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Research Article

Asymptomatic Malaria among Adolescents Attending Secondary Schools in Ardo-Kola and Jalingo Local Government Areas (LGAs), Taraba State, Nigeria

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ABSTRACT
Malaria is one of the most important public health challenges in sub-Saharan Africa. The aim of this study was to assess asymptomatic malaria in relation to the sociodemographic as well as the risk factors exposing the adolescents attending secondary schools in Ardo-Kola and Jalingo Local Government Areas, Taraba State to malaria infection. A total of two hundred and eighty-six (286) samples were collected from adolescents attending secondary schools within the selected LGAs. Four schools were selected and equal samples were collected from each school to obtain the required sample size. All the samples were screened for malaria parasitaemia using microscopy and molecular techniques. The findings of this study revealed a prevalence of 13.9% (40/286) among the adolescents. In relation to age, infection was significantly higher 22.7% (15/66) among between 12-16 years old (χ^2 = 15.879, p = 0.053). Keeping of opened containers of water around the house significantly exposed the adolescents to malaria infection in Ardo-Kola, and Jalingo Local Government Areas of Taraba state, Nigeria with an adjusted odd ratio (aOR) of 5.09 (%CI95:1.20-7.98, p=0.015). The findings indicate that despite ongoing malaria control efforts, silent transmission persist within the understudied age group, contributing to continuous malaria transmission in the urban and rural communities.

Keywords: Adolescents; Ardo-Kola; Asymptomatic; Jalingo; Malaria; Secondary schools

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INTRODUCTION

Malaria is one of the most important public health challenges in sub-Saharan Africa, with Nigeria contributing about 27% of the world malaria burden (WHO, 2024). While serious attention has been paid to symptomatic malaria, the asymptomatic malaria cases where people harbour the malaria parasites without apparent symptoms has received less attention. Asymptomatic malaria poses a significant challenge to malaria control efforts because individuals undiagnosed serve as reservoirs unknowingly, which maintains the transmission of malaria within communities (Biruksew *et al.,* 2023). The increase in the transmission of malaria, notwithstanding the ongoing preventive and control measures, has necessitated a deeper understanding of asymptomatic malaria, particularly among adolescents which are vulnerable group.

The transmission of malaria is influenced by socio-economic, behavioural and environmental factors. Adolescents, which are a group that is often overlooked in malaria research, are particularly vulnerable because of their increased mobility and limited access to health care services (Sani and Doko, 2024). Studies have demonstrated that adolescents experience increased rates of asymptomatic malarial infections in comparison to other age populations, which leads to sustained transmission in endemic

areas (Fikadu and Ashenafi*,* 2023). The issues of asymptomatic malaria extend beyond only health concerns to include reduced cognitive function, absenteeism from schools, and the long-term economic consequences due to weakened educational outcomes (Dosoo *et al*., 2023).

Being hyperendemic for malaria, Nigeria has undertaken various prevention and control measures, which includes the use of indoor residual sprays (IRS), intermittent preventive treatment (IPT), and continuous distribution of insecticide-treated nets (ITNs). However, malaria still remains prevalent, particularly in regions with conducive environmental conditions for vector breeding (Okeke *et al.,* 2020).

Asymptomatic malaria presents serious epidemiological and public health issues. Unlike in symptomatic malaria, which prompts people to quickly seek medical care, asymptomatic individuals do not exhibit fever or other symptoms, making them to harbour and transmit the parasites unknowingly for extended periods of time (Cheaveau *et al.,* 2019). This type of silent transmission can serve as a stumbling block to malaria elimination strategies, as conventional diagnostic and treatment methods primarily target symptomatic individuals.

Research carried out in Ethiopia by Biruksew *et al*., (2023) discovered that adolescents with asymptomatic malaria infections significantly contributed to the transmission of malaria within their communities, which indicate that educational institutions might serve as critical focal points for the surveillance and intervention of malaria. In the same way, a study by Sani and Doko (2024) in Nigeria had shown that asymptomatic malaria is widespread among adolescents, with a prevalence which ranged from 20% to 50% depending on geographic and environmental factors. This study was conducted to determine the asymptomatic malaria infection in relation to the socio-demographic factors, as well as to find the risk factors exposing the adolescents of secondary schools to malaria infection in Jalingo and Ardo-Kola Local Government Areas, Taraba State, Nigeria.

