Available: DOI: https://doi.org/10.54117/gjpas.v1i2.18 ***Research** article*

Gadau Journal of Pure and Allied Sciences
Gadau J Pure Alli Sci, 1(2): 95-102 (2022)
ISSN: 2955-1722
DOI: https://doi.org/10.54117/gjpas.v1i2.18

Prevalence of malaria infection and Associated Risk Factors among students of Bauchi State University Gadau, Bauchi State, Nigeria

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Abstract

Malaria is one of the leading causes of mortality and morbidity in tropical and subtropical regions of the world. Most of the global malaria burden is in sub-Saharan African countries, including Nigeria. This study aimed to determine the prevalence and risk factors of malaria infection among students of Bauchi State University Gadau (BASUG), Bauchi State of Nigeria. A cross-sectional study involving 400 BASUG students was conducted between June and November 2020. A sample of 400 university students aged 15 to 30 years were tested for malaria infection. The thick and thin blood films were prepared and viewed using the standard parasitological microscopy technique to detect the *Plasmodium* parasite. Data on risk factors were obtained using a simple questionnaire. All collected data were analyzed with Statistical Package for Social Science (SPSS) version 24. A chi-square analysis was performed, and the strength of association was measured using Odds Ratio (OR) at 95 % CI. The overall prevalence of malaria among university students was 59.8%. The differences in the prevalence of malaria infection to sex and age were not statistically significant ($p>0.05$). There is a statistically significant difference in the prevalence of malaria infection among students who live off-campus and their counterparts ($\chi^2=23.4$, df=1, p=0.90) and among students who do not use mosquito nets compared with other students who use it ($\chi^2=23.4$, df=1, p=0.90). The binary logistic regression analysis revealed that the students who stay off-campus are nearly two times more infected with malaria infection than those who lived on-campus [COR (95% CI): 1.56 (1.04-2.35)]. The students who do not sleep under the mosquito-treated net appeared to be at a high risk of malaria infection compared to those who use it [COR (95 % CI): 0.55 (0.36-0.83)]. Malaria is prevalent among the students of BASUG, Bauchi state, and this is glaring evidence indicating malaria is a public health challenge. The non-use of mosquito nets in the study area is one of the major risk factors influencing transmission. Health education on mosquito prevention should educate the students on the importance of using a mosquito bed net, fumigation, and indoor residual spray in their surroundings.

Article History
Received: 02/04/2022
Accepted: 27/08/2022
Published: 28/08/2022

Keywords
BASUG;
Nigeria;
Malaria infection;
University students;
Risk factors

How to cite this paper: Abubakar, B.M., Haruna, A., Moi, I.M. and Katagum, Y.M. (2022). Prevalence of malaria infection and Associated Risk Factors among students of Bauchi State University Gadau, Bauchi State, Nigeria. *Gadau J Pure Alli Sci, 1(2): 95-102*. https://doi.org/10.54117/gjpas.v1i2.18 .

1.0 Introduction

Malaria is a serious public health problem caused by the *Plasmodium* parasite of the Apicomplexans family (Awosolu *et al.*, 2021). The disease is transmitted from one person to another through the bite of female *Anopheles* mosquitoes (Cox, 2010). It primarily

infects people worldwide in tropical and subtropical areas, mainly in Sub-Saharan Africa(Ezihe *et al.*, 2019). Malaria is a parasitic infection caused by several *Plasmodium* species. *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, and *Plasmodium ovale* are the four primary malaria parasites that cause infection in humans, whereas *Plasmodium knowlesi* is a zoonotic species prevalent in Southeast Asia (Awosolu *et al.*, 2021). *P. falciparum* is the most pathogenic and, together with *P. vivax*, causes most death, while *P. ovale* and *P. malariae* cause a milder form of malaria that is rarely lethal (Beare *et al.*, 2006; Gething *et al.*, 2012). Even though preventable, malaria has continued to cause significant morbidity and mortality worldwide, especially in sub-Saharan Africa. The breeding of mosquitoes and the spread of malaria are aided by the environmental conditions of tropical and subtropical African countries, such as constant high temperature, humidity and copious stagnant waters due to poor drainage systems (Ogomaka, 2020).

