

Malaria prevalence among potential HIV/AIDS outpatients from selected hospitals in a metropolitan city of Central Nigeria

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ABSTRACT Malaria and HIV co-infection are of public health concern, most especially in sub-Saharan Africa. Therefore, this study investigated malaria parasite prevalence and a key haematological parameter among potential HIV/AIDS outpatients in selected hospitals in the metropolitan city of Central Nigeria in July, 2021. A total of 200 subjects' blood were screened for HIV as well as *Plasmodium*, parasitemia and packed cell volume (PCV) levels. Of the 200 samples examined, all the just walk-in (naive) subjects were HIV positive among which only 33 (16.5%) were infected with *P. falciparum*. There was a significant variation ($\chi^2= 8.482$, $df = 2$, $P = 0.01439$) in malaria parasite prevalence in relation to subjects' locations. More females were infected, however, *Plasmodium* prevalence in relation to sex showed no significant difference ($\chi^2= 0.095778$, $df = 1$, $P = 0.757$). *P. falciparum* prevalence in relation to age groups significantly varied ($\chi^2= 18.682$, $df = 5$, $P < 0.01$) in which age group 20-29 years HIV/AIDS subjects were more infected (7.5%). Subjects who had tertiary education qualification were the most infected (25.0%). Parasitemia was more dominant in females than in infected males. Subjects whose PCV was between 30-34% were the most infected (28.57%) while those with a PCV levels of 20-24% and 40-44% were *Plasmodium* parasite free. Thus, a very high significant difference ($\chi^2= 56.607$, $df = 4$, $P < 0.001$) in malaria infection in relation to PCV levels of the HIV/AIDS subjects. In conclusion, the 100% HIV infection recorded in all the just walk-in outpatients is of great public health concern that demands urgent attention of policy makers and stakeholders on the dynamics of current HIV infection status in the metropolitan city of Lafia in order to curb the continuous rapid spread. Also, all inhabitants in the study area should endeavor to protect themselves against human-vectors contact through the use of all forms of protection against mosquitoes such as sleeping under insecticide treated-bed nets in order to prevent malaria transmission.

KEYWORDS: Just walk-in outpatients, HIV/AIDS, Malaria, Haematological parameter, Metropolitan city of Lafia

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INTRODUCTION

As scientist advance in the production of vaccines for the protection of malaria (Sullivan *et al.*, 2021), its co-infection among human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) patients are still of public health concern (Alemu *et al.*, 2013). Malaria is an infection due to the presence of parasitic protozoan of the genus *Plasmodium* (*Plasmodium ovale*, *Plasmodium vivax*, *Plasmodium falciparum*, *Plasmodium malariae*) within the red blood cells through the bite of an infected female *Anopheles* mosquito mainly in tropical countries (Unata *et al.*, 2015). Malaria and HIV infection are currently considered two of the main global health problems, together causing over 2.5 million deaths annually (UNAIDS, 2010; WHO, 2010). WHO estimates that half of the world's population is

at risk of malaria with Sub-Saharan Africa bearing the major toll, accounting for almost 80% of the malaria cases in the world (WHO, 2010). In 2019, malaria accounted for 228 million cases and resulted in 405,000 deaths (WHO, 2019).

Malaria and HIV are the two greatest challenges facing Africa today, yet the interaction between these two infections in the region has been studied occasionally. The outcome of an interaction between HIV infection and malaria could work in either direction, i.e., HIV infection might reduce immunity to clinical malaria resulting in more frequent infection among the semi-immune and non-immune, or malaria might enhance the progression of HIV infection to clinical AIDS (Chandramohan and Greenwood, 1989). Sub-Saharan Africa has more than 70% of the over 42 million HIV/AIDS infected persons worldwide and it is currently the leading cause of death in the region. Nigeria, the most populous African country, harbors over four million persons living with HIV/AIDS (Akinsete, 2003), with the Central region of Nigeria having the highest HIV infection levels in the country in 2003 (Federal Ministry of Health, Nigeria, 2003.) and recently dropped to the second most infected region in the country with HIV prevalence of 2.0% (UNAIDS, 2019).