MATERIALS AND METHODS

Study Area

This study was carried out in Ardo-Kola and Jalingo Local Government Area (LGAs) of Taraba State, Nigeria. The LGAs are located in the central and northeastern parts of Taraba State, Nigeria respectively. Jalingo LGA, the State capital, serves as the administrative and commercial hub of Taraba State. It encompasses the areas such as while Ardo-Kola LGA lies adjacent to it, sharing a close socio-economic relationship. Jalingo LGA is positioned at approximately 8°89’41’’N latitude and 11°35’80’’E longitude, while Ardo-Kola LGA is situated at approximately 8°70’04’’N latitude and 11°33’63’’E longitude and is predominantly agrarian, with farming and livestock rearing as the primary occupations of the inhabitants. Major ethnic groups in the areas include the Fulani, Jukun Kona, and Mumuye.

Study Design and Sample determination

A cross-sectional design was used. This design is appropriate for assessing the prevalence of asymptomatic malaria and identifying associated factors among adolescent in secondary schools at a specific point in time. This design also allows for the collection of data from a representative sample of the population, and enables the examination of relationships between malaria prevalence, and socio-demographic, environmental, and behavioural factors.

The sample size for this study was determined using the Cochran’s formula as follows:

$$n = \frac{z^2 x\ p(1-p)}{e^2}$$

Where:

n= initial sample size

Z = Z-value (e.g., 1.96 for 95% confidence level)

p = estimated proportion of the population with the attribute.

e = margin of error (usually 0.05 for 5%)

$$n = \frac{1.96^2 \text{x } 0.25(1-0.25)}{0.05^2}$$

$$n = \frac{3.8416 \text{ x } 0.25 \text{ x } 0.75}{0.0025}$$

$$n = \frac{0.7203}{0.0025}$$

$$n \approx 288$$

Ethical Considerations

Ethical approval for this study was obtained at the ethical unit of Federal Medical Center, Jalingo (FMC/JL/HREC/49). Informed consent was issued to the participants prior to their involvement in the study. All data from this study was used only for academic purposes.

Inclusion and Exclusion Criteria

Adolescents from JSS1-SSS3 in the selected schools who provided informed consent and willing to participate in the study. Any participant that did not meet the criteria above were excluded from the study.

Instrument for Data Collection

A structured questionnaire was used to capture the demographic data (age, gender, school type) and malaria-related history (recent fever, use of mosquito nets, history of malaria treatment, and preventive measures).

Collection of Samples

A total of two hundred and eighty-six (286) samples were collected from adolescents attending secondary schools in Ardo-Kola and Jalingo Local Government Areas of Taraba State, Nigeria. Four schools were selected and equal samples were collected from each school to obtain the required sample size. The samples collected were tested for malaria parasitemia using microscopy, and molecular techniques.

Laboratory Procedures

Thick Blood Film Smear

Blood samples were smeared onto a clean grease-free microscopic slide. They were allowed to air-dry and were stained using a Giemsa stain. They were then observed using oil immersion objective under the microscope. Results were recorded based on the number of parasites seen under the microscope (Cheesbrough, 2006).

Polymerase chain reaction (PCR)

Both positive and negative samples were selected and subjected for molecular analysis using polymerase chain reaction (PCR) to amplify the parasites DNA in the samples. Specific primers and probes that target parasite-specific genes, such as the *Plasmodium* 18S rRNA gene were designed and used during the analysis (Deora *et al.*, 2025).

Data Analysis

Data collected from the study were analysed using the Statistical Package for the Social Sciences (SPSS) version 27.0. Descriptive statistics, including frequencies, percentages were employed to summarize the socio-demographic characteristics of the participants and the prevalence of malaria. A Chi-square analysis was carried out to explore the relationship between malaria infection and the categorical variables, including socio-demographic factors, environmental exposures, and preventive practices. All analyses were done at a 95% confidence interval.