An estimated 3.2 billion individuals worldwide are a at risk of acquiring malaria each year (Awosolu *et al.*, 2021). Furthermore, in 2017, nearly 219 million cases were reported in 87 countries, resulting in approximately 435,000 deaths (WHO, 2018). Malaria caused the majority of worldwide morbidity and mortality, with nearly 3.1 billion dollars spent on malaria control and elimination projects in Sub-Saharan Africa in 2017 (WHO, 2018). Malaria is spread all year in Nigeria, where more than 194 million people are at risk of contracting malaria disease. As a result, Nigeria had the highest malaria prevalence worldwide in 2007(FMOH, 2009). Malaria significantly contributes to the rise in hospital visits throughout Nigeria's six geo-political zones (Adeyemo *et al.*, 2014). The Nigerian Federal Ministry of Health estimated 110 million clinical malaria cases each year, costing the country NGN 132 billion in treatment and preventative costs (FMOH, 2009). The intensity of malaria transmission is determined by demographic (age and gender) and environmental factors (presence or absence of bushes and forests that enhance mosquito breeding). Climate elements such as temperature, humidity, and rainfall, which may favour mosquito vectors' rapid growth and development, are also risk factors for malaria transmission. These factors have been well reported in previous studies in Nigeria (Gunn *et al.*, 2015; Morakinyo *et al.*, 2018) and elsewhere (Dejazmach *et al.*, 2021; Kalinga *et al.*, 2019) regarding the prevalence of malaria infection.

Most malaria studies and interventions in Nigeria have focused on pregnant women (Agomo *et al.*, 2009; Fana *et al.*, 2015) and infants (Morakinyo *et al.*, 2018; Olasehinde *et al.*, 2010). It is challenging to create risk-based preventive interventions in academic settings like universities. University students frequently engage in late-night or early-morning activities, whether academic or otherwise, putting them at risk of *Plasmodium*-infected mosquito bites and thus malaria infection. Aside from mortality, the effects can include disruptions in school attendance, performance, and student absence. However, despite the high prevalence of malaria infection reported from various high institutions of learning in Nigeria (Adepeju, 2017; Ezugbo-Nwobi *et al.*, 2011; Ibekwe *et al.*, 2009; Udeze *et al.*, 2013) and other parts of the world (Bamou and Sevidzem, 2016; Solomon and Teklu, 2019), there is still a dearth of information on the prevalence of malaria infection among students in the present study area. Therefore, this study was designed to determine the status of malaria among the students of Bauchi State University Gadau, Nigeria, and determine the risk factors associated with the infection. The findings of this study will help the university management understand the prevalence of malaria infection among their students and the associated risk factors for the transmission of malaria infection.

2.0 Materials and Methods

2.1 Study Area

The study was conducted at Bauchi State University's main Campus, Gadau, Bauchi State. A cross-section study was conducted between June 2020 and November 2020 to determine the prevalence of malaria infection affecting students of Bauchi State University Gadau, both living on campus and off-campus. The area is geographically located between latitudes 11º 53′ 38″ North of the Equator and longitudes 10º 2′ 55″ East of the Greenwich meridian and occupies a total land area of 1398 km² (Figure 1).

2.2 Sample Size determination

A simple random sampling was used to determine malaria prevalence among tertiary students. According to Thrusfield (2018), the sample size was calculated with an expected prevalence of 50% at a 95% confidence level, and 5% desired absolute precision for the study area.

$$n = \frac{(1.96^2 \times P)\,(1-P)}{d^2}$$

Where: n=required sample size, P is the expected prevalence, and d is the desired absolute precision at 1.962=z-value for the 95% confidence level. The expected prevalence was assumed to be 50% because no previous study had been conducted in the study district. This gave us a minimum sample of 384. However, the sample size calculated was adjusted to 400 as the baseline sample size of our study to avoid bias in the selection of the tertiary students.

