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Original Article

Plasmodium falciparum AND *Plasmodium malariae* AMONG HIV-INFECTED INDIVIDUALS IN NORTH CENTRAL NIGERIA

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ABSTRACT

Malaria is a leading cause of disease burden in Nigeria, although surprisingly few contemporary, age-stratified data exist on malaria epidemiology in the country. Transmission of *Plasmodium falciparum* and *P. malariae* among HIV – infected individuals was studied in Jos, Central Nigeria to ascertain the prevalence of malaria and HIV infection with a specific focus on how risk factors differ between demographic groups. Blood samples were collected from individuals by venepuncture in tubes containing Ethylene diamine tetra acetic acid (EDTA). Thick and thin blood smears were made and stained with Giemsa. These were screened for HIV and microscopically examined for malaria parasites according to standard procedure. The demographic data of the patients were obtained and documented. Out of 933 HIV-infected individuals screened for *Plasmodium* parasites, an overall malaria prevalence of 16.2% (151/933) was observed. Of this number, 120(12.8%) were infected with *P. falciparum*, 28(3.0%) were infected with *P. malariae* while 3(0.3%) had mixed infections. *P. falciparum* and *P. malariae* were found more in patients under 15 years of age (33.3%). Malaria was least common among the 15-25 year old age group (14.2%, 95% CI: 7.6- 20.8%). There was however no significant difference ($P>0.05$) in the *Plasmodium* species distribution among the different age groups (Cal $\chi^2 = 7.6187 < \text{Tab } \chi^2_{0.05}$, $df_5 = 11.07$). This study showed that HIV/AIDS, *P. falciparum* and *P. malariae* are prevalent within the population and calls for concerted effort and intervention by the Government.

Keywords: *P. falciparum, P. malariae*, Mixed infection, Malaria, HIV.

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INTRODUCTION

Despite decades of aggressive control efforts to combat malaria and Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), the two deadly diseases remain the most prevalent infections in sub-Saharan Africa (Nwuzo *et al.,* 2013; Uju *et al.,* 2013). Malarial and HIV/AIDS infections exhibit an overlapping characteristics, in terms of their geographical distribution and resultant rate of co-infection (Sarah and Kami, 2009), which make them major public health problems, especially in tropical countries (Baron *et al*., 1994). Together, they accounted for over 3 million deaths in 2007 (WHO, 2008; UNAIDS, 2014), and millions more are adversely affected each year (Sarah and Kami, 2009). Currently, it is estimated that 22 million (20.5 million – 23.6 million) Africans are infected with HIV (UNAIDS, 2008) and at least 500 million suffer from malaria each year (CDC, 1994). The two diseases have been identified as diseases of poverty and contribute to poverty by affecting young people who would have otherwise entered the workforce and contribute to the development of their local community (Sarah and Kami, 2009).

Malaria is caused by parasitic protozoan of the genus *Plasmodium* (*Plasmodium ovale, Plasmodium vivax, Plasmodium falciparum, Plasmodium malariae and Plasmodium knowelsi*) and is transmitted through the bite of an infected female *Anopheles* mosquito (Amuta *et al*., 2012). It remains a life - threatening vector borne disease and has a significant impact on the economic development of most tropical and sub-tropical countries (WHO, 2008; Okwelogu *et al.,* 2012). Of the four *Plasmodium* species that infect humans, *P. falciparum* is the most virulent followed by *P. malariae* and is responsible for the majority of morbidity and mortality due to malaria (WHO, 2008; Sarah and Kami, 2009). *P. falciparum* has been reported to stimulate HIV replication through the production of cytokines (interleukin 6 and tumor necrosis factor) by activated lymphocytes (Whitworth *et al.,* 2000). The geographical distribution of both species is widespread and likewise differs in transmission-time (Molineaux *et al*., 1980). For novel control measures, there is need to follow the trend of transmission of both species.

Worldwide, 1.2 billion people are at risk of malaria infection, resulting in 500 million infection and more than 1 million deaths each year (Abdullahi *et al.,* 2015), 90% of such deaths occurring in sub-Saharan Africa (Amuta *et al.,* 2012). Those who are at risk are young children, pregnant women and HIV/AIDS patients whose immunities are compromised (Dada, 2015). In Africa, malaria causes approximately 20 percent of all child deaths. Some children suffer an acute attack of cerebral malaria that quickly leads to coma and death; others succumb to the severe anaemia that follows repeated infections or to the consequences of low birth weight caused by malaria infection while in the mother's womb. Malaria during pregnancy has resultant effects on maternal health and birth outcomes. Malaria has a crippling influence on the continent's economic growth and perpetuates vicious cycles of poverty. It costs Africa US $10 billion to $12 billion every year in lost Gross Domestic Product -even though, it could be controlled for a fraction of that sum (UNICEF, 2015). In Nigeria, where the malaria situation has little changed, almost 60 million people (about 50% of the population) experience one episode of malaria or the other during the year and the disease kills over 200,000

people annually mainly infants below the age of five (WHO, 2008).

