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Research Article

PREVALENCE OF MALARIA AMONG SICKLE CELL PATIENTS IN SELECTED PRIMARY HEALTH CARE CENTRES (PHCC) IN TAKUM LOCAL GOVERNMENT AREA, TARABA STATE

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ABSTRACT

Sickle cell disease (SCD) poses significant health challenges in sub-Saharan Africa where the prevalence is relatively high. Malaria, a prevalent infectious disease in Nigeria exacerbates the complications associated with sickle cell anaemia. Understanding the epidemiology of malaria among sickle cell anaemia patients is crucial for effective management and control strategies. This cross-sectional study is aimed to determine the prevalence of malaria infection among patients with sickle cell anaemia patients in selected Primary Health Care Centre in Takum L.G.A, Taraba State, Nigeria. The study involved the screening of sickle cell anaemia patients in selected health facilities in Takum L.G.A, Taraba state from January to August 2023. Data on the demographic characteristics of the patients were collected using structured questionnaires and 5ml blood samples was collected into labelled EDTA container. Parasitological examination was conducted to determine malaria prevalence and statistical analysis was performed using SPSS version 27.0. the study revealed malaria prevalence of 4.3% among SS patients. Malaria infection was more common among male patients and among children aged 1-10yrs, non-educated individuals and those in low-income occupation like farming, trading, artisan and students. The result underscores the importance of targeted intervention to mitigate malaria burden among sickle cell anaemia patients, including educational campaigns, use of malaria prophylaxis, access to preventive measures such as long-lasting treated nets and improved environmental sanitation practices. Implementing these strategies is crucial for reducing malaria related morbidity and mortality in the affected communities.

Keywords: Patients, Sickle, Anaemia, Malaria, Healthcare, Takum.

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Introduction

Malaria caused by the protozoan parasite belonging to the species Plasmodium falciparum is considered the most significant public health problem worldwide and ranks top in its socio-economic, community and public health burden in tropical, sub-tropical areas, sub- Saharan Africa and South-West

Asian countries (Minakawa *et al.,* 2006; Hochman & Kim., 2009; WHO., 2011). It is a major cause of morbidity and mortality in malaria endemic communities in many African countries (Aninagyei *et al.,* 2022). *Plasmodium falciparum* accounts for the greater part of malaria linked mortality in Nigeria since more than 90% of the populace lives in malaria endemic areas (Guerra., *et al* 2008 & Aninagyei *et al.,* 2022). *Plasmodium falciparum* is vectored by the female *Anopheles* mosquito and is the most dangerous form of malaria accounting for the highest rates of complications and mortality.

Plasmodium falciparum infection is more prevalent in sub-Saharan Africa than in other regions of the world. and almost every malarial death is caused by this unicellular protozoon (WHO., 2017 & WHO., 2021). In 2019, malarial cases were estimated to about 229 million globally in 87 malaria endemic countries, declining from 238 million in 2000 while malarial deaths reduced from 736,000 in 2000 to 409,000 in 2009. Nigeria accounts for 27% and 23% global cases and deaths respectively (WHO., 2020). The endemicity of *Plasmodium falciparum* in Nigeria was established by the World Health Organization in 2017 and the population at risk includes children, pregnant women and the non-immune (Carrington., 2001 & WHO., 2017). *Plasmodium falciparum* infection is associated with serious co-infections, it causes severe anaemia leading to high mortality rates, impaired physical and cognitive development in children as well as reduced immune functioning (WHO., 2011). *Plasmodium falciparum* infection is characterized by acute or intermittent or continuous fever which is accompanied by shivering, sweating, fatigue, vomiting, joint pains and headache. In severe infection, it causes yellow discoloration of the skin, seizures, coma and death (Caraballo., 2014 & WHO., 2017). A high malaria infection rate within a country is attributed to poverty promoting condition (Hotez *et al.,* 2006).

