



Research Article

Seasonal Variation of Malaria Infections among Outpatients Attending Muhammad Abdullahi Wase Teaching Hospital Kano State, Nigeria

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ABSTRACT

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Malaria is a serious public health problem in Sub-saharan Africa including Nigeria, with the potential to increase significantly in response to seasonal changes. The aim of the study was to determine the influence of seasonal variations on the prevalence of malaria infection among outpatient attending Muhammad Abdullahi Wase teaching hospital Kano state, Nigeria. The objectives were to establishing the correlation between malaria infections and seasonal variations, and also determining the prevalence during different seasons, and evaluating the gender distribution of infection. The study was carried out from January to December, 2019, involving the use of microscopic examination of 840 blood samples using thick and thin film methods. Out of 840 patients examined (57.1%) had a malaria infection. Wet season had the highest prevalence rate of malaria infection (33.2%) than dry season (23.9%). There was a statistically significant differences ($P < 0.05$) in the prevalence rate of malaria infection in relation to season. In relation to the gender females had higher (31.9%) prevalence rate of malaria infection than males (25.2%) and there was no significant difference in the prevalence rate of the infection in relation to sex ($P > 0.05$). Concerning age groups, patients aged 26-30 years had the highest prevalence rate (9.04%), while those aged 40 and above had the lowest. However, the variation in prevalence among age groups was not statistically significant ($P > 0.05$). This study confirmed that malaria infection still remains an important public health problem in the study area. Therefore, full implementation of adequate public health measures need to be undertaken to mitigate the endemicity of the disease, such as the Roll Back Malaria control Strategies as well as health education and environmental modifications are advocated is recommended.

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INTRODUCTION

Malaria remains a significant public health challenge in 97 tropical and subtropical countries. On a global scale, around 214 million malaria cases occur each year, posing a risk of infection to 3.2 billion individuals (WHO, 2015). In 2015, approximately 438,000 deaths were linked to malaria, with a notable concentration in sub-Saharan Africa, where an estimated 90% of all malaria-related deaths occur (WHO, 2015). Nigeria bears the heaviest malaria burden worldwide, reporting about 51 million cases and 207,000 deaths annually, constituting roughly 30% of the total malaria burden in Africa. Moreover, 97% of the country's population, approximately 173 million people, is at risk of infection (WHO, 2014). Malaria is responsible for 60% of hospital outpatient visits, contributing to approximately 11% of maternal mortality and 30% of child mortality, particularly among children under 5 years old (WHO, 2015; FMH, 2014).

Malaria stands out as a severe global health issue (Narain, 2008) and is a significant public health concern in Nigeria (Federal Ministry of Health, 2005). It constitutes approximately 60% of all outpatient visits and 30% of hospital admissions (FMOH, 2007). The prevalence of malaria contributes to increased morbidity, mortality rates, and overall health challenges, particularly in developing nations like Nigeria (Carrington, 2001). In 2001, malaria held the 8th position as a major contributor to Global Disability Adjusted Life Years (DALY) and secured the second spot in Africa (WHO, 2002).

In Nigeria, *Plasmodium falciparum* stands out as the most virulent and widespread malaria parasite, responsible for 98% of the estimated malaria cases. Transmission of these parasites occurs through the bites of infected female Anopheles mosquitoes (WHO, 2019; Manyi *et al.*, 2014). Nigeria reports the presence of various malaria parasite species, including *P. falciparum* and *P. malariae* (Matur *et al.*, 2011).

Malaria currently affects a larger population globally than any other disease, being endemic in over a hundred countries and ranking among the top ten most prevalent and lethal diseases worldwide (WHO, 2002).

Similar to other African nations, Nigeria experiences a high mosquito breeding rate and continuous transmission throughout the year, with a particular intensification during the rainy season. Contributing to this scenario are factors such as ignorance, poverty, unsanitary environmental conditions, unfavorable behavioral attitudes, and inadequately planned socio-economic projects, all of which collectively contribute to an elevated transmission rate (Mbanugu and Ejims, 2000).