Plasmodium parasites constitute a major public health problem globally, with negative impact on the socio-economic development of their victims (Dorathy et al., 2019). Thus, the epidemiology of *Plasmodium* infections in Nigeria is complicated because of the diversity of environmental conditions in different regions of the country. Road constructions, demolition of buildings, and deteriorating drainage systems have created suitable breeding sites for *Plasmodium* parasitic vectors in many parts of Nigeria (Lapang et al., 2019; Ombugadu et al., 2020).

According to Ojurongbe et al. (2019), the prevalence malaria parasitemia was higher in HIV-infected adults (24%) in a study in Jos North, Central Nigeria where participants resident in rural areas reportedly had higher prevalence of malaria parasitemia than urban dwellers. Although Gonzalez et al. (2012) found out that the rate of *Plasmodium* infection, parasites density, the risk of severe anemia and hospitalization were higher among HIV infected children as compared to the adult patients. Studies by Unata et al. (2015) and Del-Tejo et al. (2021) in Usman Danfodiyo University Teaching Hospital, Sokoto State, Nigeria and Brazil respectively reported higher prevalence of malaria infection among patients with HIV infection of 45% and 91.60% respectively.

Report from the studies by Bashirat and David (2018) showed that the prevalence of malaria infection among HIV infected patients varied in relation to age groups in which age group 1-10, and 11-20 had the highest prevalence rate of infection (71.4%), while age group 51-60 was the least infected (40%). Sex wise, the female patients had higher malaria infection rate as compared to the male ones in the different sampled groups. Similarly, Goselle et al. (2009) findings on malaria infection in HIV/AIDS patients in Jos Plateau State, Nigeria showed a significant variation in *Plasmodium* infection in relation to age and sex. Malaria infection in relation to CD4 cells count groups varied significantly, patients with CD4 cells count less than 200 cells per μl had the highest malaria prevalence (36.1%) (Bashirat and David, 2018).

There is paucity of information with respect to malaria and HIV/AIDS co-infection in Lafia metropolis of Nasarawa State, Nigeria. Hence, the need for the investigation on the prevalence of malaria and a key haematological parameter among potential HIV/AIDS outpatients in three selected hospitals in a metropolitan city in lowland area of Central Nigeria.

MATERIALS AND METHODS

The Study Area

The study was conducted in Lafia, the capital city of Nasarawa State, a Guinea Savannah Zone of North Central Nigeria. Lafia is located between latitude 8°24'N, 9°1'E and longitude 8°13'E, 9°8'N. Like the other parts of the State, it is characterized by a tropical sub-humid climate with two distinct seasons. The wet season lasts from about the beginning of May and ends in October. The main economic activity of the State is agriculture: Cash crops such as yam, cassava and melon are grown (Agidi *et al.*, 2017). The dry season is experienced between November and April. Annual rainfall figures range from 1200 mm to about 2000mm. The average maximum and minimum daily temperatures are 35 °C and 21 °C in rainy season and 37 °C and 16 °C in dry season respectively and relative humidity of 30% (Agidi *et al.*, 2018). The population of the area is 330,712 according to the National Population Census (National Population Commission, 2006).

Ethical Clearance

The ethical clearance was granted with the code, REG. No: NHREC 18/06/2017 from the Health Research and Ethics Committee of the Ministry of Health, Nasarawa State, Nigeria.

Sampling Period

Samples collection was carried out in the month of July 2021 across three health facilities namely: Kowa hospital, Shabu and Sandaji primary health care (PHC) facilities.

Sample Collection and Screening for Malaria Parasite

A total of 200 just walk-in subjects' blood were sampled for the study. Five millilitres (5 ml) of blood sample was obtained by venous-puncture from each of the subjects into a well labeled bottles containing Ethylene Diamine Tetra-acetic Acid (EDTA) anti-coagulant through the assistance of Medical Laboratory Scientists in the health facilities. The following information was collected from each subject, age, sex and educational qualification. A thick and thin blood film was prepared from each sample on two separate glass slides for staining and microscopic examination for detection of malaria parasite using the method by Cheesbrough (2010).

