**Malaria and Haematological Status of Individuals in Lafiagyi Badegi Community, Katcha Local Government Area, Niger, Nigeria**

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**ABSTRACT**

Malaria transmitted by *plasmodium* infected female *Anopheles* mosquito is a severe public health challenge that causes significant morbidity and mortality worldwide, particularly in sub-Saharan Africa. A survey of malaria and hematological status of individuals in Lafiagyi Badegi community, Katcha Local Government area of Niger state North central Nigeria was conducted in January, 2022. Blood samples from 60 individuals (20 men, women and 20 children of ages and weights ranging from 5-57 years and 23 – 73 kg respectively were collected into Ethylenediamine Tetraacetic Acid (EDTA) bottles and subjected to malaria rapid diagnostic test, haematocrit and haemoglobin assays. The results showed 29.9 % of the sampled population tested positive for malaria. Malaria prevalence was higher in the male population (16.67 %)in the young males prevalence was 11.67 %. The age group with the highest malaria prevalence was 10-17 years (10 %). Malaria-positive individuals had significantly (p<0.05) lower levels of haemoglobin but higher levels of packed cell volume compared to malaria-negative individuals. There were fluctuations in bodyweight for age groups and malaria status, mean weight for age group 10-17 years positive for malaria was 28.4 kg while for malaria negative was 25 kg. Also 51.8 kg and 57.85 kg for age group 18-25 years positive and negative to malaria respectively. The battle to eradicate malaria is yet to be won therefore, regular malaria prevalence surveys are to be carried out and malaria and mosquito control strategies should be improved upon and sustained to further reduce malaria prevalence.

**Keywords**: Malaria, Haematocrit, Haemoglobin, Age, Weight

**1.0 Introduction**

Malaria is an acute febrile illness caused by *Plasmodium* (*P*) parasites, which are spread to people through the bites of infected female Anopheles mosquitoes. There are five parasite species that cause malaria in humans, and 2 of these species; *P. falciparum* and *P. vivax* pose the greatest threat (Escalante *et al.,* 2022). *P. falciparum* is the deadliest malaria parasite and the most prevalent on the African continent. *P. vivax* is the dominant malaria parasite in most countries outside of sub-Saharan Africa (WHO, 2022).The first symptoms; fever, headache and chills usually appear 10–15 days after the infective mosquito bite and may be mild and difficult to recognize as malaria. Left untreated, *P. falciparum* malaria can progress to severe illness and death within a period of 24 hours (Del Prado *et al.,* 2014; WHO, 2022).

In 2021, nearly half of the world's population was at risk of malaria. Some population groups such infants, children under 5 years of age, pregnant women and patients with HIV/AIDS, as well as people with low immunity are at considerably higher risk of contracting malaria and developing severe disease. According to the latest World malaria report, there were 247 million cases of malaria in 2021 compared to 245 million cases in 2020. The estimated number of malaria deaths stood at 619 000 in 2021 compared to 625 000 in 2020 (WHO, 2022; Buki, 2023). Over the 2 peak years of the pandemic (2020–2021), COVID-related disruptions led to about 13 million more malaria cases and 63 000 more malaria deaths globally. The WHO African Region continues to carry a disproportionately high share of the global malaria burden. In 2021 the Region was home to about 95 % of all malaria cases and 96 % of deaths. Children under 5 years of age accounted for about 80 % of all malaria deaths in the Region.Four African countries accounted for just over half of all malaria deaths worldwide: Nigeria (31.3 %), the Democratic Republic of the Congo (12.6 %), United Republic of Tanzania (4.1 %) and Niger (3.9 %) (Angupale*et al.,* 2023).

Malaria is transmitted throughout Nigeria, with 97 % of the population at risk of malaria.  The duration of the transmission season ranges from year-round transmission in the south to three months or less in the north. Nigeria had the highest number of global malaria cases (27 % of global malaria cases) and the highest number of deaths (32 % of global malaria deaths) in 2020. The country accounted for an estimated 55.2 % of malaria cases in West Africa in 2020 (WHO, 2021). The primary vector across most of the country is *Anopheles (An.) gambiae s.s*., accounting for 67.1 % of all the *An. gambiae s.s*. collected, with *An. funestus* as a secondary vector in some areas of Nigeria (Kahamba*et al.,*2022).