The factors that contribute to the spread and transmission of malaria depend on the interaction between the human host, the anopheles vector, malaria parasite and environmental conditions (Arora & Arora., 2009). However, there is significant risk of infection in urban areas, where indiscriminate waste disposal and the presence of swamps, gutters and thick vegetation encourage the breeding of the mosquito vector that causes malaria (Anumudu., 2006). In rural and urban areas, breeding sites of the female Anopheles mosquito is common during the rainy season where there is abundant of bushes, stagnant water around residential homes, while in the dry season, stagnant and smelling streams, irrigation ponds for dry season farming, indiscriminate disposal of domestic, commercial and industrial waste provides suitable environment for the infected mosquito to breed and proliferate. In the northern parts of Nigeria, due to the high shortage of water, many residents in both urban and rural areas harvest and store their water in commercial plastic tanks, clay pot, open buckets and basins. These water storage containers have been identified as good breeding sites of the mosquito vector.

The connection between sickle cell disease and malaria was first discovered in the 1940s (Esoh &Wonkam., 2021). Patients with sickle cell traits (AS) have shown some resistance to severe forms of malaria (Depetris-Chauvin & Weil., 2018) because the sickle cell traits confer some resistance to malaria (Piel *et al*., 2010). Individuals with sickle cell anaemia (SS) do not have protection from malaria. Malaria is both a precipitating factor of vaso-occlusion and a cause of haemolytic anaemia. Malaria causes destruction of erythrocytes by direct red cell lysis, phagocytosis and immune destruction with liberation of the parasites and erythrocyte material into the circulation, thus resulting in haemolytic crisis ((Serjeant, 2001., Gullet., 2001 & Luzzatto., 2012). Haematological derangements such as low platelet count, low white blood cell count and low lymphocyte counts are the most important predictors of *Plasmodium falciparum* infection.

The association of *Plasmodium falciparum* malaria with sickle cell anaemia is well described in Sub-Saharan Africa but is rare in the United States of America (Glickman *et al.,* 2021). However, this relationship has remained undocumented in Nigeria. Sickle cell anaemia (SCA), an autosomal recessive disorder due to the presence of a mutated form of hemoglobin S (HbS) and is a neglected non-communicable disease of public health concern worldwide (Lopez *et al.,* 2014; Pecter *et al.,* 2021 & Sedrak *et al.,* 2023). Sickle cell anaemia is an inherited blood disorder from two abnormal copies of the β-globin gene which occurs in chromosome 11. The disease alters the shape of the red blood cells to a sickle shape which makes the red blood cells sticky and rigid and prone to getting trapped in small vessels, hence blocks blood from reaching the different parts of the body to cause pain and tissue damage (Lopez *et al.,* 2010). Sickle cell anaemia is a serious public health concern, present mainly in African countries (Makani *et al.,* 2007 & Rees *et al.,* 2010). The World Health Organization (WHO) estimates that 300,000 children are born of sickle cell disease each year, 75% of whom are in sub-Saharan Africa (Silver-Nunes & Ferreira 2007., Roucher *et al.,* 2012). Malaria remains a menace and is a public health concern in Nigeria, because it impacts on the health of the populace, affects income and capital which in turn constitutes a huge burden on the dwindling economy and result in poor health outcomes and an increasing severity of diseases among patients with sickle cell anaemia (Carrington., 2001 & WHO., 2021).

Despite the various interventions introduced by WHO, UNICEF, governmental and non-governmental organizations, malaria still remains a disease of public health concern since it continuously inflicts tremendous medical, social and economic burden on human population resulting in millions of deaths globally (WHO., 2011; Minakawa *et al.*, 2006). Malaria accounts for a quarter proportion of malaria linked morbidity and mortality in sickle cell patients. Some sickle cell patients are symptomatic while some are asymptomatic of *Plasmodium falciparum* malaria. Individuals with sickle cell anaemia are more vulnerable to life threatening malaria in malaria endemic countries hence, require hospitalization. Malaria infection causes haematological derangement hence patient with HbSS had a least chance of surviving malaria infection because even low-level malaria infection can precipitate severe anaemic crises that would likely prove fatal without rapid access to blood transfusion services (Uyoga *et al.*, 2022). Since diagnosis of sickle cell anaemia is often overlooked and delayed until the disease becomes chronically manifested, studies could not have linked -malaria deaths in undiagnosed sickle cell anaemia patients resulting in dearth of information in the study location. Although, several epidemiological studies have been carried out on the prevalence of malaria in most parts of Taraba State, no research study have been carried out on *Plasmodium falciparum* malaria infection in sickle cell patients in the study area resulting in limited knowledge related to malaria, thus hindering appropriate and effective malaria intervention program to the targeted vulnerable population.