Human Immunodeficiency Virus (HIV) is a lentivirus (family: Retroviridae) and is the major etiological agent of Acquired Immunodeficiency Syndrome (AIDS), a condition in humans in which the immune system begins to deplete, leading to life threatening opportunistic infections (Nwuzo *et al.,* 2009; Nwuzo *et al.,* 2013). The disease has spread over the last 3 decades and has a great impact on health, welfare, employment and criminal justice sectors; affecting all social and ethnic groups throughout the world (Awoyemi and Olusegun, 2016). As at December 2014, the estimated overall number of people living with HIV (PLWHIV) was approximately 36.9 (34.3- 41.4) million and sub-Saharan Africa was the most affected region, having 25.8 (24.0 – 28.7) million PLWHIV and 66% of all people with HIV infection living in the region (Joint United Nations Global Fact Sheet, 2015). According to UNAIDS report (2014), 9% of people living with HIV globally reside in Nigeria. Notwithstanding the progress in institutional reforms and political commitment to tackle the disease in Nigeria, the country still habours more citizens being placed on life - saving medication of active antiretroviral therapy (AART) to increase the survival of such HIV seropositive individuals (Nigeria National Agency for the control of AIDS, 2012). Although, the availability of a number of HIV intervention and use of antiretroviral medicines have reduced AIDS disease and spread of the virus by half, the disease is still without cure and preventive vaccine does not appear feasible in the very near future (UNAIDS, 2008). The overlapping features of malaria and HIV/AIDS has established the fact that people living with HIV/AIDS are at increased risk of clinical malaria and severe illness, and HIV infection can decrease the protection offered by anti-malarial treatment (Amuta *et al.,* 2012). Malaria contributes to a temporary increase in viral load among HIV- infected people which may worsen clinical disease and increase mother to child transmission (Corbelt, 2012). Besides, malaria causes anaemia which often requires blood transfusion, a procedure that increases the risk factor for HIV infection, where universal blood screening has not been achieved. Thus, these relationships make case for full understanding of opportunistic infections especially malaria parasites in HIV infections, bearing in mind the consequences of their co-infection. This study was, therefore designed to assess the malaria parasites associated with HIV infection in individuals in Jos, North-central, Nigeria.

MATERIALS AND METHODS

Description of Study Area and Population

This study was conducted at the Laboratory for AIDS and Leishmaniasis Research, Jos University Teaching Hospital (JUTH) and International Centre for Scientific Culture (ICSC) World Laboratory (AIDS Research Centre for West Africa) located at the Plateau Specialist Hospital, Jos. The two study areas also served as reference Centres for North-central Nigeria, including some parts of the Federal Capital Territory Abuja. Jos Plateau is located in the middle belt zone of Nigeria and situated in the northeastern part of North-central Nigeria. It is situated approximately between Latitudes of 57^0N and Longitudes 8^0 55'E. There is sparse vegetation on the landscape which is mostly rocky, but with chains of hills and many captivating rocky formations. The temperature and other climatic conditions make Jos the nearest

equivalents to that of Europe and America.

The participants were HIV positive individuals attending Plateau Specialist Hospital, Jos. Informed consent was sought from each participant in the study and ethical clearance was obtained from the Management of the Jos University Teaching Hospital (JUTH). The following information was collected from each patient: age, sex and occupational status. Respondents were likewise educated on the details of the significance of the study.

Parasitological Assay

Blood samples were collected aseptically by venepuncture after swabbing the area with 70% alcohol (Nwuzo *et al.*, 2013). Five (5) mls sterile syringe was used to draw 5ml of blood sample from each patient, out of which 2mls and 3 ml was aseptically dispensed into sterile Ethylene diamine tetra acetic acid (EDTA) and sterile tubes, respectively (Cheesbrough, 2010) respectively. Thick and thin blood smear were made and stained with Giemsa. These were microscopically examined for malaria parasites according to methods described by WHO (1991) and Nwuzo *et al.* (2013).

Screaming of Human serum for HIV infection

For serodiagnosis of HIV infection, human sera were screened for HIV antibodies using the Enzyme-linked, immunosorbent assay (ELISA) technique on serum/plasma derived from blood obtained by venepuncture. The following HIV screening kits were used according to availability of supplies viz- Vironostika (Organon, Tekinka Corporation, USA); Capillus (Cambridge Diagnostic, Ireland) and Ricombigen (Cambridge Bristech Ltd, immunoblot/Western Blot assay (Biorad, Novapath, Diagnostic Group, USA). For all positive sera, at least one band of *gag* especially p24 and one band of *env* protein band gp120 or gp41 was present.