The prevalence of malaria infection among adolescent patients varies across different locations, even within the same country, possibly influenced by socio-demographic, environmental, and climatic factors (Yohanna, *et al.*, 2019; Ngum *et al.*, 2023). In Nigeria, various studies have reported malaria prevalence rates of 66.7% (Dawaki *et al.*, 2016), 64.0% (Nmadu *et al.*, 2015), and 58.0% (Awosolu *et al.*, 2021). Socio-demographic factors like age, gender, education, occupation, and income, which directly impact human exposure and treatment, as well as climatic factors such as temperature, humidity, and rainfall supporting mosquito vectors' growth, have been extensively documented in urban and peri-urban centers (Ngum *et al.*, 2023; Awosolu *et al.*, 2021).

In Africa, malaria transmission tends to be higher in rural settings compared to urban areas, potentially due to factors such as increased vector density, poor housing conditions, and inadequate drainage systems in rural areas (Oladeinde *et al.*, 2012). Given these considerations, there is an urgent need to investigate seasonal variations in malaria transmission and prevalence, influenced by factors like rainfall, open gutters, stagnant ponds, temperature, and others. This study aims

to establish the relationship between malaria infections among outpatients and their seasonal variations, as well as to determine the prevalence of malaria infection among male and female genders and different age groups in the study area.

MATERIAL AND METHOD

Study Area

Kano State is located at the north western region of Nigeria laid between latitude $10^{\circ}33' N$ and $12^{\circ}23' E$ and longitude $7^{\circ}45' N$ and $9^{\circ}29' E$ with total land area of 21,276.872 kilometers with 1,754,200 hectares for agricultural activities and 75,000 hectares forest vegetation and grazing land (Abaje, 2014). The state occupied a central position of the northern part of Nigeria. Kano State falls mostly within Sudan savanna zones. The State is the most largest or dense populated cities in Nigeria. It plays a major role in farming, trading and is also serving as commercial town. The weather is hot and sunny with temperature between $35^{\circ}C$ to $40^{\circ}C$ which drops with the beginning of rainy season (mid May-September). The area has two distinct seasons. The dry season begins from late October to May with a spell of harmattan period from November to February and the rainy season is usually short and commence in late May to September (Abaje *et al.*, 2014).

This study was carried out at general outpatient department (GOPD) of Muhammad Abdullahi Wase teaching hospital, Nassarawa, which is located in Kano metropolis, Kano State, Nigeria. The hospital is usually attended by low and moderate socio-economic groups and therefore, is affordable and accessible to most dwellers of Kano city and neighboring Local Governments Areas

Ethical Clearance

Ethical approval for the study was obtained from Ministry of Health Kano, Kano State, based on the recommendation of Muhammad Abdullahi Wase teaching hospital ethical committee. Verbal informed consent was also sought from a

cross-section of outpatients attending Muhammad Abdullahi Wase teaching hospital before blood samples were collected from the patients.

Inclusion and Exclusion Criteria

The inclusion criteria comprised outpatients aged 0 to 41 and above who presented with febrile illness (with an axillary temperature $\leq 37.5^{\circ}C$) and exhibited a recent history of fever within the past 48 hours, along with additional clinical symptoms of malaria such as headache, dizziness, joint pain, anorexia, and malaise. Exclusion criteria encompassed individuals who were critically ill and required immediate attention, those with mental illness, and individuals undergoing malaria treatment or having completed antimalarial treatment within two weeks prior to the study.

Sample Size Determination

The sample size was determined using the standard epidemiological formula (Fisher's formula for cross-sectional descriptive study) for calculation of minimum sample size (Jaykaran and Tamoghna, 2013).

$$n = \frac{Z^2 p(1-p)}{d^2}$$

Where,

n = Sample size

Z = standard normal distribution at 95% confidence level = 1.96

P = prevalence or proportion of value to be estimated from previous studies.

d = precision, tolerance limit, the minimum is 0.05.

Proportion of failure (= 1 - p).

Study Subjects

The study involved the enrollment of 840 patients, comprising 360 males and 480 females across various age groups. Individuals attending the outpatient department of Muhammad Abdullahi Wase Teaching Hospital were

recommended blood malaria tests by healthcare providers upon presenting symptoms such as high fever, indicating a potential malaria infection, for confirmation.