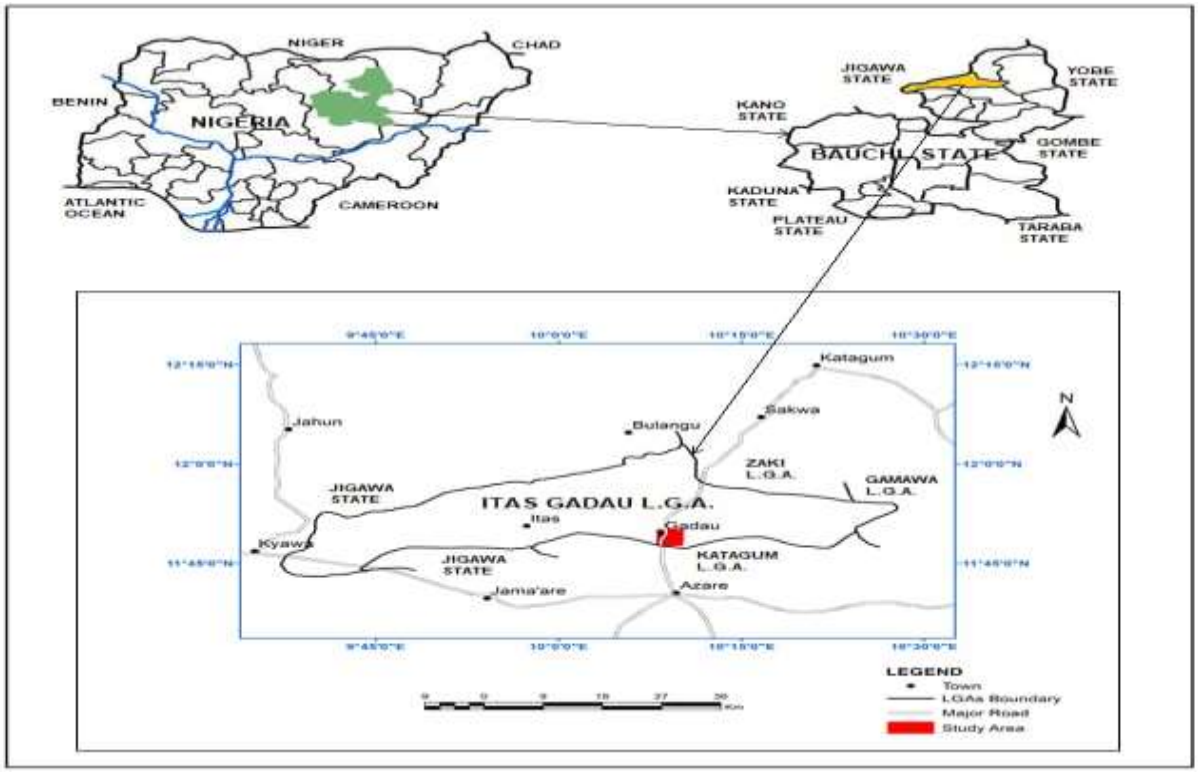

Figure 1: Map of the Study Area.

2.3 Sample Collection and Analysis

The presence of malaria *Plasmodium* was analyzed in a sample of 400 university students aged 15 to 30 years old from the study area. The students were also administered simple questionnaires to access the associated risk factors associated with malaria infection. Finger prick blood samples were collected using a careful aseptic procedure by swabbing the finger with 70% alcohol and allowed to dry before pricking. Subsequent drops of blood were collected on a clean microscopic slide to make the thick blood films, after which all slides were labelled accordingly. All samples collected were taken to the Department of Biological Sciences Laboratory, Bauchi State University Gadau, for analysis.