Parasite concentration was calculated as described for areas of non-endemicity (Moody, 2002) by determining the number of parasitized red blood cells (RBCs) (not individual parasites) seen in 10,000 red blood cells and expressing the number of parasitized cells as a percentage (Moody, 2002). The approximate level of parasitemia (number of parasites per microliter) was calculated; it was assumed that 1 μ L of blood contains 5×10^6 erythrocytes when the subject's baseline erythrocyte count was not available (Moody, 2002).

Screening of Subjects for HIV

Determine test kits was first used to screen the above collected blood in order to ascertain the HIV status of the subjects. Thereafter, the Uni-Gold and Stat-Pak kit (Uni-Gold™ Recombigen® HIV-1/2) were used to screen the positively sampled blood in order to reconfirm the HIV infection/status of the subjects by putting a drop of chase buffer into the specimen pad and allowed for 15 minutes (no longer than 60 minutes) and the result was read (TrinityBiotech, 2012).

Determination of Packed Cell Volume (PCV)

Two hundred (200) microhaematocrit centrifuge tubes were filled with the blood to three-fourth their lengths and sealed by means of Bunsen blue flame to the 2mm red mark (Cheesbrough, 2009). The tubes were arranged and balanced on the microhaematocrit centrifuge and spun at a relative

centrifugation force (RCF) of 12,000 \times g for 5 minutes. This was followed by adequate reading of the red packed cell (i.e. PCV) on haematocrit reader and the average value was taken (Cheesbrough, 2009).

Statistical Analysis

Data obtained was expressed in simple percentages and analyzed using R Console software version 4.1.1. Pearson's chi-square test was to compare proportions of malaria infection among HIV and AIDS potential outpatients in relation to age groups, sex as well as educational qualifications. Level of significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

Prevalence of HIV/AIDS as well as Plasmodium Parasite in Just Walk-In Outpatients

All the 200 just walk-in subjects examined tested positive for HIV infection out of which 33 (16.50%) were positive for *Plasmodium falciparum* which was the only *Plasmodium* parasite detected in the study (Table 1). The relatively high malaria prevalence recorded in this study may likely be due to lower immune response caused by HIV/AIDS infection as well as the poor prevention practices by the subjects which predisposes them to bites of infected malaria vectors. The result is in a good agreement with studies on malaria-HIV/AIDS co-infected subjects in other parts of the country who recorded 24%, 14.2%, 39 and 65% malaria infection rate among HIV patients in Jos (Iroezindu et al., 2012), Uyo (Amadi et al., 2018), and Federal Medical Centre Keffi (Bashirat and David, 2018; Yahaya et al., 2020). Similarly, this aligns with the findings in North Central Nigeria and Osogbo where malaria prevalence among HIV-infected individuals was 16.2% and 18.5% respectively (Olusola et al., 2014; Inyama et al., 2016). Furthermore, findings from South Africa (Cohen et al., 2005), Mozambique (Saracino et al., 2012) and Cameroon (Sandie et al., 2019) have reported 36%, 61.7% and 14% respectively malaria prevalence among HIV seropositive patients. Subjects who attended Shabu PHC had the highest malaria prevalence of 22.85% (24/105) followed by subjects that visited Sandaji Clinic 10.00% (4/40) while Kowa Clinic subjects had the least malaria prevalence of 9.09% (5/55). Thus, the prevalence of malaria infection amongst HIV/AIDS outpatients in relation to the three (3) hospitals sampled showed a high significant difference ($\chi^2 = 15.574$, $df = 2$, $P = 0.0004151$). The observed variation in infectivity rates across the locations surveyed possibly suggest differences in microclimatic conditions of the areas as well as agricultural activities makes Shabu area to provide a very suitable breeding sites for malaria vectors over the other two locations. This is in tandem with the cross-sectional study on fine-scale variation in malaria prevalence across ecological regions in Madagascar by Rice et al. (2021) who revealed that in localized hotspots, malaria prevalence varied more than 10-fold between nearby (< 50 km) communities in some cases.