Data Analysis

Data obtained were analyzed using descriptive statistics. Ninety five percent (95%) confidence interval was used to establish the upper and lower limits for ranges of observations. Simple chi square (χ^2) tests were also applied to establish significant difference in the prevalence among the demographic features. The Z -test for proportions was used to compare prevalence differences in relation to gender. All analyses were performed using Microsoft excel 2007 and Statistical packages for Social Science, 21st version.

RESULTS

The result of the age-prevalence of *Plasmodium* species in HIV positive patients attending Plateau Specialist Hospital, Jos is detailed in Table 1. Out of 933 HIV positive patients screened for malaria parasites 151 (16.2) were positive. *Plasmodium falciparum* was more prevalent (12.8%) than *P. malariae* (3.0%). With respect to age group, the highest prevalence of both *P. falciparum* and *P. malariae* among the HIV positive individuals examined, were found in patients below 15 years of age (33.3%); this was followed by age group above 50 years of age. Mixed infection was recorded for age group 26-35 years, 36-45years and 46-50 years. The least prevalence was found among age group between 15-25 years of age. There was however, no significant difference ($P>0.05$) in the *Plasmodium* species distribution among different HIV positive age group (cal $\chi^2 = 7.6187$ (tab χ^2 0.05 df $_5 = 11.07$).

The sex prevalence characteristics of malaria parasites among HIV positive

patients attending Jos Plateau specialist Hospital is presented in Table 2. The prevalence of malaria parasite in relation to sex revealed that the females had higher prevalence rate (16.4%) than males (15.9%). With respect to parasite species, there was high prevalence of *P. falciparum* among the male subjects (13.6%) that in female subjects (12.3%). The reverse was the case for *P. malariae*; where female subjects recorded higher prevalence (3.9 %) than male subjects (1.8 %). A statistically significant difference was observed in malaria infection between male and female HIV positive patients.

According to occupational status, the prevalence of *Plasmodium* species among HIV positive individuals attending Jos Plateau Specialist Hospital is presented in Table 3. The highest malaria prevalence was recorded among the business class 38 (20.7%), followed by job seekers 8 (18.6%), civil servants 62(17.7%) and farmers 3(17.6%). Farmers were the most infected with *P. falciparum* (17.6%) followed by people in business (16.8%) and applicants (16.3%), while *P. malariae* was most common among student subjects (4.2%). There was however no statistical significant difference ($P>0.05$) in malaria parasite prevalence among the different occupational status of the subject examined ($df_{10} = 18.31$).

Table 1: Age-Related Prevalence of *Plasmodium* Species in HIV-Infected Individuals.

Age Group		No. (%) Positive				
(yrs)	No. Screened	*P.f*	*P.m.*	Mixed	Total	95% C.I
<15	3	1(33.3)	1(33.3)	0(0.0)	2(66.7)	12.3-121.1
15-25	133	12(10.6)	4(3.5)	0(0.0)	16(14.2)	7.6-20.8
26-35	405	49(12.1)	10(2.5)	1(0.2)	60(14.8)	11.2-18.4
36-45	321	42(13.1)	10(3.1)	1(0.3)	53(16.5)	12.3-20.7
46-50	63	11(17.5)	1(1.6)	1(1.6)	13(20.6)	10.4-30.8
>50	28	5(17.9)	2(7.1)	0(0.0)	7(25.0)	8.6-41.4
Total	933	120(12.8)	28(3.0)	3(0.3)	151(16.2)	13.8-18.6

P.f- P. falciparum; P.m- P. malariae; Mixed- *P. falciparum* and *P. malariae.*

Table 2. Sex-Related Prevalence of Malaria Parasites Among Patients Infected With HIV.

		Malaria Positive (%)				
Sex	No. examined	*P.f*	*P.m*	Mixed	Total	95% C.I.
Male	397	54(13.6)	7(1.8)	2(0.5)	63(15.9)	12.3-19.5
Female	536	66(12.3)	21(3.9)	1(0.2)	88(16.4)	13.2-19.6
Total	933	120(12.9)	28(3.0)	3(0.3)	151(16.2)	13.8-18.6

P.f- P. falciparum; P.m- P. malariae; Mixed- *P. falciparum* and *P. malariae.*

Table 3. Prevalence of *Plasmodium S*pecies by Occupation in HIV Positive Individuals.

