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Distribution of *Plasmodium falciparum* Infection in Relation to Socio-Demographic Variables of Subjects in Benue State, Nigeria.

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ABSTRACT

The morbidity and mortality of malaria have continued to pose serious health challenges to the health sector in the sub-Saharan Africa, including Nigeria. The scourge of this disease has continued unabated despite series of control interventions to reduce the spread. This study was therefore, conducted between April and August, 2018 to evaluate some selected socio-demographic variables that may be associated with the distribution of *Plasmodium falciparum* infection in the study area. Finger pricked blood samples were obtained from 510 volunteered participants across the three senatorial districts of Benue State. Thick blood films were prepared on grease free slides, air dried and stained with Giemsa for 10 minutes. The smears were examined on light microscope using oil immersion. A standard questionnaire was also structured and administered to participants to generate data on their socio-demographic status. A total of 454 (89.0%) participants out of the 510 examined were infected with *Plasmodium falciparum* across the study area. Female subjects were more infected (89.9 %,) with *P. falciparum* than their male counterparts (88.2 %,). There was a significant difference ($P < 0.05$) in malaria parasite infection among participants that had primary education (97.4%) and those with tertiary education (74.4%). For occupation, traders had the highest (99.2%) infection with the malaria parasite while teachers had the least infection (69.0%). The difference in *P. falciparum* infection across the different occupations was statistically significant ($P < 0.05$). A significant difference ($P < 0.05$) in *P. falciparum* infection also existed among participants that were married (91.6%) and those that were single (35.3%). There were insignificant differences ($P > 0.05$) in *P. falciparum* infection among the different household's monthly income, family size, age and gender respectively. All the socio-demographic variables associated with the distribution of malaria in this study were linked to poverty hence, the need to intensify more free malaria interventions targeting the poor and vulnerable in the Benue communities and beyond.

KEYWORDS: Social variables, Demographic variables, Malaria, Benue, Nigeria.

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INTRODUCTION

Though, morbidity and mortality due to malaria are declining globally, malaria is still a major challenge for the public health sector and socio-economic development especially in the Tropics including Nigeria (WHO, 2020). Malaria has continued to be a health challenge especially among sub-Saharan African countries including Nigeria, despite the numerous interventions to curtail the burden of malaria (Benjamin *et al*., 2019). Series of interventions through the use of insecticide treated mosquito nets, indoor

spraying with residual insecticides and Artemisinin-based Combination Therapy (ACT) have not been able to totally eradicate the scourge of malaria in sub-Saharan Africa (Dawaki *et al*., 2016). Nearly half of the world's population is at risk of malaria. Most malaria cases and deaths occur in the sub-Saharan Africa (WHO, 2020). By 2018, the African region was home to 93% of malaria cases and 94% of malaria deaths, with Nigeria having 25% of the worldwide malaria cases (WHO, 2020).

Malaria is a disease that is not just commonly associated with poverty but evidence suggests that, malaria is a significant cause of poverty and a major cause of hindrance to economic development (Worrall *et al*, 2005; Gollin and Zimmermann, 2007). They further reported that poverty has a great capacity of increasing the risk of malaria since those in poverty do not have the financial abilities to prevent or treat the disease. The economic impact includes costs of health care, days lost in education, working days lost due to sickness, decreased productivity due to brain damage from cerebral malaria and loss of investment and tourism (Greenwood *et al*., 2005). The disease has contributed so much of heavy burden to some countries, where it may be responsible for 30-50% of hospital admissions, up to 50% of outpatient visits, and up to 40% of public health spending (Ricci, 2012). For instance, It has been reported in Brazil that, Poor socio-demographic profile of the studied subjects was one of the main reasons for the occurrence of malaria among the population (Ferreira *et al*., 2012).