Sample Size

A total of 840 blood samples were collected from outpatients attending Muhammad Abdullahi Wase teaching hospital with varying age ranging from 1 to 41, and above 41 years, in the study area.

Sample Collection

Blood samples were collected using disposable 5ml syringe for each patient from January to December, 2019. Blood sample from patients were collected under the supervision and guidance of Hospital Laboratory Technician. Collected blood samples were subsequently stored in bottle containing Ethylene-diamine-tetra acetic acid (EDTA) to prevent coagulation.

Thick Blood Films

Thick blood films were prepared according to the procedure of Cheesbrough (2005). A large drop of well-mixed blood sample of each patient was placed at the center of a clean microscope slide. Disposable stirrer was used to spread the blood in a circular motion over an area of about 15mm in diameter. The slide was allowed to air dry at room temperature. The dried unfixed thick blood films were arranged on a staining rack and flooded with 10% Giemsa stain in phosphate buffer (pH 7.2). The slide was allowed to stand for 10 minutes after which they were washed using tap water gently and kept in an upright position in a draining rack to air dry. Two drops of oil immersion were placed on each of the stained thick blood film. The slide was then mounted on the microscope and examined using x100 objectives lens to determine the parasitaemia level of *P. falciparum*.

Thin Blood Films

A thin blood film was prepared according to the procedure of Cheesbrough (2005). A drop of well mixed blood sample was placed at 1cm away from the edge of the slide. A spreader was

placed at an angle of 45°C to the blood and touches the blood to run along the slide drawing the blood behind it until the drop was smeared. The dried thin blood films were arranged on a staining rack and fixed using absolute methanol for 1 minute, 10% Giemsa solution in phosphate buffer (pH 7.2) was poured on the slide and left to stain for 20 minutes. The slides were rinsed carefully and thoroughly using tap water and left in an upright position to air dry. Two drops of oil immersion was placed on each of the stained thin blood film. The slide was the mounted on the microscope and examined using x100 objectives lens to check the present of malaria parasite infection.

Data Analysis

The data obtained were subjected to statistical analysis using statistical package for Social Sciences (SPSS) version 16.0 software to determine any significant relationship between, gender, age group, and seasonal Variation of malaria infection among outpatients attending Muhammad Abdullahi Wase teaching hospital Kano. The results were expressed as mean and sum of error mean. Chi-squared test was performed to determine the level of significant relationships. Differences of means were considered significant at a 95% confidence limit.

RESULTS

A total of 840 blood samples were collected from outpatients at the Muhammad Abdullahi Wase Teaching Hospital and subjected to microscopic examination. Table 1 shows the seasonal fluctuations in malaria infection among the outpatients attending the hospital, indicating a higher prevalence during the wet season (33.2%) compared to the dry season (23.9%). Statistical analysis revealed a significant difference in the seasonal variations of malaria parasite infection.

Table 2 displays the gender distribution of malaria infection among outpatients attending Muhammad Abdullahi Wase Teaching Hospital. Out of the samples, 57.1% tested positive for

Plasmodium falciparum parasite, with 25.2% being male and 31.9% female. However, there was no statistically significant difference between infected males and females.

The prevalence of seasonal distribution of malaria infection among different age groups sampled at the hospital is presented in table 3. The highest prevalence (9.04%) was observed among individuals aged 26-30 years, followed by those in the age groups of 16-20 years, 21-25 years, 6-10 years, 0-5 years, 31-35 years, 36-40 years, and 11-15 years, with prevalence rates of 8.33%, 7.85%, 8.1%, 7.38%, 4.3%, and 3.809%

respectively. The lowest prevalence (3.57%) was recorded in the age group of 40 and above years. However, statistical analysis indicated no significant difference ($P>0.05$) in prevalence among the age groups.

Fig 1: shows monthly variation of malaria infection among outpatients attending Muhammad Abdullahi Wase Teaching hospital, the month of August showed the highest rate of malaria infection with 10.95% while month of March April and December shows the lowest rates of malaria infection.