RESULTS

Table 1 shows the description of the participants to the study conducted in secondary schools in Ardo-Kola and Jalingo Local Government Areas, Taraba State, Nigeria. The participants from Salihu Dogo secondary school had 24.2% (69/286), while those from malum were 25.8% (74/286). Female participants were 50.6% (145/286) and Males were 49.3% (141/296). Participants that were < 11 years had 1.7% (5/286), while those that were > 16 years had 75.1% (203/286). Muslim participants were 70.9% (203/286), while those from other religion were 2.0% (6/286).

Figure 1 shows the agarose gel electrophoregram of *Plasmodium falciparum* DNA. The Molecular weight marker (DNA ladder) showed fragment sizes ranging from approximately 100 bp to 1500 bp, used as a reference for estimating PCR product sizes. Lanes 4, 14 and 21showed distinct bands at approximately 100 bp, consistent with the expected size of the amplified fragment of the *Plasmodium* 18S rRNA gene, indicating the presence of *P. falciparum* DNA. Lanes 2, 11 and 17 showed no visible bands, suggesting that these samples were negative for *P. falciparum* DNA.

Table 2 shows asymptomatic malaria in relation to sociodemographic characteristics of adolescents attending secondary schools in Ardo-Kola and Jalingo Local Government Area. A total of 286 students were examined, out of which 13.9% (40/286) tested positive for asymptomatic malaria infection. For age, infection was 0.0% (0/5) among those ≤11 years, while 22.7% (15/66) was observed among the 12–16 years. There was a significance (χ^2 = 15.879, p = 0.053).

Table 4 shows the risk factors exposing adolescent students in secondary schools to asymptomatic malaria in Ardo-Kola and Jalingo Local Government Areas, Taraba State, Nigeria. Adolescent sstudents having empty pots filled with water around their house were significantly exposed to malaria infection with an adjusted odds ratio (aOR) of 5.09 (%CI95:1.20-7.98, p=0.015).

Table 1: Description of the participants attending secondary schools in Ardo-Kola and Jalingo Local Government Areas, Taraba State, Nigeria

Variables	Participants (%), (N=286)
Schools	
Salihu Dogo	69 (24.2)
Malum	74 (25.8)
Kofai	72 (25.1)
Nukai	71 (24.8)
Sex	
Male	141 (49.3)
Female	145 (50.6)
Age (years)	
[< 11]	5 (1.7)
[12 - 16]	66 (23.0)
[>16]	215 (75.1)
Religion	
Christianity	77 (26.9)
Islam	203 (70.9)
Other religion	6 (2.0)