Malaria transmission has also been found to be severely affected by environmental factors such as climate, topography, rainfall, and socio-economic conditions of a particular population (Tesfaye *et al*., 2011; Ayele *et al*., 2013). Perhaps, Tropical countries like Nigeria are characterized with heavy rainfall, high humidity and warm temperatures making it conducive for mosquito breeding and malaria transmission. A study conducted in Nigeria by Amuta *et al*. (2014), Bawa *et al*. (2015), Oyefabi *et al*. (2015) indicated that, the increased risk of malaria infection among pregnant women could be related to illiteracy, low educational status, unemployment, low income and gravidity of the pregnant women.

The dynamics of malaria are better understood based on the native socioeconomic conditions to discover the role of local factors influencing malaria distribution in a particular geographical area (Ouedraoga *et al.*, 2018). A clear understanding of socio-demographic factors that influence the distribution of malaria is important for developing intervention for a more effective containment of the dreaded parasite in malaria endemic regions. This study therefore, investigated selected socio-demographic variables that may be associated with the distribution of *Plasmodium falciparum* in Benue State, North Central Nigeria.

Study Area

The study was conducted in Benue State, located in the North Central Nigeria. The state is located within Guinea Savannah belt with Makurdi as the Capital. It is characterized with the second largest river in Nigeria, River Benue and rainfall is experienced in the state between 900- 1000 mm annually. Benue State is characterized with intensive agricultural activities during the wet season (Amuta *et al.,* 2015). The state lies between longitude 7.47^{o} and 10^{o} East and latitude 6.25^{o} and 8.8^{o} North of the Equator. It shares boundaries with Nasarawa State to the North, Kogi State to the West, Taraba State to the East, Cross-river State to the South, and Enugu State to the Southwest respectively. The state is divided into three senatorial districts, namely: North-East (Zone A), North-West (Zone B) and the South district (Zone C) respectively.

Study Design

Random sampling technique was adopted for this study. From each of the senatorial districts, one general hospital was selected and the use of structured questionnaire was employed in the survey. General Hospital Katsina-Ala was selected from Zone A, General Hospital Makurdi from Zone B and General Hospital Otukpo from Zone C respectively. The study was conducted during the wet season between April and August, 2018.

Sample Size/Collection

A total of 510 volunteered participants whose informed consents were sought for and obtained, were included for the study.
Finger pricked blood samples from 510 subjects were collected from the volunteered participants after informed consent.

Microscopic Examination of Blood Samples

Blood samples were obtained from all the volunteered participants via the thumb prick technique. Thick films were prepared on pre-cleaned grease- free glass slides. Dacie and Lewis (2001) protocol for thick blood films preparation were adopted. The thick smears were stained with 10% Giemsa for 10 minutes. The stained thick blood smears were air dried and examined using light microscope with a high power oil immersion objective lens (X100) for the identification of malaria parasites (Dacie and Lewis, 2001; Ojurongbe *et al.,* 2013). Each slide was examined twice by different laboratory scientists before confirming it negative or positive. Slides on which disagreements were recorded were immediately re-examined for the third time before the final decision was arrived at (Koita *et al.,* 2012).

Questionnaire Survey

A well-structured multiple choice questionnaire was administered to volunteered participants for the purpose of collecting information on their socio-demographic variables in relation to malaria in the study area.

Data Analysis

Chi-square statistic was used to determine the significant differences in the infection rates among household's monthly income, family size, occupation, educational status and marital status. The same statistical tool was used to determine the significant difference between male and female subjects and between the different age groups. In all the analysis, p-values less than 0.05 were considered statistically significant.

RESULTS

A total of 510 subjects were examined for *Plasmodium falciparum* infection across the three Senatorial districts in Benue State. Meanwhile, 454 out of the total examined were infected (89.0%). Female subjects were more infected (89.9 %,) with *P. falciparum* than their male counterparts (88.2 %,) as depicted in **Table1**. There was no significant variation (χ^2=1.95, df = 2, P> 0.05) between female and male infection rates. Teenagers between the ages of 11 and 20 were more infected (89.6%), while the least infection was recorded among school age children {(<10 years) (77.8%)}. However, there was no significant difference (P > 0.05) in the malaria parasites' infection rate.