The thick blood films were prepared in accordance with the World Health Organization-recommended technique (Organization and Control, 2010). A drop of blood was smeared to a moderate thickness on a grease-free microscopic slide, let air dry, then stained with 10% Giemsa stain. The blood was left for 10 minutes before washing away with clean water. The slide was then placed vertically and was allowed to dry before being coated with immersion oil and examined at a magnification of 100 under a microscope. Positive results are indicated by the presence of ring forms of *Plasmodium* trophozoites.

2.4 Data Analysis

The presence or absence of malaria infection was computed. The chi-square test was used to calculate the differences in prevalence between age groups and sex at a 95% confidence level using SPSS version 24. Malaria-related risk factors were identified using bivariate logistic regression analysis. P-values less than 0.05 were considered significant.

2.5 Ethical Consideration

Approval for this study was sought from the Head of the Department of Biological Sciences of Bauchi State University. Consent was obtained from the occupants of all rooms used.

3.0 Results

The result of the study showed that the prevalence of malaria infection among university students in the study area was 59.8%. Out of the 400 university students enrolled, 283 (70.7%) were male, and 117 (29.3%) were female. The highest prevalence was observed in the male students, 176 (62.2%), while the female had 63 (54.3%). The observed differences in the prevalence of malaria infection among sex do not vary significantly ($\chi 2 = 2.1$, df = 1, p = 0.15) (Table 1). In terms of age, 85 (21.3%) university students were between the age group of 15-19 years, 213 (53.2%) between the age group of 20-29years, and 102 (25.5%) between the age group of 30 and above were enrolled in the present study. The highest prevalence of malaria infection was recorded among the 20-29 years age group (62.0 %), followed by the 30 years and above age group (61.8%). Meanwhile, the15-19 years age group has the least infection rate (51.8%). However,

the result showed no statistically significant difference in the prevalence of malaria infection within the age groups (χ^2=2.86, df=2, p=0.24).

In terms of student residence, out of the total number (400) of the university students enrolled in the present study, 163 (40.8%) stay in the university hostel. In comparison, 237 (59.2%) remain outside the institution (off-campus). A high prevalence of malaria infection was observed among students who live off-campus, 151 (63.7%), while students on campus have 88 (54.0%). The results showed a statistically significant association between the malaria infection and the type of residence where the student lives (χ^2=3.79, df=1, p=0.03), as shown in Table 1.

Table 1: Socio-demographic features of the prevalence of malaria infection sex and age of the study area.

Variables	Frequency	Percentage (%)	No. Positive (%)	No. Negative (%)	χ^2	*p*-value
Sex						
Male	283	70.7	176 (62.2)	107 (37.8)	2.13	0.15
Female	117	29.3	63 (54.3)	53 (45.7)		
Age (years)						
15-19	85	21.3	44 (51.8)	41 (48.2)		
20-29	213	53.2	132 (62.0)	81 (38.0)	2.86	0.24
30-above	102	25.5	63 (61.8)	39(38.2)		
Student residence						
On campus	163	40.8	87 (53.4)	76 (46.6)	4.65	0.03
Off-campus	237	59.2	152(64.1)	85 (36.9)		

3.2 Risk factors associated with the malaria infection

Of the 400 university students surveyed, 201 (50.3%) had the habit of sleeping under a treated net, while 199 (49.7%) do not. The analysis shows that this factor is associated with the prevalence of malaria infection as it is statistically significant (χ^2=8.26, df=1, p=0.004). On the other hand, out of the total number of students who participated in the study, 223 (55.8%) don't use an insecticide in their rooms, while 177 (44.2%) are of the habit of using that. However, the result showed no statistically significant difference in the prevalence of malaria infection between the students who use insecticide and those who do not (χ^2=2.86, df=1, p=0.91) as shown in Table 2.

Table 2: Frequency of risk factors associated with malaria infection among university students.