There are significant regional, rural-urban, and socioeconomic differences in the prevalence malaria and it ranges from 16 % in the South and South East Zones to 34 % in the North West Zone. Malaria is a public health problem in Niger state according to report by the National Malaria Elimination Program (NMEP) (2020). Niger State has a high burden of malaria with a prevalence rate of 27.3 % among children under 5 and 34.6 % among pregnant women (NMEP, 2020). Malaria was found to be a leading cause of admissions in hospitals and death among children under five in Niger state (Okafor *et al.*, 2017; Oresanya *et al.,* 2019). A study by Ahmed *et al*. in 2019 reported that the prevalence of malaria in Niger state was significantly associated with factors such as age, gender, educational level and occupation of the head of the household (Ahmed *et al*, 2019).

In terms of Malaria control efforts, the NMEP has implemented various interventions in Niger state such as distribution of Insecticide-Treated Nets (ITNs), indoor residual spray (IRS), and provision of artemisinin-based combination therapy (ACT) for treatment (Monroe, 2020). However, challenges such as inadequate funding, poor health infrastructure, and resistance to anti-malarial drugs and insecticides continue to hinder the control and elimination of malaria in the state (NMEP, 2020). This study therefore attempts to evaluate the prevalence of malaria and haematological status among different groups of individuals in Lafiagyi Badegi Community, Katcha Local Government Area, Niger, Nigeria

**Study Area**

This study was carried out in Niger state. Niger is a state in the north central region of Nigeria and largest state by land mass in the country with an area of 76,363 sq km (26,484 sq mi). The State has 25 Local Government Areas with a population of about 6,783,300 people (population estimation of 2022). Study area selected was a rural village called Lafiagyi Baddeggi in Katcha Local government. A local government area with a population of about 207,400 taken from the national census of 2022. It is located at Latitude 9o09’N and Longitude 6o14’E. The major inhabitants of the region are mostly Nupe and Gbagyi, who are primarily farmers.

**Study Population and Sample**

The study population consisted of a pool of men, women and children, ranging from ages 5 – 57 years. A total of 60 volunteers were used for this survey comprising of 20 children, 20 women and 20 men.

**Survey Technique**

A group of people (60) from different households who consented to take part in this survey were selected at random and a series of questionnaires were administered pertaining to their health conditions and medical history in the month of January, 2023. The age, sex, weight and temperature were also recorded.

**Collection of Blood Samples**

Two (2) ml of blood were obtained from each subject by vein puncture technique. A soft rubber tubing tourniquet was fastened to the upper arm of the subject to enable the index finger feel for the appropriate vein. The puncture site was then sterilized by applying Denatured alcohol (methylated spirit) and vein puncture was made with a 2ml syringe. The blood was transferred into an ethylenediamine tetra-acetic disodium acid (EDTA) vacutainers to avoid clotting and ensure preservation of the samples (Elmo, 2014).

**Malaria Rapid Diagnostic Test (RDT)**

A drop of blood was placed in a square hole of the sample well using a dipstick. Two (2) drops of buffer solution was added to the developer well. The reading was taken after 20 minutes.

**Haematocrit (Packed Cell Volume) Test**

Two milliliters (2ml) of blood was collected and mixed gently in an EDTA anticoagulant bottle. Blood sample was inverted gently sixtimes and thoroughly mixed to re-suspend the red blood cells. A micro haematocrit tube was used to collect the blood sample. Capillary tube was dipped into the collected blood at an angle to fill by capillary action 2/3 of the micro haematocrit tube. Capillary tube was sealed with plasticine. and placed in the micro haematocrit centrifuge for four (4) minutes at 9,000 rpm. Using Hawksley’s micro haematocrit reader, the haematocrit was determined (Ajwad, 2021).