Table 1: Distribution of *P. falciparum* Infection by Microscopy in Relation to Sex and Age in Benue State.

	Number Examined	Prevalence in Makurdi (%)	Prevalence in Katsina (%)	Prevalence in Otukpo (%)	Total (%)
Sex					
Male	272	68(25)	85(31)	85(31)	**240(88.2)**
Female	238	67(28)	64(27)	85(36)	**214(89.9)**
Total	**510**	**135(26.5)**	**149(29.2)**	**170(33.3)**	**454(89.0)**
Age					
1-10	9	3(33.3)	2(22.2)	2(22.2)	**7(77.8)**
11-20	460	123(26.7)	132(28.7)	157(34)	**412(89.6)**
	41	9(22)	15(36.6)	11(26.8)	**36(87.8)**
	510	**135(26.5)**	**149(29.2)**	**170(33.3)**	**454(89.0)**

Sex: χ^2= 1.95, df = 1, P> 0.05; Age: χ^2= 2.33, df = 2, P > 0.05

The distribution of *P. falciparum* infection in relation to educational status and occupation using microscopy was determined as shown in **Table 2.** Participants with primary education had the highest infection rate (97.4%, 114/117) followed by participants without any education qualification (95.5%, 21/22). Participants with tertiary education had the least infection rate (74.4%, 119/160) followed by those with secondary school education (94.8%, 200/211). There was a significant difference (χ^2=151, df = 3, P < 0.05) in the distribution *of P. falciparum* infection across the educational status of participants. Distribution of *P. falciparum* infection according to occupation indicated that, traders had the highest infection rate (99.2%, 120/221) while the least infection was recorded among teachers (69.0%, 49/71) followed by civil servants (74.0%, 71/96). The results revealed that occupational status had a significant effect (χ^2=60.8%, df = 5, P < 0.05) on the distribution of *P. falciparum* infection in the study area.

Table 2: Distribution of *P. falciparum* Infection in Relation to Educational and Occupational status of Participants in Benue State.

Social- Demographic Characteristics	Number Examined	Number Positive	Percentage Infected (%)
Education			
None	22	21	95.5
Primary	117	114	97.4
Secondary	211	200	94.8
Tertiary	160	119	74.4
Occupation			
Farming	39	38	97.4
Trading	121	120	99.2
Civil Servants	96	71	74.0
Artisans	102	97	95.1
Teaching	71	49	69.0
Others	81	79	97.5

Education (χ^2= 151, df = 3, P < 0.05)
Occupation (χ^2= 60.8, df =5, P < 0.05)

The results, as presented in **Table 3,** shows that participants who had monthly income less than #30,000 had the highest *P. falciparum* infection rate (95.8%) compared to those who had their monthly income greater than #30,000 (86.9%). Though, there was no significant difference (χ^2 = 0.43, df =1, P > 0.05) in the infection rate among the participants based on the different household's monthly income. The highest infection rate (91.7%) was found among families with more than 10 members, while the least infection rate (88.4%) was recorded among families with less than 5 members. However, family size was found to have no significant effect (χ^2 = 1.17, df =2, P > 0.05) on the infection rates.

Participants who were not married had the least infection rate (35.3%), while married participants had the highest malaria infection rate (91.6%). The results showed that there was a significant difference (χ^2= 24.45, df = 2, P < 0.05) in the ***Plasmodium falciparum*** infection rate with respect to marital status.

Table 3: Distribution of *Plasmodium falciparum* Infection with Respect to Selected Socio-demographic Variables in the Study Area.

Variables	Number Examined	Number and (%) Infected	χ^2= (95% CI)
Household monthly income			
<#30,000 (NGN)	120	115 (95.8)	
≥#30,000 (NGN)	390	339 (86.9)	χ^2= 0.43, df =1, P > 0.05
Family Size			
≤5 Members	320	283 (88.4)	
6-10 Members	178	160 (89.9)	
>10 members	12	11 (91.7)	χ^2= 1.17, df=2, P > 0.05
Marital Status			
Married	478	438 (91.6)	
Not Married	34	12 (35.3)	
Divorced	6	4 (66.7)	χ^2= 24.45, df=2, P < 0.05

*NGN= Nigeria Naira (#)

*One (1) US$ Dollar = #360 Nigeria Naira.