Table 1: Seasonal Distribution of malaria infection among Outpatients attending Muhammad Abdullahi Wase teaching hospital Kano

Type of season	Number Examined	Number infected (%)
Dry season	450	201 (23.9)
Wet season	390	279 (33.2)
Total	840	480(57.1)

P =0.0023

Table 2: Gender distribution of malaria infection among Outpatients attending Muhammad Abdullahi Wase teaching hospital

Gender	Number Examined	Number infected (%)
Male	360	212(25.2)
Female	480	268(31.9)
Total	840	480(57.1)

P= 0.6248

Table 3: Age distribution of malaria infection among outpatients attending Muhammad Abdullahi Wase teaching hospital

Age	Number Examined	Number infected (%)
0 - 5	43	52(6.19)
6 - 10	57	62(7.38)
11 -15	78	32(3.809)
16 -20	114	70(8.33)
21 – 25	136	66(7.85)
26 - 30	140	76(9.047)
31 - 35	108	52(6.19)
36 - 40	100	40(4.76)
41 and above	64	30(3.57)
Total	840	480(57.1)

P=1.647

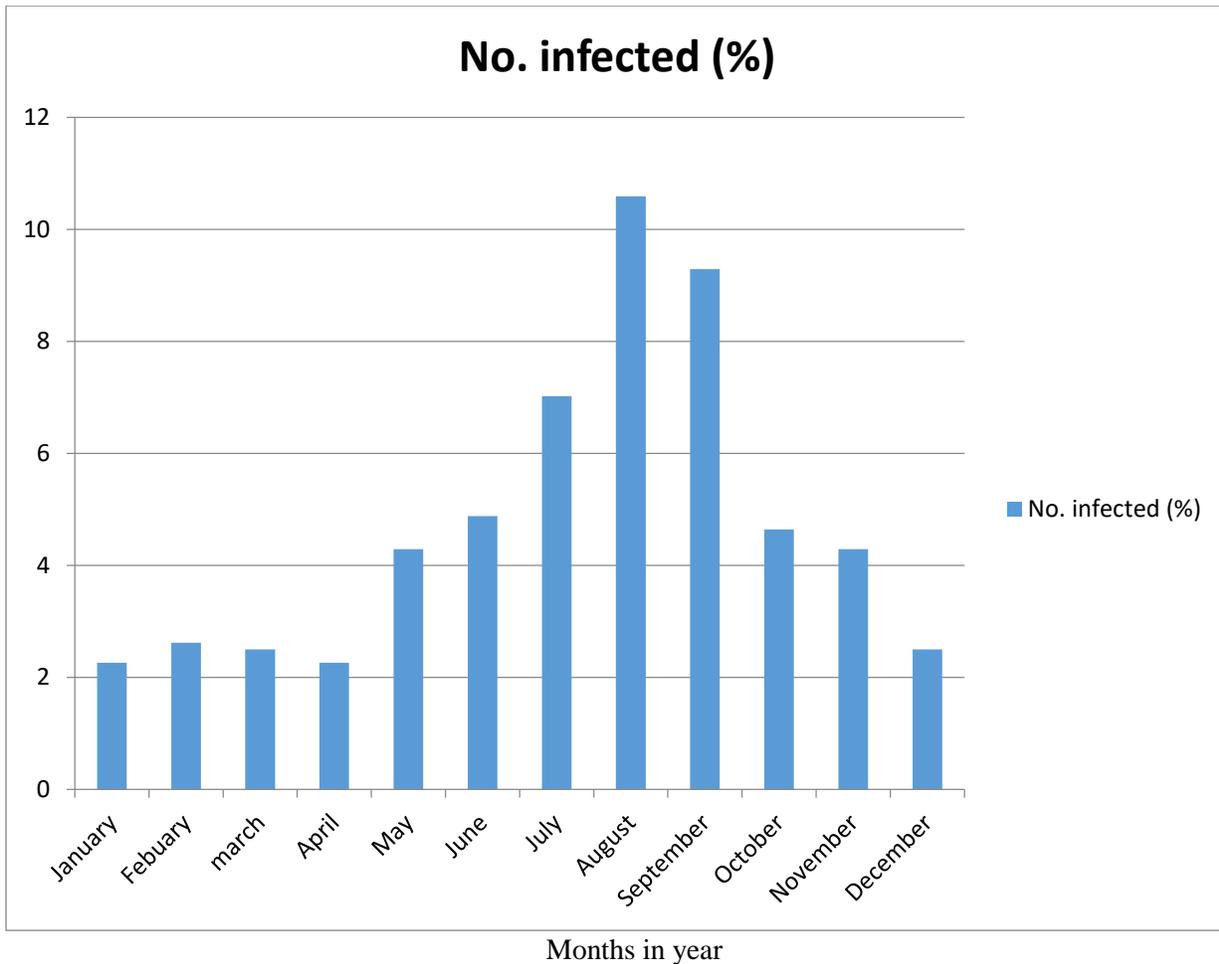


Figure 1: Prevalence of Malaria among Out-Patients in relation to Months of the year in Muhammad Abdullahi Wase teaching Hospital, Kano State, Nigeria.

DISCUSSION

The recent investigation conducted at Muhammad Abdullahi Wase Teaching Hospital in Kano state revealed a high 57.1% prevalence of *Plasmodium falciparum*, the malaria causing parasite, among outpatients attending the hospital. This high prevalence aligns with the World Health Organization's (WHO) 2019 report, indicating that *P. falciparum* accounted for 99.7% of malaria cases in the WHO African Region. This finding is consistent with previous studies by Anumudu *et al.* (2019) and Yahaya *et al.* (2012) conducted at Wudil General Hospital,

Kano State, and in Imo state, Nigeria, reporting prevalence rates of 57% and 53%, respectively. The prevalence observed in the current study surpasses those from Maiduguri, where Molta *et al.* (1993) and Samdi *et al.* (2012) reported rates of 35.2% and 27.26%, respectively. The higher prevalence in the current study could be attributed to poor sanitary practices and inadequate drainage and sewage disposal systems, creating stagnant water bodies that serve as ideal breeding habitats for malaria vectors (Nasir *et al.*, 2015).

The recorded malaria fever infection rate of 57.1% in this study affirms the presence of