Table 1. Prevalence of *Plasmodium* Parasite in Just Walk-in HIV/AIDS Outpatients

Health Facility	No. Examined	No. Infected	% Infected
Shabu PHC	105	24	22.86
Kowa Hospital	55	5	9.09
Sandaji PHC	40	4	10.00
Total	200	33	16.5

Sex-and-Age Groups Wise Prevalence of Plasmodium Parasite

Malaria prevalence in relation to sex showed no significant difference ($\chi^2 = 0.09467$, $df = 1$, $P = 0.7583$). This agrees with the finding by Njila et al. (2022) who obtained no variation in malaria infection between sex among patients of two government hospitals in North Central Nigeria.

Although *Plasmodium* parasite infectivity was more in females 20 (17.24%) than males 13 (15.48%) as shown in Table 2. This could be as a result of their late evening household chores such as cooking which usually coincides with the feeding time of the malaria vectors hence predisposes them to mosquito bites. The result of this study correlates with the findings of Unata *et al.* (2015) and Mac *et al.* (2019) who reported higher malaria prevalence in females than males infected with HIV/AIDS in studies conducted in Usman Danfodiyo University Teaching Hospital, Sokoto State and the National Hospital Abuja respectively. On the contrary, findings of Yahaya *et al.* (2020) recorded higher malaria prevalence in males than female subjects attending Antiretroviral Therapy (ART) in a health care facility in Central Nigeria.

Age group 20-29 years had the highest malaria prevalence 7.50% (15/75) followed by the age group 30-39 years 6% (12/97) then 10-19 (3/7) and 40-49 years (3/13) with a prevalence rate of 1.5% each while age groups 50-59 and ≥ 60 years had no malaria infection 0.00% (0). Hence, the prevalence of malaria in relation to age groups showed a high significant difference ($\chi^2 = 18.682$, $df = 5$, $P = 0.002203$). The pooled result of age groups 20-29 and 30-39 years having the highest malaria prevalence over other age groups could be attributed to the fact that they are the most socially active age groups who are most likely to engage in outdoors social activities late into the night hours thereby making themselves vulnerable to the exophagic behaviour of malaria vectors. Also, the zero-malaria prevalence among age groups 50-59 and ≥ 60 years old HIV/AIDS subjects could possibly be as a result of the active immune response being experienced in these age groups as well as a general reduction in economic activities within these age groups would support their immunity as well as reduce their chances of being exposed to malaria vectors outdoors. The result of the study concurs with the works of Goselle (2009) who reported age group 21-30 years as having the highest malaria prevalence among HIV/AIDS subjects. The result of this study did not align with the findings of Unata *et al.* (2015) and Bashirat and David (2018) who found high prevalence in age groups 0-10 and 11-20 years respectively.

Table 2. Prevalence of *Plasmodium* Parasite in Relation to Sex and Age Groups of the Volunteers in the Selected Hospitals

Age group (years)	Sex				Total No. Examined	Total No. Infected (%)
	Female		Male			
	No. Examined	No. Infected (%)	No. Examined	No. Infected (%)		
10-19	6	2 (33.33)	1	1 (100.00)	7	3 (1.50)
20-29	40	11 (27.50)	35	4 (11.43)	75	15 (7.50)
30-39	64	5 (7.81)	33	7 (21.21)	97	12 (6.00)
40-49	4	2 (50.00)	9	1 (11.11)	13	3 (1.50)
50-59	1	0 (0.00)	4	0 (0.00)	5	0 (0.00)
≥ 60	1	0 (0.00)	2	0 (0.00)	3	0 (0.00)
Total (%)	116	20 (17.24)	84	13 (15.48)	200	33 (16.50)

Education Wise Prevalence of *Plasmodium* Parasite

Prevalence of *Plasmodium* Parasites on Potential HIV/AIDS subjects in relation to educational qualifications is shown in Table 3. No significant difference ($\chi^2 = 3.7247$, $df = 3$, $P = 0.2928$) was observed in malaria prevalence in relation to educational qualifications of the potential HIV/AIDS subjects. Nevertheless, subjects with tertiary educational qualification were the most infected (25%) followed by primary school subjects (15.78%) then subjects with informal training (15.55%) whereas secondary school (post-primary or high school) leavers had the lowest malaria prevalence (15.38%).