Plasmodium Species Occupation	No. Screened	*P. f (%)*	*P. m (%)*	Mixed (%)	Total (%)
Civil servants	350	49(14.0)	11(3.1)	2(0.6)	62(17.7)
Business	184	31(16.8)	7(3.8)	0(0.0)	38(20.7)
Housewife	119	9(7.6)	4(3.4)	0(0.0)	13(10.9)
Students	72	9(12.5)	3(4.2)	0(0.0)	12(16.7)
Job Seekers	43	7(16.3)	1(2.3)	0(0.0)	8(18.6)
Force	39	2(5.1)	1(2.6)	0(0.0)	3(7.7)
Farmers	17	3(17.6)	0(0.00)	0(0.0)	3(17.6)
Clergy	4	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Self -employed	60	6(10.0)	0(0.0)	0(0.0)	6(10.0)
Drivers	28	2(7.1)	1(3.6)	0(0.0)	3(10.7)
Others	17	2(11.8)	0(0.0)	1(5.9)	3(17.6)
Total	933	120(12.9)	28(3.0)	3(0.9)	151(16.2)

DISCUSSION

In sub-Saharan Africa, which is a malaria endemic area, HIV - infected individuals are at greater risk of malaria and HIV co-infections. This increases the incidence and severity of clinical malaria and the infection has been found to double the risk of malaria parasitaemia in clinical malaria (Nwuzo *et al.,* 2013; Patnaik *et al.,* 2014). The overall malaria prevalence in this study was 16.2% which is lower than the report of Tatfeng *et al.* (2010) who recorded high prevalence rate of malaria (88.8%) in HIV infected individuals in Benin city. This finding doubled previous findings in the same area, where prevalence rate of 32.0% was recorded (Goselle *et al.,* 2007). This may be attributed to varying malaria-transmission pattern and/or variation in socio-economic and hygiene characteristics of the subjects examined (Patnaik *et al.,* 2014).

In the present study, the prevalence of *P. falciparum* was higher (17.8%) than that of *P. malaria* (3.0%). This is in line with previous works in Nigeria, where *P. falciparum* was the most prevalent malaria parasite reported (Hoffman *et al.,* 1999; Simooya *et al.,* 1988; Nwuzo *et al.,* 2013). *Plasmodium falciparum* is the most important cause of malaria infection and is responsible for about 80% of the malaria reported cases and 90% of deaths (Alvaro *et al.,* 2015).

The prevalence of malaria parasite among HIV positive individuals was highest in patients below 15 years of age. This may be due to irregularity in the sample size of each age group and/or otherwise due to their low immune response to parasite invasion. Dutta and Bharttacharqua (2008) reported that malaria infection is high in younger age group. Age has been identified as a co-factor in disease progression, and the immunity to malaria and HIV-infection has been shown to be age -dependent (Wisapa *et al.,* 2001; Awgu, 2009). By implication, infants thus suffer a disproportionately high rate of infection than older persons. On the other hand, Uneke *et al.,* (2005) reported lower malaria infection rate (13.3%) among HIV positive individuals below 20 years of age in the study area. This disparity in the findings could be attributed to the seasonal variation of the transmission pattern of malaria in Jos and its environs.

Malaria was significantly more prevalent among females (16.4%) than in males (15.9%). This may be due to

the fact that females in this area are more exposed to infected female *Anopheles* mosquito bites compared to their male counterparts They also stay out doors during mosquito-biting hours carrying out domestic activities. The finding in this study is similar to the work of Dada (2015) who reported a higher infection rate in females than males. This is however, in contrast to the findings of Bonilla and Rodrigvez (1993) where males had a higher malaria parasite infection rate than females.

Plasmodium falciparum malaria was found to be higher among farmers (17.6%) than in other occupations while *P. malariae* occurred more among students (4.2%). The relatively high malaria prevalence among farmers could be due to frequency of exposure to *Anopheles* mosquitoes and/or staying outdoors, particularly during the hot seasons. Also, it may be due to increased rate of mosquito-man contact during farming activities (Inyama *et al.,* 2003).

CONCLUSION

The high level of malaria and HIV reflected in this study suggests that both diseases pose a serious public health problem in the Jos area, central Nigeria. The spread of HIV was reported to have reached a high level in Nigeria (>5%) and would therefore require urgent intervention to curb its endemicity. This study identified job seekers, businessmen, civil servants, farmers and drivers as HIV and Malaria risk groups. There is therefore the need for a concerted action across HIV and Malaria disease control programmes. This will tackle the various socio-cultural practices that enhance spread of infection as well as inculcate behavioural change in the populace. This study shows that HIV /AIDS is prevalent within the population and calls for concerted effort by the government, policy makers and indeed all and sundry to intensify efforts in developing novel and effective policies and services needed to reduce the substantial disease burden among the general population.

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