Risk factors	Frequency	Percentage (%)	No. Positive (%)	No. Negative (%)	χ^2	*p*-value
Use of treated net						
No	199	49.8	133(66.8)	66(33.2)	8.26	0.004
Yes	201	50.2	106(52.7)	95(47.3)		
Use of insecticide						
No	223	55.8	125(56.1)	98(43.9)	2.86	0.91
Yes	177	44.2	114(64.4)	63(35.6)		

3.3 Binary logistic regression analysis

The binary logistic results for the factors associated with malaria infection are presented in Table 3. The binary logistic regression analysis shows that the students stay off-campus are nearly two times to be infected with malaria parasites than those who lived on-campus [COR (95% CI): 1.56 (1.04-2.35)]. The student who didn't use to sleep under the treated net appeared to be a high-risk of getting of malaria parasites compared to those who used [COR (95 % CI): 0.55 (0.36-0.83)].

4.0 Discussion

The results obtained in the study showed a high prevalence of malaria among Bauchi State University Gadau (BASUG) students living in Gadau. The prevalence of malaria infection among the students examined was 59.8 %. This revealed that the students were infected with malaria at a significant rate. The findings were similar to those reported by Simon-Oke and Akinbote (2020) among University students in Akure, Nigeria, who discovered 60.5 percent of malaria infection. The majority of the students were asymptomatic, making them potential disease reservoirs.

Table 3: Bivariate logistic regression analysis of variables associated with risk factors of malaria infection in the study area

Variables	Frequency of Malaria infection		COR (95% CI)
	Subtotal (%)	Positive (%)	
Sex			
Male	283	176 (62.2)	1.38 (0.89-2.14)
Female	117	64 (54.3)	1
Age (years)			
12-19	85	44 (51.8)	1
20-29	213	132 (62.0)	1.52 (0.91-2.52)
30 and above	102	63 (61.8)	1.51 (0.84-2.69)
Student residence			
On campus	163	87(53.4)	1
Off campus	237	152(64.1)	1.56 (1.04-2.35)
Use of treated net			
No	109	133(66.8)	1
Yes	201	106(52.7)	0.55 (0.36-0.83)
Use of insecticide			
No	223	125(56.1)	1
Yes	177	114(64.4)	1.42 (0.95-2.13)

COR: Crude Odd Ratio

Furthermore, according to recent malaria risk maps, malaria prevalence in Nigeria ranged from less than 20% in certain places to over 70% in others (Onyiri, 2015). The result from the present study was relatively higher than what was reported by Mukhtar *et al.* (2020), who recorded a 26.0% prevalence of malaria infection among some undergraduate students in Kano state, northwest Nigeria. In some higher institutions, the high prevalence was reported, such as Awosolu *et al.* (2020), who found a substantially higher frequency of malaria (84.20%) among students at the Federal University Of Technology, Akure, south-west Nigeria. Likewise, Ibekwe *et al.* (2009) in Nnamdi Azikwe University in Awka, South-Eastern, Nigeria, and Adepeju (2017) in Federal University Of Technology, Akure, south-west, Nigeria reported 80.3 % and 80.0% malaria prevalence among their students, respectively. The high prevalence of malaria may be explained by the presence of bushes and stagnant water around most students participating in this study. This can increase mosquito breeding in the environment and, resulting in infection transfer to people living in such locations. On the other hand, the high malaria infection prevalence could be ascribed to student activities such as night reading in class, which is commonly practiced by most students and is generally done in the open, exposing them to mosquito bites.

From our findings, the males have a higher prevalence rate (62.2%) than their female counterparts (54.7%), even though the difference is not statistically significant. The high percentage prevalence observed in the male student in the present study agrees with what was reported by Ezihe *et al.* (2019) and Ezugbo-Nwobi *et al.* (2011) among Azikiwe's University students. Similarly, Adepeju (2017) reported a high prevalence among Federal University Of Technology students, Akure. However, However, the findings of this study contradict those of Oyinlola *et al.* (2015), who found that female participants (31.2%) have a higher chance of contracting malaria than male participants (27.7%). The fact that males were more infected than females in the present study could be due to the sample size difference. So also, during warmer weather, males expose their bodies and prefer to sleep outside under insecticide-treated nets; therefore, the likelihood of being bitten by the mosquito vector increases. Males in some settings use health care services less than females because they may prioritize their health less, making them hesitant to go long distances to health centres even when malaria is suspected (Müller *et al.*, 1998).