The lack of variation in malaria prevalence across all subjects' educational status possibly suggests that malaria vectors endophagic and exophagic behaviour have no regard for subjects' educational background, they feed on anyone and everyone. Also, the cutting across of malaria infection on all subjects in this study is probably due to subjects' lack of access to improved preventive measures (i.e. limited number of long-lasting insecticide-treated bed nets) and inadequate prophylactic treatments by agencies responsible for malaria control in the area. This is not in accordance with the report by Yahaya *et al.* (2020) who opined that those with non-formal education were the most malaria infected group (61.5%) while those with tertiary education had the least malaria prevalence of 30.8%.

Table 3. Prevalence of *Plasmodium* Parasite in Potential HIV and AIDS Subjects in Relation to Educational Qualification

Educational status	No. Examined	No. Infected	% Infected
Informal	45	7	15.55
Primary	57	9	15.78
Secondary	78	12	15.38
Tertiary	20	5	25.00
Total	200	33	16.5

Parasitemia in Just Walk-In HIV/AIDS Subjects in Relation to Sex

Malaria parasitemia between sex of potential HIV/AIDS subjects showed no significant difference ($\chi^2 = 0.0027352$, $df = 1$, $P = 0.9583$). Though parasitemia was high in females (11.55%) than male counterparts (11.30%). The lack of variation in malaria parasitaemia (i.e. the number of parasitized RBCs) in female and male HIV infected subjects possibly suggests that both sexes have the same immunosuppression level. This is not in tandem with the findings of Iroezindu *et al.* (2012) who reported high malaria parasitemia in male than female HIV infected patients.

The Association between Malaria Infection and Packed Cell Volume Status of Just Walk-In HIV/AIDS Subjects

Subjects whose PCV range was 30-34% had the highest malaria infection (28.57%) followed by 25-29% (18.08%) and 35-39% (7.40%) respectively, while PCV range of 20-24% and 40-44% had no malaria infection (Table 4). Hence, there was a very high significant difference ($\chi^2 = 56.763$, $df = 4$, $P = 1.387 \times 10^{-11}$) in malaria prevalence in relation to the various PCV groups of the subjects. The observed variation possibly suggests malaria infection usually thrives in anemic subjects that is those whose PCV is below the normal range <35% as seen in this study. This is in consonance with the studies that was done in the city of Zaria, Nigeria where women that had PCV <30% were highly infected (42.9%) than those with normal PCV (16.2%) (Obed *et al.*, 2021). The result of this study was not in agreement with the work by Onyenekwe *et al.* (2008) who found dominant malaria infectivity prevalence of 24.81% among individuals who were within the normal PCV range of 36–38%.

Table 4. The Association between Malaria Infection and Packed Cell Volume Status of Just Walk-In HIV and AIDS Outpatients

PCV Range (%)	No. examined	No. infected	% Infected
20-24	10	0	0
25-29	94	17	18.08
30-34	49	14	28.57
35-59	27	2	7.40
40-44	20	0	0
Total	200	33	16.50

CONCLUSION

The hundred percent (100.00%) HIV infection recorded from the just walk-in subjects (naive) in this study is of great public health concern that calls for urgent response among policy makers and stakeholders on the dynamics of current HIV infection status in the metropolitan city of Lafia in order to curb the continuous rapid spread. This study shows that malaria infection was present in about one-fifth (20.00%) of the HIV/AIDS positive subjects recorded. Also, *Plasmodium* infection rate varied across age groups, localities and PCV ranges but this was not the case for educational status as well as sex of the subjects. Parasitemia was more in the infected females than males though showed no variation in immunosuppression level. The individuals whose PCV level fell below the standard range were mostly infected with malaria. It is recommended that inhabitants of Lafia metropolis who indulge in promiscuous activities should always use protection so as not to contract HIV infection. Also, the subjects and all the inhabitants of the metropolitan city of Lafia should endeavor to protect themselves against human-vectors contact through the use of all forms of protection such as sleeping under insecticide-treated bed nets.

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