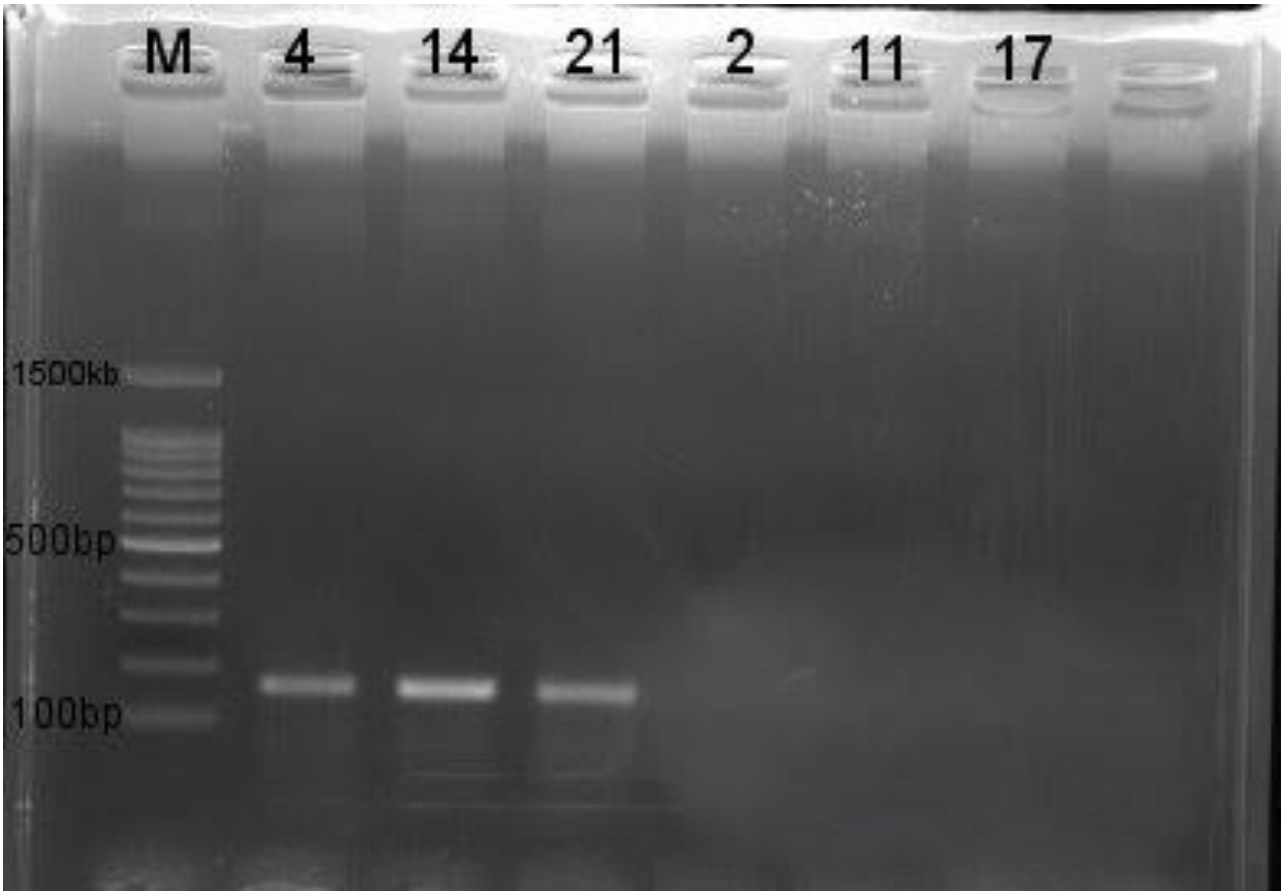

Figure 1: Agarose gel electrophoregram showing PCR amplification results for the detection of *Plasmodium falciparum* DNA in selected samples

Keys: lane M = Molecular weight marker (DNA ladder), Lanes 4, 14, 21 = Positive samples Lanes 2, 11, 17 = Negative samples

