnostic testing, indicating progress in malaria case management. Preventive practices, including the use of long-lasting insecticidal nets and insecticide spraying, are moderately adopted but not consistently optimized. Therefore, strengthening health education, improving access to affordable treatment, and enhancing environmental and vector control8 measures are critical steps toward reducing malaria burden in these communities.

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