**Heamoglobin (Hb) Count**

Haemoglobin was analyzed based on the cyanide-free sodium lauryl sulphate (SLS) haemoglobin determination method using Sysmex KX 4000i haematology analyzer (Sysmex Corporation, Kobe, Japan).

**Data Analysis**

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 25. The obtained data were subjected to descriptive statistics using percentages and averages as well as Analysis of variance (ANOVA) wherethe values arerepresented as the mean±SD (standard deviation). The Duncan's Multiple Range Test was used to deduce which mean values were significantly different at p<0.05 among the group means.

**Results**

The percentage malaria infection amongst sampled individuals in relation to demographic characteristics (sex and age group) are presented in Tables 1 and 2. The results showed that 29.9 % of the total sampled population were positive for malaria, while 70.1 % were negative. The male had the highest malaria prevalence of 16.67 % while the prevalence in female was 7.99 %. Young males within the age group of 5-17 years (11.67 %) were most prone to malaria infection while, young females were the least prone group (3.33 %) to malaria infection in Lafiagyi Badegi Community (Table 1). Age groups 10-17 years had the highest prevalence of malaria (10 %) followed by 18-25 years (8.33 %) and the least prevalence in >40 years no malaria infection detected (Table 2).

**Table 1: Percentage Malaria Infection according to Gender of Individuals in Lafiagyi Badegi Community of Niger State**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variables** | **Number of samples (n= 60)** | **Percentage population (%)** | **Mean age ± SD (years)** | **Number positive (%)** | **Number of Negative (%)** | **Prevalence (%)** |
| Male | 31 | 51.66 | 24.90±13.26 | 10 (16.66) | 21 (35) | 16.67 |
| YM | 11 | 18.33 | 10.73±2.37 | 7 (11.66) | 4 (6.67) | 11.66 |
| OM | 20 | 33.33 | 31.75±11.13 | 3 (5) | 17 (28.33) | 5 |
| Female | 29 | 48.33 | 24.07±12.69 | 8 (13.33) | 21 (35) | 7.99 |
| YF | 9 | 15 | 9.88±2.47 | 2 (3.33) | 7 (11.66) | 3.33 |
| OF | 20 | 33.33 | 29.6±11.38 | 6 (10) | 14 (23.33) | 10 |
| Total | 60 | 100 | 23.9±13.33 | 18 (29.9) | 42 (70.1) | 29.9 |

YM= Young Male, OM= Older Male, YF= Young Female, OF= Older Female

**Table 2: Percentage of Malaria Infection according to Age ofIndividuals in Lafiagyi Badegi Community of Niger State**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Age (years) | Male (%) (n=31) | Female (%) (n=29) | Positive Male (%) | Positive Female (%) | Negative Male (%) | Negative Female (%) |
| ≤9 | 4 (12.9) | 4 (13.8) | 3 (9.7) | \* | 1 (3.2) | 4 (13.8) |
| 10-17 | 7 (22.6) | 5 (17.2) | 4 (12.9) | 2 (6.9) | 3 (9.7) | 3 (10.3) |
| 18-25 | 6 (19.4) | 10 (34.5) | 2 (6.5) | 3 (10.3) | 4 (12.9) | 8 (25.8) |
| 26-40 | 8 (25.8) | 5 (17.2) | 1 (3.2) | 1 (3.5) | 7 (22.6) | 4 (13.8) |
| >40 | 6 (19.4) | 3 (10.3) | \* | \* | \* | \* |

\*No malaria detected

Table 3, shows the haematological parameters (PCV and haemoglobin) of positive and negative individuals (men, women and children) in Lafiagyi Badegi community. Observed in the result was that the mean PCV and haemoglobin was higher in men (39.55 % and 13.18 g/dl respectively) than in other groups. Meanwhile, the least PCV and haemoglobin was recorded for women (35.10 % and 11.76 g/dl respectively). In Table 4, the haemoglobin count in positive individuals (12.11±1.88 g/dl) was lower than count in malaria negative individuals (12.19±2.02 g/dl) although not significantly (p>0.05) different. Whereas, the PCV in malaria positive individuals (36.57±5.65 g/dl) was higher than was observed for malaria negative individuals (36.33±6.07 g/dl). The haemoglobin count and PCV were within the standard values in all the groups.