On the other hand, females are rarely nude and prefer to stay indoors doing housework, limiting their exposure to Malaria vectors. Variation in the frequency and intensity of exposures to the mosquito vector responsible for *Plasmodium* parasite transmission affects the infection rate (Ezugbo-Nwobi *et al.*, 2011). Some studies have reported that females have stronger parasite immunity, which has been related to genetic and hormonal reasons (Zuk and Mckean, 1996). Female estrogen has been demonstrated to enhance anti-plasmodium immune response, whereas testosterone lowers anti-plasmodium immunological response (Krücken *et al.*, 2005)

The present findings showed that students aged 20-29 have the highest prevalence (62.0%), followed by those aged 30 and above (61.8%). The least prevalence was observed among those students whose age range is between15-19 (51.8%). However, it is interesting

that their difference did not vary significantly. This result is also in line with the observation work of Adesina (2013) and Ntoumi *et al.* (1995). Similarly, the findings were consistent with those of Richard *et al.* (2019), who concluded that prevalence is a function of exposure rather than age. This conclusion, however, did not support the findings of Ani Ani (2004), who found a higher frequency among the youngest age group (16-20). They said the younger generation has a weakened immune system and is more prone to illnesses. Therefore, the differences in parasite density found between age groups could be linked to an individual's level of immunity, which varies with age and lifestyle.

Our findings also show that students who live off-campus have a higher prevalence of malaria infection (63.7%) than those on campus (54.0%), which varies significantly. However, differences in the prevalence of malaria infection observed among these students in terms of their residence in the present study support the findings of Carter *et al.* (2000). The study shows that malaria transmission is not uniform throughout an endemic area but rather patchy and depends on two primary factors: the location of breeding sites and the clustering of human habitations where people serve as malaria infection reservoirs. The presence of stagnant water due to poor drainage patterns observed around the residents of those students who lived off-campus in the study area might be the attributing factor for the high prevalence of malaria infection. However, there is overcrowding among students who live both on and off-campus, thereby making using a mosquito net as a preventive measure cumbersome. Finally, the bivariate logistic regression analysis reveals that the students who stay off-campus are nearly two times to be infected with malaria infection than those who live on-campus [COR (95% CI): 1.56 (1.04-2.35)]. So also, the analysis of bivariate logistic regression shows that non utilizing a mosquito net is one of the primary risk factors in this study area since it increases the likelihood of malaria infection. The tertiary university students that do not sleep under the mosquitoes treated net in the present study appeared to be a high-risk period of malaria infection [COR (95 % CI): 0.55 (0.36-0.83)]. Previous research in Nigeria and other malaria-endemic areas have found similar results (Awosolu, 2020, Ogomaka, 2020).

5.0 Conclusion

Malaria is endemic in Gadau, Bauchi state, and this is glaring evidence indicating malaria is a public health challenge even among the students of Bauchi State University Gadau. Major risk factors influencing transmission include the student residence and non-use of mosquito nets in the study area. Therefore, the university management should periodically educate students on the need to use a mosquito bed net, fumigation, and indoor residual spray in their surroundings. The university student should also be enlightened about mosquito breeding site identification and removal on and off-campus. These are essential for reducing the prevalence of malaria infection among them. So also, the enforcement of the rule on frequent public sanitation within the university hostels by the university management is essential and recommended. It should also be extended among the university students who live off-campus as these are critical for malaria management in Nigeria's higher education institutions. One of the study's drawbacks is that it did not include vector surveillance to confirm the malaria vector species in the research area. However, as previously noted, the baseline information provided by the present study will assist the university management in planning, formulating, and implementing a malaria control program in the study area.

Declarations

Consent for publication

All authors have read and consented to the submission of the manuscript.

Availability of data and material

Not Applicable.

Competing interests

All authors declare no competing interests.

Funding

There was no funding for the current report.

Reference

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