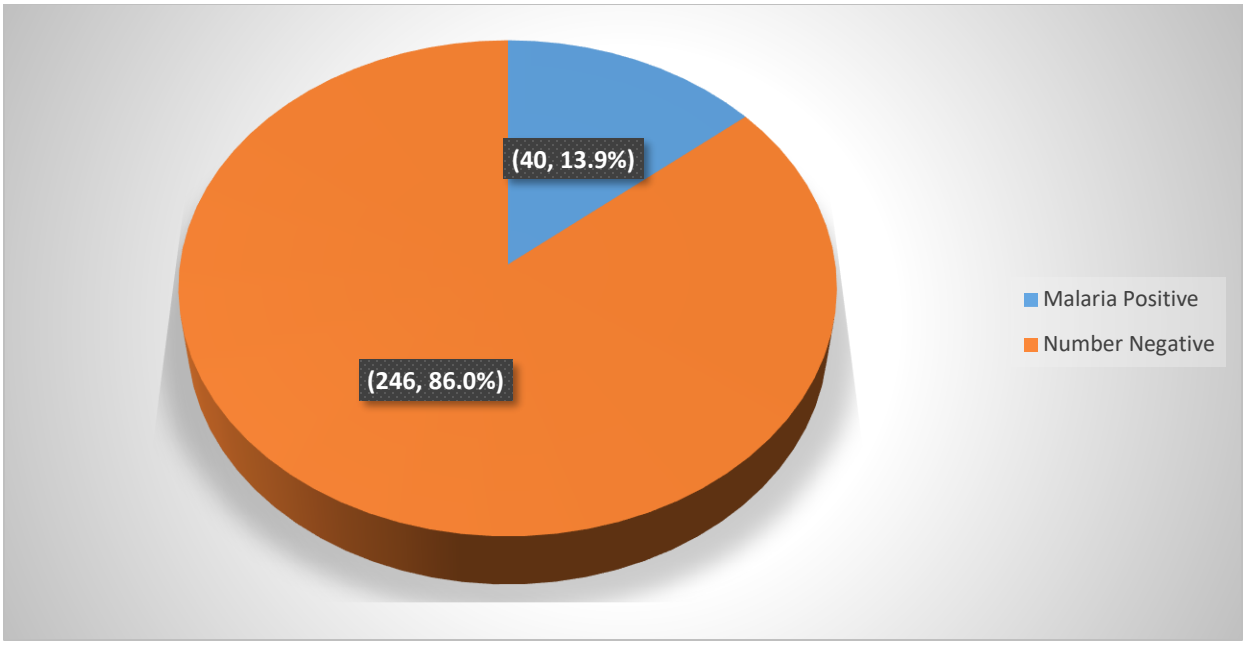

Figure 2: Prevalence of asymptomatic malaria among adolescents attending secondary schools in Ardo-Kola and Jalingo Local Government Areas of Taraba State, Nigeria

Table 2: Asymptomatic Malaria in Relation to Socio-demographic Characteristics of Adolescents Attending Secondary Schools in Ardo-Kola, and Jalingo Local Government Areas of Taraba State, Nigeria

Socio-demographic Variables	No. Examined	Malaria positive (%)	χ^2	P-value
Infection	286	40 (13.9)		
Schools			2.972	0.396
Salihu Dogo	69	7 (10.1)		
Malum	74	14 (18.9)		
Kofai	72	8 (11.1)		
Nukai	71	11 (15.5)		
Sex				
Male	141	20 (14.2)	0.389	0.530
Female	145	20 (13.8)		
Age (years)				
≤11	5	0 (0.0)	15.879	0.053
12–16	66	15 (22.7)		
>16	215	25 (11.6)		
Religion				
Christianity	203	29 (14.3)	0.997	0.608
Islam	77	11(14.2)		
Other religion	6	0 (0.0)		

Table 3: Asymptomatic Malaria in Relation to Prevention and Treatment of Malaria among Adolescents Attending Secondary Schools in Ardo-Kola and Jalingo Local Governments of Taraba State, Nigeria.

Prevention and Treatment Strategies	No. Examined	No. Positive (%)	χ^2	P-value
Preventive Measures against Malaria			0.133	0.442
Yes	255	35 (13.7)		
No	31	5 (16.1)		
Treatment during Last Three Months			2.444	0.486
None	146	20 (13.7)		
Once	53	7 (13.2)		
Twice	55	11 (19.0)		
More than twice	32	2 (6.3)		
Type of Treatment received			0.509	0.520
Antimalarial tablets	259	35 (13.5)		
Intravenous injections	17	5 (12.5)		
Self-Satisfaction with Treatment			0.135	0.420
Yes	172	23 (13.4)		
No	114	17 (14.9)		

Table 4: Environmental and Behavioural Risk Factors among Adolescents Attending Secondary Schools in Ardo-Kola and Jalingo Local Government Areas, Taraba State, Nigeria