**Table 3: Mean Hematological Parameters of Sampled Individuals in Lafiagyi Badegi Community in Niger State**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Groups** | **Mean PCV (%)** | **Mean HB (g/dl)** | **\*Standard PCV Range (%)** | **\*Standard HB range (g/dl)** |
| All Individuals | 36.50 ± 5.89a | 12.17 ± 1.97ab | 23-57 | 10-18 |
| Men | 39.55 ± 3.75b | 13.18 ± 1.25b | 38-52 | 13.5-17.5 |
| Women | 35.10 ± 4.06a | 11.76 ± 1.36a | 34-48 | 12-15.5 |
| Children | 34.85 ± 7.91a | 11.62 ± 2.64a | 23-48 | 10-15 |

\*Standard Value Virgil and Ayalew (2000).

**Table 4: Mean Hematological Parameters of individuals Positive for Malaria Blood Samples in Lafiagyi Badegi Community in Niger State**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Malaria Status (Number) | HB (g/dl) | PCV (%) | Number (%) | \*Standard HB (g/dl) | \*Standard PCV (%) |
| Positive (18) | 12.11±1.88a | 36.57±5.65a | 18 (29.9) | 9.8 | 29.4 |
| Negative (42) | 12.19±2.02a | 36.33±6.07a | 42 (70.1) | 12-13 | 36-41 |
| Total (60) | 12.16±1.97a | 36.50±5.89a | 60 (100) | 12-13 | 36-41 |

\*Standard obtained from Inam *et al*. (2018) and WHO (2020)

**Table 5: Mean Weight of Individuals Sampled for Malaria in Lafiagyi Badegi Community in Niger State**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Weight (kg)** | **Mean weight (kg)** | **Number of sample (%)** | **Positive Number (%)** | **Mean weight in Positive (kg)** | **Mean weight in Negative (kg)** | **Prevalence (%)** |
| 18-25 | 22 | 13 (21.67) | 5 (38.46) | 23.3 | 21.9 | 8.33 |
| 26-35 | 30.07 | 7 (11.67) | 4 (57.14) | 30.87 | 29 | 6.67 |
| 36-55 | 49.9 | 13 (21.67) | 5 (38.46) | 48.8 | 50.6 | 8.33 |
| 56-65 | 62.3 | 13 (21.67) | - | - | 62.3 | - |
| 66-82 | 71.14 | 14 (23.33) | 4 (28.57) | 73 | 70,4 | 6.67 |

Table 5 depict the prevalence of malaria according to weight distribution of the sampled subjects. It was observed that malaria was more prevalent in weight range of 18-25 kg and 36 - 55kg (8.33 % for both) and least prevalent in 26-35 kg and 66 - 82 kg weight ranges. Subjects within the weight range of 56 - 65 kg did not test positive for malaria. Table 6 showed the prevalence of malaria on the basis of temperature. Malaria was more prevalent at temperatures ≤ 36.6 ºC (23.33 %) than at temperatures ≥ 36.7 ºC (6.67 %).

**Table 5: Mean Temperature of Individuals Sampled for Malaria in Lafiagyi Badegi Community in Niger State**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Temperature (ºC)** | **Mean Temp. (ºC)** | **Number of sample (%)** | **Positive Number (%)** | **Mean Temp. in Positive (ºC)** | **Mean Temp. in Negative (ºC)** | **Prevalence (%)** |
| ≤36.6 | 36.5 | 40 (66.67) | 14 (35) | 36.5 | 36.5 | 23.33 |
| ≥36.7 | 36.8 | 20 (33.33) | 4 (20) | 36.8 | 36.8 | 6.67 |