MATERIALS AND METHODS

Study Area

The study was carried out in Takum L.G.A of Taraba State. Takum L.G.A is located in the southern part of Taraba state, Nigeria with headquater in Takum. The local government was created from Wukari Local Government Area IN 1975 at $7^0$16''00''N$9^0$59'00''Estate lies within the coordinates $8^0$00'N10^0'E. Takum L.G.A borders the Republic of Cameroon in the south, Ussa Local Government Area to the west, Donga Local Government Area to the north. Communities within Takum are Tati, Muji, Simta, Bette, Fette, Chanchaji, Bika and Kashimbilla. The major ethnic groups in Takum are Kuteb, Jukun, Tiv, Chamba, Ichen, Fulani and Hausa. Takum L.G.A has an area of 2503km2 and a population 135,349 (National population Commission., 2019). The river Benue tributary supplies the local government area with adequate water supplies for its agricultural activities. The area of the state is tropical with vegetation characterized by a typical guinea savannah. There are two distinct seasons, the wet and dry season. The residents of the state are mostly involved in commercial and subsistence farming and in livestock production. Communities living on the banks of the rivers engage in fishing all year round. Other occupational activities include: pottery, cloth-weaving, dyeing, mat-making, carving, embroidery and blacksmithing.

Study Design

This is a hospital based cross-sectional research study designed to determine the prevalence of malaria among sickle cell anaemia patients in selected health facilities in Takum L.G.A, Southern Taraba state, Nigeria. All sickle cell anaemia (SS) patients who consented for the study were screened for malaria infection.

Study population

The study population comprises of all consenting sickle cell anaemia patients who present themselves in the Out-Patients Department (OPD) in five (5) designated primary healthcare (PHCC) facilities in Takum L.G.A, Taraba State from January to August 2023. The method of Sapoka (2006) was used to determine the sample size at 0.05 significant levels.

$$N = \frac{z^2pq}{d^2}$$

Where:

N= Desired sample size

z^2=Standard normal deviate set at 1.9^2

P=Proportion in the target population estimated to have a particular characteristic.

q= 1-p (either the patient has or does not have the characteristics)

d= Degree of accuracy set at 0.05.

$$N=\frac{1.9^2 \text{ X } 820 \text{ X } 0.5}{0.5^2}$$

= <u>3.61 X 408 X 0.5</u>

0.0025

= <u>1498.15</u>
0.0025
=294.576

Specimen collection

Five (5mls) of whole blood was collected by venepuncture (Cheesebrough., 2006) into labelled EDTA bottles. Two drops of blood were placed on a clean glass slide to form a thick film. Giemsa statin was added to the slide and allowed to fix for 30 minutes. The slide was slanted to allow the stain to run off, tap water was made to run through the slide. The slide is air dried and a drop of oil immersion was added to the slide and viewed under x40 magnification. The parasite density will be counted according to the WHO standard formula (WHO., 2016).

Data Collection

Structured questionnaire was used to collect information on the respondents' age, gender, occupation status, educational status and risk factors of malaria.

Ethical Permission

Ethical permission for the study was obtained from the Health and Research Ethic Committee, Taraba State Ministry of Health, Jalingo. Further permission was obtained from the Management of the health facilities and informed consent was sought and obtained from the SS patients or their guardian.

Statistical analysis

The data obtained from this study was entered into Microsoft Excel and exported to Statistical Package for Social Sciences (SPSS) version 27.0 for data analysis. Chi square (χ^2) test was used to compare the relationship between infection and demographic profiles of the participants.