Risk Factors	No. Examined	Malaria Positive (%)	OR [%95CI]	P-value
Living near stagnant water			0.10 [0.03-1.23]	0.936
Yes	129	19 (14.7)		
No	157	21 (13.4)		
Having empty pots filled with water around house			5.09 [1.20-7.98]	0.015
Yes	153	25 (16.3)		
No	133	12 (9.0)		
History of Malaria			0.29 [0.09-2.01]	0.649
Yes	116	11 (9.5)		
No	170	29 (14.1)		
Use of Mosquito Repellent Creams			0.04 [0.00-0.90]	0.495
Yes	117	17 (14.5)		
No	169	23 (13.6)		
Use of Mosquito Repellent Sprays			0.51 [0.20-1.31]	0.284
Yes	126	15 (11.9)		
No	160	25 (15.6)		
Having Net on Windows			0.04 [0.01-1.90]	0.478
Yes	169	23 (13.6)		
No	117	17 (14.5)		
Frequent Engagement in Outdoor Activities			0.01 [0.00-1.09]	0.572
Yes	98	14 (14.3)		
No	188	26 (13.8)		

DISCUSSION

This study assessed the prevalence and associated risk factors of asymptomatic malaria among adolescents attending secondary schools in Ardo-Kola and Jalingo Local Ggovernment Areas, Taraba State, Nigeria. The study revealed a total prevalence of 13.9% among the adolescents. The prevalence observed in this study is consistent with the report by Ajakaye and Ibukunoluwa (2019), who reported an asymptomatic malaria prevalence of 13.8% among school-aged children in Osogbo, Osun State, Nigeria. Okoli *et al.* (2020) reported a similar prevalence of 15.2% in Imo State, Nigeria. The relatively lower rate recorded in this study may be attributed to improved malaria control measures, including the use of insecticide-treated nets (ITNs) and increased awareness campaigns among school children in urban Jalingo metropolis and nearby Ardo-Kola LGA.

The findings in this study suggest that local environmental management remains an important determinant of malaria transmission, even to the nearby Ardo-Kola Local Government Area within the same locality.

In relation to age, the highest prevalence was observed among students aged 12–16 years. The malaria infection was significantly associated to the age of 12-16 years. This trend suggests that early adolescents are more vulnerable to asymptomatic malaria than younger or older counterparts. This finding supports the report by Balogun *et al.* (2021), who observed that partial immunity develops with age. School-aged children remain a major reservoir for malaria parasites due to subclinical infections. This indicates that despite ongoing malaria control efforts, silent transmission reservoirs persist within this age group, contributing to continuous malaria transmission in the community.

With regards to the environmental and behavioural attitudes as exposing risk factors of the adolescents to asymptomatic malaria infection showed that the presence of empty pots filled with water around their homes highlights the domestic breeding sites that sustains malaria transmission. Ibrahim *et al.* (2021) in Kano, Kano State, Nigeria, and Saidu *et al.* (2018) in Abuja, the Federal Capital Territory also reported that improper water storage and poor sanitation promote mosquito breeding sites.

CONCLUSION

The findings of this study revealed that asymptomatic malaria infection remains a public health concern among apparently healthy school-aged individuals, with an overall prevalence of 13.9%. The presence of empty pots filled with water around the adolescent homes was an exposing risk factor to malaria infection.

Therefore, it is recommended that routine malaria screening should be incorporated into school health programs to identify asymptomatic carriers among adolescents. Both students and households should be sensitized to maintain proper environmental sanitation. Community-led initiatives such as monthly clean-up exercises, proper waste disposal, and destruction of mosquito breeding sites should be encouraged and supported by local health authorities. Public health agencies should intensify campaigns on the regular use of insecticide-treated mosquito nets, particularly among school-aged children. Government and non-governmental health agencies should strengthen malaria surveillance systems to include asymptomatic infections as part of monitoring frameworks. Policies should emphasize school-based interventions and community-level vector control.

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Authors' Contributions

HRS, WBE, and NEJ: Conceptualization and study design. AVY, AOJ, NEJ, TBT: Data collection, laboratory analysis, data interpretation and original draft preparation. HRS: Project coordination/supervision, data analysis, validation of results, and final manuscript approval. HRS, WBE, AVY, AOJ, TBT, and NEJ revised and approved the final manuscript.

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