malaria fever infection in the investigated area. However, this relatively high prevalence could pose significant public health concerns if not promptly addressed. Notably, there is an evident discrepancy in the infection prevalence among patients concerning the season in the study area. This variation could be attributed to the favorable climatic conditions during certain months of the study period, which promote the breeding of *Anopheles* mosquitoes.

Studies, including those carried out by Samdi *et al.* (2012) and Molta *et al.* (1995) have emphasized the influence of seasonal variations in rainfall on the prevalence of malaria in different regions of Africa.

Molta *et al.* (1995) specifically observed that the monthly malaria figures among individuals in the Sahel region exhibit seasonal fluctuations, with low values characteristic of the dry season and high values during the rainy season. This pattern contrasts with wet forest areas of Nigeria, where malaria transmission occurs at high levels throughout the year (FMOH, 1991). Understanding and addressing these seasonal variations is crucial for effective malaria control strategies in the study area.

The results obtained from the study revealed a higher prevalence of malaria among females compared to males during the study period, the result aligning with findings from previous works conducted by Anumudu *et al.* (2019), Yahaya *et al.* (2012), Anas *et al.* (2017), and Idris *et al.* (2022) in Imo state metropolis and Kano state, Nigeria. The higher prevalence among females may be attributed to the fact that males engage in activities that expose them to more infective mosquito bites compared to their female counterparts, who are often at home and more protected from such bites. This observation is also influenced by the socio-cultural beliefs of the people in the study area, primarily consisting of Muslims and Hausa-Fulani tribes.

The Islamic belief in restricting the movement of females could contribute to less contact with

Anopheles mosquitoes compared to their male counterparts. Additionally, cultural norms may play a role, as it is considered culturally inappropriate for females to socialize outdoors with friends and relatives. This cultural aspect aligns with the findings of Mbanugu and Ejims (2000). Understanding these gender specific variations is crucial for tailoring effective malaria prevention and control measures in the study area.