DISCUSSION

There were equal chances of *P. falciparum* infection among all ages and gender in the study area. The malaria infection rate among male subjects was similar with that of females. This is contrary to the report of Adekunle *et al.* (2014) in Ogun State where there was significantly higher infection rates across age groups and gender. The close frequency of infection between males and females suggest that both sexes had similar susceptibility to mosquito vector bites and malaria parasite transmission Females could be more infected during pregnancy when they are known to have suppressed immunity as reported by Isah *et al*. (2014) and McLean *et al*. (2015). The slightly higher infection rate in females compared to males in this study is consistent with a study conducted in Kano Nigeria, where malaria infection was slightly higher in males (61.2%) than in their female (59.7%) counterparts (Dawaki *et al*., 2016). Studies conducted in Yemen (Al-mekhlafi *et al*., 2011), Tanzania (Winskill *et al*., 2011), and South Ethiopia (Loha and Lindtjorn, 2012) reported that, male subjects had higher malaria infection rates compared to their female counterparts due to exposure, inherent and cultural determinants. This report is contrary to the slightly higher malaria infection rates among gender in the present study. It could be deduced that the continuous exposure of male subjects to mosquito bites could have made them to develop partial immunity, hence making them to present with less clinical malaria cases, as similarly reported in Kenya (Smith *et al*., 1999; Kepha *et al*., 2016).

The pattern of *P. falciparum* infection across age groups demonstrated clearly that all age groups were susceptible, although the highest infection was recorded among teenagers between the ages of 11- 20 years while the least infection was found among children between 1 – 10 years. Exposure within, around and away from the house (outdoor activities) could account for the observed high malaria infection rate among teenagers. This observation was also reported in Kano, Nigeria, (Dawaki *et al*., 2016), where higher rates of malaria infection was found in teenagers between the ages of 12 and 17 years. This was attributed to exposure to mosquito bites because they engaged in more outdoor activities than their younger counterparts especially at night. The increase in infection rates was not proportional to increase in age in the present study, which is consistent with other studies in Ghana (Abeku *et al.,* 2008) and East African highlands (Acheampon *et al.,* 2011). This finding is however, not consistent with other studies conducted in Nigeria (Elechi *et al.* 2015), where an increase in susceptibility with increase in age was reported. A study conducted in Kenya by Kepha *et al*. (2016) reported that, *P. falciparum* infection reduces with increase in age, but yet this was also at variance with the findings in the present study. The reason for the variation may be due to differences in age groups and sample sizes considered in both studies.

There was a significant difference in the distribution of *P. falciparum* among participants of different educational and occupational groups in this study. Higher infection rates were recorded among participants with only primary education (95.5%) while the least infection rate was recorded among participants with tertiary education (74.4%). This was found to be partially consistent with the report of Kabirul *et al*. (2012) in Bangladesh. In their report, the level of education was significantly related to malaria prevalence in Zone 1 but not in Zone 2.

Contrary to the present study, Benjamin *et al*. (2006) reported that educational status and house type were not significantly associated with the distribution of malaria infection; though, those with only primary education still recorded the highest (37.3%) malaria parasite infection. The present study has revealed that traders had the highest infection rate (99.2%) followed by people with unspecified occupation (97.5%). The higher occurrence of malaria infection among traders and unspecified occupation could be attributed to ignorance about the transmission and control of malaria**,** lack of or improper use of Insecticide Treated Nets (ITNs) could have exposed participants to malaria parasite infections, poor sanitation and low social-economic conditions as found in this study have also been reported by Dawaki *et al*. (2016). Moreover, it has been reported that malaria and poverty are connected intimately, as malaria primarily affects low- and lower-middle income earners, where the poorest are affected most severely by malaria due to their poor socioeconomic and environmental status, and inadequate services for prevention, diagnosis, and treatment (WHO, 2014; Dawaki *et al*., 2016).