**Discussion**

The prevalence of malaria parasites in this study was higher than that of a reported by Racheal *et al*.(2020) who recorded a prevalence of 23 % in Minna, Niger State among blood obtained from blood donors at General Hospital Minna. Similarly, Hannah *et al.* (2011) recorded a prevalence rate of 27.3 % among blood donors at the University of Ilorin Teaching Hospital. Agboola *et al*. (2019) also recorded a prevalence of 28 % among the blood donors at the University Teaching Hospital, Lagos. The higher prevalence could be attributed to several factors such as lack of awareness and education on malaria, absence of proper health care systems in the rural community of Lafiagyi Badegi in Niger State. Despite the Study being carried out in the month of January when the transmission of malaria is relatively low in this part of the country due to the climatic condition, the prevalence of malaria is considered to be higher than other studies carried out in urban regions (University hospitals) in the south.

The high malaria prevalence observed in Males in the present study corresponds with the report of Afolabi *et al*. (2020) who found out in a study conducted in Nigeria that the incidence of malaria was higher in men compared to women. This may be attributed to the fact that men may be careless in adhering to treatment as such are less likely to use malaria preventative measures. Similarly, the case may be for younger males who in this study were more prevalent than younger females. Younger females in contrast to male may be more yielded to parent instruction and care. From observation, the community being primarily into agriculture sees a lot of the males (10-40 years of age) usually tend their farm lands which leave them at risk and more exposed to malaria. Human stress sometimes induces falciparum recrudescence of an otherwise asymptomatic infection (Shanks, 2015). The high prevalence of malaria observed in older women could be due to the fact that women within child bearing ages may have reduced immunity to malaria due to immunosuppressive effects of pregnancy (Brabin, 1983; Azeezand Akinbo, 2022). The study further showed that amongst age groups 10-17 years was the most prevalent (10 %) and age group ≤9 years being the least prevalent (5 %). However, none of the participants above the age of 40 years were positive.

The higher values of mean packed cell volume and haemoglobin countin men compared to women and children, may be due to several physiological differences such as hormonal, genetic and environmental factors. Men produce testosterone which stimulates the production of erythropoietin, a hormone which increases red blood cell production (Spivak, 2012). The author also revealed that men havehigher red blood cell count than women and children because of difference in size of RBCs. As such men require more oxygen to fuel larger bodies and therefore produce more RBCs to meet the demand (Spivak, 2012).

Thehigh PCV count in positive individuals than negative individuals as observed in the present study, may due to the fact that in malaria infected individuals, there is an increased destruction of red blood cells by the parasite. Which leads to a decrease in total number of red blood cells in circulation. However, the remaining red blood cells become denser and more compact leading to an increase in PCV as observed in a study by George *et al*. (2013) which showed that individuals positive to malaria had higher PCV levels compared to negative individuals.

The effect of malaria on the weight of individuals did not show consistency as mean weight of positive individuals was higher than mean weight of negative individuals with the exception of weight ranges between 36-55 kg which showed a decrease in positive individuals which backs up symptoms of malaria which results in loss of appetite, dehydration from sweating due to fever leading to loss in body mass. The higher prevalence of malaria noticed at temperatures ≤36.6 ºC may seem to be in contrast with what is known of malaria being a febrile illness. It is expected that higher prevalence would be observed at temperature greater or equal to 36.6 ºC for individuals in Lafiagyi Badegi community in Niger state. Fisher (2021) explained that during defervescence (when the central thermostat begins to reset)stage of malaria, patients will generally experience drenching sweats, which rapidly reduce the body temperature.It may be that most of the sampled patients were tested during this stage as such at ≤ 36.6 ºC, malaria was observed in them causing a higher prevalence.

**Conclusion**

The malaria prevalence of individuals in Lafiagyi Badegi community area in Niger State 29.9 % is still on the high side. Males are more prone to malaria in this community (16.6 %), Malaria prevalence highest in male age group 10-17 years (10 %). Higher values of Packed Cell Volume and haemoglobin count(39.55 % and 13.18 g/dl respectively) occurred in male. There was an inconsistent variation in weight and temperature of the individuals that were positive to malaria and those that were negative.Therefore, regular monitoring of malaria and haemotological status of individuals in malaria endemic areas is a necessity for a sustainable health and well-being of the individuals in the community.

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