The age related prevalence analysis indicated that malaria was most prevalent among subjects aged 26-30. This finding is consistent with previous studies by Idris *et al.* (2023), Chukwuocha *et al.* (2012), and Idris *et al.* (2022), which reported that the age groups 26-30 have the highest burden of malaria infection. The highest prevalence observed in this age group may be attributed to their occupational and socio-cultural settings. Individuals in this age range, whether due to work or schooling, tend to expose them more and are consequently more susceptible to mosquito bites compared to those who spend more time indoors.

On the contrary, the lowest infection was observed among the age group of 41 and above, the result is consistent with the findings of Yahaya *et al.* (2012) and Idris *et al.* (2022). The lower prevalence in this age group may be due to the development of immunity against malaria parasites as individual's age. This aligns with the well-established concept that there is a natural acquisition of immunity to infectious diseases, including malaria, as individuals grow older. Existing knowledge suggests that there is typically high prevalence at younger ages, gradually decreasing as natural immunity develops with increasing age (Golassa *et al.*, 2013).

The study indicates a notable impact of weather variables on malaria prevalence, with an observed increase during the rainy season (July to October) across the year. Malaria reached its peak in July and was at a minimum in October.

Additionally, the trend analysis of malaria prevalence and temperature indicates a seasonal pattern. These findings align with prior research conducted by Efe and Ojoh (2013), Anumudu *et al.* (2019), and Yahaya *et al.* (2012), which have all asserted that the rainy season provides favorable environmental conditions conducive to mosquito breeding, survival, and increased biting rates.

Moreover, the results affirm that malaria transmission in Kano State exhibits significant intra monthly variations. The study highlights that malaria prevalence tends to increase with rising relative humidity, consistent with the observations made by the International Institute for Sustainable Development (2013) and previous research indicating that high relative humidity lengthens the lifespan of mosquitoes and supports the completion of the necessary life cycle for the malaria parasite (Githeko, 2009). Understanding these weather-related patterns is essential for developing effective strategies for malaria prevention and control in the region.

CONCLUSION AND RECOMMENDATION

This study provides valuable insights into the prevalence of malaria infection among outpatients attending Muhammad Abdullahi Wase Teaching Hospital in Kano state, Nigeria. The findings indicate that malaria remains a significant public health concern in the region, with a high prevalence rate of 57.1%. The study identified seasonal variations in malaria infection, with the wet season exhibiting a higher prevalence rate (33.2%) compared to the dry season (23.9%). Additionally, gender specific variations were observed, with females having a higher prevalence rate (31.9%) than males (25.2%). Age related analysis revealed that individuals aged 26-30 years had the highest prevalence rate, while the age group of 41 and above recorded the least prevalence. The recommendations include the need for targeted interventions during peak transmission periods, especially in the rainy season. These

interventions include intensifying vector control measures, distributing bed nets, and conducting indoor residual spraying. Gender specific strategies are essential due to a higher prevalence of malaria among females, requiring tailored health education campaigns and equitable access to preventive measures. It is recommended to customize malaria control interventions based on age specific prevalence rates, implementing targeted vaccination campaigns and educational programs for different age groups. Additionally, developing weather responsive strategies for malaria prevention, public health education campaigns, and strengthening healthcare infrastructure are emphasized to reduce transmission and improve public health outcomes in the region.

Limitation of the Study

The study on seasonal variation of malaria infection at Muhammad Abdullahi Wase Teaching Hospital in Kano State, Nigeria, has limitations including a restricted sample size at a single hospital, limiting generalizability. Methodological limitations arise from reliance on microscopy, suggesting the need for more advanced diagnostic techniques. The one-year study duration may not capture all seasonal variations, and external factors like environmental changes were not considered. Addressing these issues in future research could enhance the study's robustness and applicability to the broader population.

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CONFLICT OF INTEREST

The authors wish to state categorically that they do not hold any conflict of interest in whatever

shape or form.

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