The least malaria infection in this study (69.0%) was recorded in teachers followed by civil servants (74.0%). Though these infection rates were high, they were lower as compared to those recorded in other occupations in the study area. The reduced malaria infection among teachers and other civil servants could be attributed to awareness on the control of malaria, financial capability and willingness to employ selected control measures such as buying and usage of ITNs, insecticides, window nets and others, as similarly reported by Loha and Lindjorn (2012);

Fana *et al*. (2015); Dawaki *et al*. (2016) respectively. Although, a contrary finding to the present study was reported by Benjamin *et al*. (2006), where civil servants had the highest (53.4%) malaria infection rate compared to the other occupations.

Although monthly income of the different households in the study area did not seem to play a significant role in the infection rates among the subjects, it was very vital in the distribution of malaria in this study. It was found that, low household monthly income of <#30,000 could be a predisposing factor for malaria infection. Low household monthly income has a great capacity of increasing the risk of malaria since those in poverty do not have the financial abilities to apply preventive measures, seek medical attention nor treat the disease. Findings in this study are consistent with the reports of studies conducted in South Ethiopia (Loha and Lindjorn, 2012), Eastern Uganda (Pullan *et al*., 2010) and Kenya (Noor *et al*., 2009; Kepha *et al*., 2016) where they separately but similarly reported that, malaria was more common among lower income earners who lived in poor housing and poor environmental conditions that increase their exposure to malaria infections. This is corroborated by the report of Dawaki *et al*. (2016) that families with low income probably could not afford indoor residual sprays and insecticides treated nets. Probably also that, low income families could not afford to build well-constructed houses, which could have exposed them to mosquito bites and subsequent high malaria infection rates. It was also reported that, residence of poorly built houses were more susceptible to malaria infection than residence in well-built houes in Uganda (Snyman *et al*., 2015) and Kenya (Ondiba *et al*., 2018).

The present study revealed that, an increase in family size was directly proportional to an increase in malaria infection. Families that were large in number had higher infection rates compared to families with smaller numbers. The least infection was found in families with ≤ 5 members. Higher *Plasmodium falciparum* infection associated with large family size may have been as a result of congestion of members, inability to afford the required health care among the numerous family members as also reported in Kaduna State, Nigeria (Benjamin *et al*., 2019). Higher infection rates of malaria parasites associated with large family size could be likened to the fact that most of the large families living in a household do not use insecticides treated nets; they are characterized with poor members who are mostly illiterates, living in poorly constructed houses. This is however, contrary to the report of Kabirul *et al*. (2012) in Bangladesh, where the number of family members residing within a household did not significantly influence malaria parasite's infection rates.

Plasmodium falciparum infection was significantly higher among married participants in this study. Consistent with the present study, Benjamin *et al*. (2019) reported that there was higher malaria prevalence (31.8%) among married participants than participants who were not married (16.0%) and or divorced (12.5%). The higher infection rate of malaria among married participants in this study may probably be as a result of inability of married participants to provide adequate health care to all members of the family, their attitude and congestion. Contrary to this finding, a research conducted in Cameroon (Anchang-Kimbi *et al*., 2015) reported that, many unmarried women were twice more infected compared with women that had husbands. They also reported that, single women had higher parasite densities compared with married women. Similarly, Mbu *et al*. (2014) reported in Yaounde Cameroon, that single women had a 4- fold higher increased risk of developing malaria during pregnancy because of young age less than 20 years and primigravidae which was also at variance with the finding in the present study.

CONCLUSION

The present study adds to the growing evidence of knowledge that educational status, occupation, and marital status may be significantly associated with the distribution of malaria in Benue State, Nigeria. Therefore, more malaria control interventions should be initiated to target the less privileged in the society. The study has revealed that improvement in the standard of living of the inhabitants of Benue State would go a long way in reducing the scourge of malaria in the area and beyond.

CONFLICT OF INTEREST

There was no conflict of interest amongst the authors.

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