RESULTS

Table 1 presents the prevalence of malaria in sickle cell anaemia patients in different communities of Takum L.G.A, Taraba state. Overall prevalence was 44 (15.0%) with the highest prevalence recorded in Tati community 10 (19.0%) while the least prevalence is recorded in Simta community 6 (9.7%). Chi square analysis was not significance for community related malaria infection (χ^2 = 2.498; df=4, P >0.05).

Table 1: prevalence of malaria in sickle cell anaemia patients in different communities of Takum L.G.A, Taraba state.

Communities	No examined	No. infected (%)
Tati	51	10 (19.6)
Muji	58	9 (15.5)
Simta	62	6 (9.7)
Bette	65	11 (17.0)
Fette	58	8 (13.8)
Total	**294**	**44 (15.0)**

Table 2 reveals the gender-related prevalence of malaria in sickle cell anaemia (SS) patients in Takum L.G.A, Taraba state. Prevalence was higher in male 28 (15.5%) than female 15 (14.0%) patents. Chi square analysis was not significance for gender-related malaria infection ($\chi^2 = 0.119$; df=1, P >0.05)

Table 2: Gender-related prevalence of malaria in sickle cell anaemia (SS) patients in Takum L.G.A, Taraba state.

Gender community	No Examined	No infected (%)
Male	187	29(15.5)
Female	107	15(14.0)
Total	294	44(14.9)

Table 3 shows the overall age prevalence of malaria in sickle cell anaemia patients in Takum L.G.A, Taraba state. Malaria infection was high in ages 1-10yrs old 17(20.5%) and low in >40yrs old 3 (7.5%). Chi square analysis was significance for age-related malaria infection ($\chi^2 = 3.502$; df=4, P <0.05).

Table 3: Age prevalence of malaria in sickle cell anaemia patients in Takum L.G.A, Taraba state.

Age (yrs)	No examined	Number infected (%)
1-10	83	17 (20.5)
11-20	66	10 (15.2)
21-30	55	8 (14.5)
31-40	50	6 (12.0)
>40	40	3 (7.5)
Total	**294**	**44 (14.0)**

Table 4 reveals the prevalence of malaria among sickle cell anaemia patients according to marital status in Takum L.G.A. Malaria infection was highest among the single patients 30 (16.4%) and low among the divorced/widowed 4 (10.8%). Chi square analysis was not significance for malaria infection (χ^2 = 0.918; df=2, P >0.05) according to marital status.

Table 4: Prevalence of malaria among sickle cell anaemia patients according to marital status in Takum L.G.A, Taraba State.

Marital status	**Total examined**	**Number infected (%)**
Single	183	30 (16.4)
Married	74	10 (13.5)
Divorced/widowed	37	4 (10.8)
Total	**294**	**44 (14.0)**

Table 5 shows the prevalence of malaria in sickle cell anaemia patients according to different educational status. Malaria infection was highest in the non-educated patients 27 (16.1%) than the educated patients 17 (13.5%). Chi-square analysis was not significance for malaria infection (χ^2 = 2.498; df=1, P >0.05) according to the educational status of the patients.

Table 5: Prevalence of malaria in sickle cell anaemia patients according to different educational status in Takum L.G.A, Taraba State.

Educational Status	**No Examined**	**No Positive (%)**
Non-Educated	168	27(16.1)
Educated	126	17(13.5)
Total	294	44(14.0)

Table 6 shows the prevalence of malaria among sickle cell anaemia patients according occupational status in Takum L.G.A, Taraba state. Malaria infection was high among the traders 16 (16.2%) and low among patients who are civil servants 1(6.3%). Chi square analysis was significance for malaria infection (χ^2 = 2.610; df=4, P <0.05) according to the patient's occupational status.

Table 6: Prevalence of malaria among sickle cell anaemia patients according occupational status in Takum L.G.A, Taraba state.

Occupational status	No Examined	No Positive (%)
Artisan	60	9(15.0)
Trader	99	16(16.2)
Farmer	81	10(12.3)
Students	38	8(21.1)
Civil servants	16	1(6.3)
Total	294	44(4.3)

Discussion

The current study corroborates the research findings of previous researchers on the endemicity of malaria infection among sickle cell patients in different communities in Nigeria. The prevalence of 44 (4.3%) falls within the Nigerian malaria risk map estimates of less than 20% in certain zones to more than 70% in other zones (Okonko *et al.*, 2010). The 4.3% prevalence is lower than those reported in a previous study in Akure in Southwestern Nigeria and among rural inhabitants of Gabon (Awosulu *et al*., 2019 & Woldearegal *et al*., 2019). The low prevalence is attributed to the use of local/indigenous plants and tea as malaria prophylactic treatments and reduced mosquito breeding sites due to the dry weather conditions.

The current result (4.3%) from this study and previous study shows that malaria infection is low for the HBSS (Kepha *et al*., 2016 & Ebadan *et al*., 2017). The high prevalence of malaria in the AA haemoglobin variant as compared to the SS variant may be due to the fact that the red blood cells create a favorable environment for the Plasmodium parasite to thrive than the SS genotype. This could be due to the high rate of oxygen consumption and a large amount of haemoglobin ingested in the peripheral blood during the mosquito vector replication stage. (Njila *et al*., 2022, Albiti *et al.*, 2014 & Ebadan *et al.*, 2017).

Gender distribution of malaria infection reveals that sickle cell male patients have higher infection 29 (15.5%) than their female counterparts 15 (14.0%). This agrees with previous research findings from other malaria-endemic areas in Nigeria (Gebretsadik *et al.*, 2018 & Escobar *et al*., 2020). The mosquito vector is mostly active in its biting activities at night when males are engaged in outdoor activities that expose them to mosquito bites, they also move without wearing clothes that cover/protect them from mosquito bites and they are less concerned about malaria prevention than the females.

The age-related prevalence of malaria infection shows that malaria was higher in the 1-10yrs old 17 (20.5%), 11-20yrs old 10 (15.2%) and 21-30yrs 8(14.5%) than the 31-40yrs old 6(12.0%) and the >40 yrs old 3 (7.5%) in all the SS haemoglobin variants. This agrees with research findings of 97 (53.9%) among ages 1-10yrs by Ibrahim *et al.*, (2023) among SS patients in rural southwestern Nigeria. According to WHO (2018), children between ages 1-5yrs are more susceptible to malaria infection and this could be attributed to a low level of immunity while children between 6-10yrs suffer malaria infection due to exposure to the mosquito vector by playing in stagnant water bodies habouring the mosquito vector, and playing without clothes. Malaria infection decreases with age (Ibrahim *et al.*, 2023).

Concerning education-related prevalence, this study revealed that malaria infection is higher among the non-educated SS subjects 27 (16.1%) than the educated subjects 17 (13.5%). This agrees with the findings of Obimakinde *et al.*, (2018) who revealed that non-educated have high malaria infection than the educated. The non-educated are not knowledgeable about the preventive practices of malaria infection. They engage in outdoor activities especially in the evenings and nights during the active biting period of the female anopheles mosquito.

Results from this study show that malaria infection is high among SS patients who are low-income earners such as students 8 (21.4%), traders 16 (16.2%), farmers 10 (12.3%) and artisans 9 (15.0%) than civil servants 1 (6.3%). This agrees with the findings of Obimakinde *et al.*, (2018). Low-income earners are mostly exposed to mosquito bites in their daily quest for survival. Students engage in late-night studies, parties and businesses which exposes them to mosquito bites. Majority of them work bare-bodied and late into the night. Civil servants make use of mosquito-repellant creams, socks, long-sleeves and sleep under long-lasting insecticide-treated nets to protect themselves against mosquito bites.

Conclusion

The study reveals that malaria infection caused by *Plasmodium falciparum* is endemic in different parts of Taraba state and it impacts on the heamatological parameters and could lead to sickle cell crisis, complications and mortality. The significant association in the prevalence of malaria in the HbSS genotype variant could be used as a criterion for including malaria prophylaxis in the treatment regime of sickle cell patients. There is need to intensify the malaria control programs by the PMI, USAID and all donor organizations and improve strategies to reduce/eradicate malaria morbidity and mortality among patients with sickle cell anaemia.

Conflict of interest

The author does not have any conflict of interest

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